Third Report of
Confidential Review of Maternal Deaths,
Kerala

WHY MOTHERS DIE

KERALA 2010-2020

OBSERVATIONS & RECOMMENDATIONS

Editors:
V P Paily, K Ambujam, Betsy Thomas
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Observations, Recommendations

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Message

'Why mothers die' - Third report - Kerala 2010 to 2020

My sincere congratulations to Professor Paily and colleagues from Kerala for conducting the important confidential inquiry and to have synthesised the findings into intelligent information to derive at recommendations that can help to reduce maternal mortality ratio (MMR) further. Kerala has achieved the SDG goals and has the lowest MMR in India and the region. Good standards of living, high percentage of literacy and committed health care has contributed to low MMR in Kerala. Adoption of recommendations in this report based on lessons learnt will help to reduce the MMR further. Part one of this report provides information on the background, continuing relevance of this inquiry and explains how the system works and the definitions used in this report. Part two provides the information on data followed by overview and summary which leads to key recommendations. Every healthcare personnel dealing with maternity care should read these recommendations to provide the best care for the women in pregnancy, labour and post-delivery. Part three deals with causes and solutions for individual problems such as haemorrhage, placenta accrete spectrum disorders, hypertensive disorders, sepsis, amniotic fluid embolism, cardiac disease in pregnancy, venous thromboembolism, neurological causes, respiratory and viral diseases, liver diseases, anaesthetic causes, renal diseases, early pregnancy problems, mental health and suicide and less common causes. This section provides greater insight into specific issues that can be overlooked and how prompt, appropriate action, cross consultation, multidisciplinary care and teamwork is essential for the best outcome.

Provision of appropriate antenatal care, safe management of labour, postpartum care, caesarean section, obstetric care in the periphery,

use of blood and blood products, management of disseminated intravascular coagulation, fluid resuscitation in shock and the use of antibiotics are discussed in section 4. This section provides the details of useful information that can be applied in many situations. Teenage pregnancies, accidents and travel related maternal deaths and near miss incidents are discussed in section 5. Section 6 provides information on follow up actions such as emergency obstetric care and life support, quality standards, obstetric rapid response team and maternal death and near miss surveillance and response. This section will help other countries and regions in India where there is no well organised audits or confidential inquiries to set health care systems that can 'measure' the quality of care and how the standards of care can be improved to eliminate preventable maternal death and near misses.

I commend this report to be read not only by maternity care providers and health administrators in Kerala, but by such personal in India and Globally.

Yours sincerely,

Sir Sabaratnam Arulkumaran
Past President of the RCOG, BMA & FIGO
29'th August 2021

Message

The moment we say MOTHER we bow our head with respect. This is universal. The fundamental principles of society make that a natural response. A society that gives utmost importance to the health of Mother is a society that marches towards overall wellbeing and prosperity.

The Government has recognized the importance of having focused attention to the health of the people and has initiated public policies, creating an enabling environment to take various measures. One such measure is a focused intervention for Maternal health and while taking this agenda forward a unique partnership is built in the State. The Department of Health and Family Welfare along with KFOG have been consistently taking constant efforts to understand the reasons affecting maternal health and taking various initiatives to tackle them. The contribution done by KFOG by bringing in technical insights has enabled the State to reach to less than 30 maternal mortality rate.

I am happy to note that an extensive research-based report is being published by the Maternal Fetal Medicine Committee, KFOG. This shows the strength of this partnership. In the State concurrently, technical audits are done regarding treatment provisioning, improvements done, capacity of functionaries built and serious cases management. Regularly the detailed study is done as to why any death has occurred. Even if it is an isolated case in interior, it gets recorded and in a scientific way, discussed at respective levels and necessary interventions are planned.

The society is indebted to all these functionaries who have been relentlessly working towards the objective of providing care and support.

I would like to mention that Dr V P Paily and all colleagues have been a great support to the initiatives taken in the area of maternal health and we would look forward to the continued support in strengthening the initiatives in health in general and maternal health in particular.

Dr Rajan Khobragade
Principal Secretary
Health and Family Welfare Govt of Kerala
Thiruvananthapuram

Foreword

It is a great pleasure, and privilege, to have been asked to write the foreword to this third edition of the deeply impressive, thought provoking and crucial report "Why Mothers Die-Kerala"; the result of the professionally led ongoing programme of confidential reviews of maternal deaths, now also including near-misses, in this beautiful State of India.

As I write I have in front of me a small replica of the Lamp of Knowledge I was privileged to light in Thiruvananthapuram in 2003 at the start of the process; at the very first workshop organised by Dr V P Paily to plan for the introduction of a state-wide maternal mortality review. I was there in my capacity as the Director of the UK Confidential Enquires into Maternal Deaths, the global gold standard for such audits, and the author and leader of the WHO global programme for maternal death and near miss reviews and audits " *Beyond the Numbers, reviewing maternal deaths and disabilities to make pregnancy safer*". As such I had by then already organised a number of Regional, Country or State workshops and have since had the honour to facilitate very many more, in every corner of the world. But the Kerala workshop has always stood out as one of the very best in which I have ever participated. I was struck by the willingness, openness, vigour and integrity of all the obstetricians and other health professionals who attended and by their commitment to work together, wisely and without recrimination, to improve the health of all Keralan mothers. I immediately knew that it would work, and would work well. And so it has proved.

Although any mother's death is one too many, and a tragedy of immeasurable proportions, sadly they continue to occur, with greater or lesser frequency in every country of the world. In Kerala, as this report shows, although there is still a way to go, the maternal death

rate is already impressively much lower than in other states or countries in the region, or indeed the rest of the middle-income world. And I am sure that much of this success lies with the generosity of spirit, professionalism, and commitment of the members of the Kerala Federation of Obstetrics and Gynaecology. They have selflessly, for no remuneration or personal gain, and in the best tradition of what I refer to as the "obstetric conscience", undertaken these reviews, which are not always easy or comfortable, and then reflected on what lessons they as individuals or team members could learn. And following on, as should happen with all such reviews, with much hard work they then turned the results into practice and developed strategies to improve other mothers' health outcomes as a result. In this report we see how such actions have led to the development and implementation of evidence-based guidelines, or even new equipments in the case of managing severe haemorrhage, as well as working in partnership with the Department of Health and their colleagues in the public sector, to develop wider beneficial maternal and new-born health care policies. Apart from such altruism, as Dr Paily says in his Preface, uniquely in the world as far as I know, this has also been achieved whilst working mainly in the private sector, an area of medicine not usually known to be conducive to encouraging the review of such critical incidents.

However, regrettably, this invaluable work will never be over. As more women's lives are saved by improved and more effective treatments for the traditional obstetric causes of maternal deaths, a growing number of mothers are affected by underlying medical or mental health conditions indirectly influenced by their pregnancy such as cardiac disease, neurological conditions, diabetes and now Covid 19. In global maternal health there is also a growing recognition of the impact a mother's social circumstances, and her vulnerabilities, may have on her own pregnancy outcomes and this is reflected in the findings in this report too. I applaud the review team for including deaths from suicides, something we started to do in the UK many years ago , and whose numbers fell significantly as a result. These are the most tragic of deaths as they usually go unreported and unnoticed in a world where the subject is still often taboo. Addressing and overcoming the social factors and determinants of ill health requires multi-disciplinary and inter-sectoral action on a broader number of fronts, which is one of the key recommendations in this report.

Clearly the lamp of knowledge that was lit all those years ago still shines brightly in Kerala today. It is my fervent hope that this shining example of how mother's lives can be saved through the successful implementation of Confidential Reviews into Maternal Deaths, will be transferred to other countries facing similar problems so that saving their own mothers lives becomes the reality that Kerala has shown to be possible. Bravo to you all.

Professor Gwyneth Lewis
OBE DSc MPH FRCOG FACOG

Ex Director of Maternal Health UK Department of Health Director UK Confidential Enquiries into Maternal Deaths 1991-2013

Director and Author "Beyond the Numbers"maternal death and disability audit programme for WHO Geneva

Foreword

Confidential review of maternal deaths is an accepted approach to prevent future maternal deaths. The United Kingdom of Great Britain and Northern Ireland have had an ongoing process of confidential enquiries into maternal deaths for most of the latter part of the twentieth century. Yet, implementing similar national confidential enquiries, particularly in low and middle-income countries with high burdens of maternal mortality continues to be challenging. As a former coordinator in the World Health Organization, my responsibilities included promoting accountability for maternal health globally, through implementation of Maternal Death Surveillance and Response. Although many low- and middle-income countries have tried to implement national maternal death review systems based on WHO recommendations, few have been successful. I am therefore inspired to see the Kerala Federation of Obstetrics and Gynaecology's (KFOG) achievements over the past two decades to establish and sustain state-wide confidential reviews of maternal deaths. It is indeed an honour to write this foreword to the ***Third Report of Confidential Review of Maternal Deaths, Kerala 2010 to 2020, Why Mothers Die, Kerala 2010- 2020, Observations, Recommendations***.

Maternal deaths are quite often under reported. I recall Professor Paily, the senior author of this report, sharing his personal experience during a regional WHO Meeting to discuss maternal death reviews, in Delhi in January 2003. His comparison of the numbers of maternal deaths in Kerala formally reported through the government system with newspaper reports of violence against health workers following childbirth in health facilities (often linked to maternal deaths), suggested that some deaths may not have been reported as maternal deaths.

With seed funding from WHO, Professor Paily and his colleagues set to work establishing the first state-wide confidential review of maternal deaths (CRMD) in Kerala. What is unique here is that unlike most other countries where governments establish the system, this CRMD was initiated by a professional society with backing from the state government. By continuing with implementation of the CRMD without external resources, KFOG has demonstrated the social conscience and deep commitment of the association and its members to improve maternal health.

The present report covers maternal deaths reviewed through the CRMD process over the last decade. In comparison to previous reports, the percentage of deaths reviewed among those reported to the state government has increased and includes data from seven in every 10 deaths reported. I hope this report will further encourage efforts to improve timely reporting and review of factors leading to maternal deaths and to learn lessons to prevent further deaths.

The report provides key summary points and recommendations for addressing the major causes of death. As in most low- and middle-income countries, haemorrhage and hypertension, remain the major causes of maternal deaths albeit lower than in most other states in India. Some actions to further improve management of complications in pregnancy and childbirth were initiated, for example, the training of doctors and nurses in management of emergencies and developing standards of care in association with the UK's National Institute of Clinical Excellence, as recommended in the previous CRMD reports. However, other measures, some of which are before arrival to the health facility such as improving the ambulance services have not been satisfactorily addressed. It is disappointing to note that although Kerala is globally renowned for its achievements in health, education, and equity, it lags other states in the availability of efficient emergency transportation. Postpartum haemorrhage can be fatal within two hours if not adequately treated.

This report that covers maternal deaths over a decade shows a declining trend in maternal mortality, currently estimated to be 28, and this is encouraging. It is possible that actions based on the previous reports contributed to the declining trend. However, there are areas for consideration in the future. For example, why is the maternal mortality still an estimate and not based on actual counts of maternal deaths? Should we not collect evidence to understand what actions will and will not reduce maternal mortality in the Kerala context? To what extent have actions in response to recommendations in previous reports contributed to the improvement in maternal survival. The recently initiated Maternal Death and Near Miss Surveillance and Response at district level should provide opportunities to address some of these questions, including better counting of deaths, more timely identification and management of locally relevant issues, and in quicker implementation of actions to prevent similar deaths. The implementation of the remedial actions and its outcomes, the challenges faced, and the solutions used to address them should be documented and shared going forward.

Given the challenges faced in many low- and middle-income countries in implementing CRMDs, this report should be a globally relevant resource for everyone committed to improving maternal health. It should be widely shared with the central and state governments in India, with professional societies, academic institutions, civil society organizations and international partners.

Matthews Mathai
Former Co ordinator Maternal Health
WHO Geneva

Foreword

Due to historical reasons Kerala has had good indicators of mortality, including maternal mortality. This is a creditable achievement, but it has two disadvantages: most of the cost-effective interventions that get best results have already been integrated into normal practice and more difficult ones are left to be implemented; there are no precedents to guide policy as most low- and middle-income countries are yet to reach this level and the strategies of high-income countries are difficult for a fiscally stressed state to replicate. So, Kerala had to design their own strategies. A necessary condition for reducing mortality is to know its major causes. The Confidential Review of Maternal Deaths (CRMD) commenced by the Kerala Federation of Obstetrics and Gynaecology (KFOG) in partnership with the Government of Kerala in 2004 and the reports that summarise the findings of the review has consistently provided evidence to guide gynecologic and obstetric policy and practice in the state.

The CRMD is unique in many ways. More than 70% of obstetric service is provided by the private hospital who have no connection to each other or to government. A confidential review undertaken voluntarily by the KFOG as part of a learning process to improve practice of its members is remarkable in a state where even teaching hospitals do not undertake systematic audit of deaths and near misses. There is no other instance of a professional association working closely with government to generate evidence to guide policy and government modifying policy in response to the evidence so generated.

The decade from 2010 to 2020 covered by this review saw many new initiatives. Kerala developed the Quality Standards in Obstetric Care, in partnership with NICE International and leading specialists in government and private sector. Kerala announced the target to reducing MMR to less than 30 by 2020 and less than 20 by 2030. In

order to improve the effectiveness of the process as a learning tool, review of near miss was added to the review. Monthly review and discussion were started at district level chaired by the District Collector, under mentorship of state level experts, to involve obstetricians in peripheral centres. These changes have created powerful tools that can help reduce MMR further.

From the data presented in the report it is obvious that much remains to be done. Hemorrhage still remains the major cause of avoidable mortality in spite of proven strategies to manage it. Deaths from hypertensive disorders of pregnancy have shown a declining trend. It is worrying that the epidemic of depression now sweeping through the state is reflected in the large number of suicides of pregnant women. As the epidemiological profile changes even for the younger age cohort and as women are disproportionately affected by the factors inducing non communicable diseases, such as lack of exercise, obesity and poor diet, and beneficiaries of life enhancing interventions such as surgery for congenital heart disease and treatment for genetic disorders become more common, new threats may emerge for obstetricians.

New threats require novel solutions, most of them in public health, primary care and organisation and financing of health. Mapping of populations to primary care providers, in PHCs and private sector, will ensure that people are followed up through life course consistently by the designated primary care team and threats from childhood or adolescents, available in primary care records, are available to obstetricians. This calls for greater integration of obstetric services with primary care teams. This would be assisted by development of Electronic Health Records, which Kerala had initiated and has now come to a standstill. As an interim arrangement, if the antenatal care module of e Health is made operational and made available to the obstetrician, who is also provided with digital tools to capture the progress of labour, the combined data base will become a powerful tool for confidential review in future. It also opens the possibility of having AI (Artificial Inteligence) backed decision support systems to support the obstetrics team. Developing a cadre of obstetric nurses will add to the capacity of the obstetric team to handle the case load. As part of ensuring male responsibility for reproductive health, the birth companion programme should be promoted by all obstetricians.

Government should also offer families the option to have the cost of every delivery met through the Karunya Arogya Suraksha Padhathi (KASP) so that there are no financial barriers to accessing good quality Obstetric services. Currently there is a tendency to access obstetric care even for normal deliveries at tertiary care centres, leading to high workload in these centres, while secondary hospitals remain underutilised. This also pushes up the cost of obstetric services in the state. This occurs due to fear of rare complications that may arise even in pregnancies with low risk factors. This can be removed if all obstetric centres are served by an efficient transport system where ambulances, with trained attendants, are available for inter facility transfer to higher centres if and when needed. Kerala is committed to reduce MMR to less than 20 by the next decade. This is doable but calls for a transformation of current approach to women's health and labour room practices. It also calls for policy makers to rethink the organisation and financing of health system in the state.

I congratulate and thank the members of the KFOG who have dedicated their time and effort to the cause of ensuring that our mothers do not die, if the death can be prevented.

Rajeev Sadanandan IAS
Former Aditional Chief Secretory Health,
Goverment of Kerala

Preface

We bring out the third edition of Why Mothers Die – Kerala with a sense of accomplishment. The Kerala Federation of Obstetrics and Gynaecology (KFOG) along with the Government of Kerala had declared a target of achieving Maternal Mortality Ratio (MMR) of 30 by the year 2020. As per available data, by March 31st 2020, we could achieve that. It is not the achievement of a single person or organization; it is the outcome of a large group of individuals who willingly worked together with the agenda of avoiding all preventable maternal deaths. The support of the government of Kerala extended through Sri Rajeev Sadanandan the Health Secretary for most of the period covered by this edition of the book is gratefully acknowledged here. The entire Department of Health, the Directorate of Medical Education and the Directorate of Health Services worked in unison to achieve this target.

The model of maternal death audit that we followed was unique; there is no similar system in any other country. The health systems of Sri Lanka and Malaysia which are quoted as examples of low cost maternal health care systems with high standards are not comparable to the ones in Kerala. Both these countries have more robust government run health systems with very little contribution from the private sector. But in Kerala, 70% of curative health care is provided by the private sector with very little insurance coverage for maternity care. The government machinery and administrative hierarchy have only limited control over these private health care providers. Even within the Health department the division into teaching (DME) and service (DHS) sectors bring in administrative hurdles. It is against this background that the KFOG stepped in to conduct the audit. The KFOG did not receive any financial support from the government for the conduct of the audit. This helped to avoid administrative delays and allegations of corruption. Since the members of KFOG belonged to

the different sections of health care – private and government, the audit process became a meeting point for the different sectors.

The Confidential Review of Maternal Deaths(CRMD) has evolved into a platform to express the philanthropic and service traits of the obstetricians. At the same time all the participants in the audit process found it a learning opportunity and helpful for personal development.

We adopted the changes suggested by the World Health Organization (WHO) to link the audit process with appropriate response (Maternal Death Surveillance and Response) MDSR. Whenever recurring problems leading to maternal death were identified, solutions were also worked out. Thus, for PPH, innovative approaches to control bleeding were developed. Standard guidelines to manage hypertension were suggested. Partnership with International agencies like NICE International helped in this. Similarly, steps to address amniotic fluid embolism and sepsis were worked out. All these are discussed in the book.

The last year under review threw up a big challenge beyond our control. I am referring to the large number of suicides, about 23 out of 133 maternal deaths. We have dedicated a chapter to this topic but recognise that obstetricians alone cannot solve this issue. It needs the concerted efforts of different specialities of medicine and departments of home, education, social justice, judiciary etc. Only a comprehensive effort bringing together these different segments of society can help in this.

While we were trying to focus on suicide came the next blow in the form of Covid 19 pandemic. Initially we were relieved to find that pregnant women were not particularly harmed by the virus. But as I write this note, alarm bells are ringing. Already at least 40 mothers lost their lives with Covid 19, the fear of third wave and possibly subsequent waves makes us anxious. The only relief that has come in the last couple of days is the drive to get pregnant women vaccinated as recommended by the central government and ICMR. Let us hope that this will help us to protect pregnant and lactating women.

V. P. Paily
State coordinator,
Confidential Review of Maternal Deaths

Preface

(Second Edition - 2006-09)

While preparing the second edition of the book "Why Mothers Die – Kerala" covering the years 2006 to 2009, we were not overjoyed. The first edition for the years 2004-2005 had given us the baseline data regarding maternal mortality in Kerala. We analyzed the underlying facts and published our recommendations for action by the government, society and the community of obstetricians. Now is the time to ponder over and take stock of the changes that have taken place since the publication of the first edition.

Coincidentally, the whole world is now focusing on Maternal Mortality Ratios (MMR) as part of the Millennium Development Goals. The target date of 2015 is only three years away. We are anxiously waiting to see if India will achieve the target MMR of 109 / 100,000 live births. The latest MMR of 212 (Sample Registration System) for the years 2007-2009 gives us optimism that if India really tries, the target MMR of 109 by 2015 is achievable. But, is there sufficient commitment shown at the central level? The basic first requirement is to allot funds to support this initiative. But even now the share of India's GDP spent on health remains pitiably low. While developed countries spend 6-10% of their GDP on health, India is spending in the range of 1-2%. Insurance coverage is at its infancy in India and most insurance agencies do not cover maternity care. All these factors leave the patient and her family having to spend on maternity care from their own pockets. Obviously the poor and unemployed will not be able to afford appropriate and timely care.

Let us look at the state of Kerala where there is the widespread perception that we have already achieved this particular Millennium Development Goal (MDG # 5) long ago. But have we? It all depends on how we look at things. Kerala was reporting an MMR of 87 even in 1992. Given that the MDG # 5 is to reduce MMR by 75% of what it

was in 1990, our goal should be to reach an MMR of 22. But Kerala's MMR as per the SRS for 2007-09 (published in june 2011) is still 81. This would imply that we have not made much progress on this front since 1990. Obviously, these figures do not tally. What are the facts? There is the need for a reliable, properly conducted study.

For a few years now, studies have shown that home deliveries have virtually disappeared from Kerala. The Family Health Survey 3 also agreed with this. If that is the case, there should be no reason to depend on any sample survey to learn about the number of births and deaths in Kerala because the registration of births and deaths is compulsory and not registering these events is punishable. However, it is clear that the administrative machinery is terribly slack in this, especially regarding registration and compilation of maternal deaths.

Knowing the actual number of mothers dying is important but more important is to know why they die – the medical and social factors related to each death. Only with that information we can devise the appropriate strategies to tackle maternal mortality. The best method to acquire that information - recognized all over the world - is the confidential review of maternal deaths. The usual strategy of setting up an open enquiry, finding the culprit and punishing them, will not work in a complex situation like maternal death, which may be the final tragic outcome of action or inaction on the part of many players including the deceased and her family, the administrative hierarchy, the medical team and society at large. That is why we started the confidential review of maternal deaths in 2004 and still continue with it.

But our observations over the last seven years do not give us reasons to be happy. The drawback regarding maternal mortality audit in the state and the reasons for maternal death remain more or less the same. A compelling order making it mandatory on the part of hospital administrations to report all maternal deaths for confidential review is still awaited.

What did we find through the audit? We reported that in 2004-05, the MMR in Kerala would have been just above 50 per 100,000. This was an estimate after allowing for cases not reported either to CRMD or the Director of Health Services. During the period that is the focus of this second edition, the number of reported deaths has actually increased. However, this need not represent an increase in the number of deaths but rather an increase in the reporting. Unfortunately, for these years also, we still have to provide an estimate of the overall MMR for the state as we are aware that there are still many unreported deaths.

Analysis of the causes of deaths reported to CRMD during 2006-09 show almost similar trends compared to 2004-05. Obstetric hemorrhage and hypertension lead the list of causes. But one welcome change is that

deaths due to amniotic fluid embolism have stabilized. Similarly, venous thromboembolism (pulmonary embolism) has not shown any escalation. But the large number of suicides (when the deaths reported to CRMD and DHS are combined) is disturbing. Suicides are often related to dowry and domestic violence. The involvement of other government departments is necessary if we want to seriously tackle this problem. Similarly, sepsis also has shown an increase. Close observation of these trends calls for remedial action in the form of workshops and CME programmes.

Another worrying observation is the relatively high number of maternal deaths at home. As per published data, Kerala has almost 100% institutional deliveries. But preliminary data suggest that about 28 deaths occurred at home, of which eight followed home deliveries. These are not included in CRMD figures as we only analyzed those cases with records. All the same, these deaths are disturbing. Does it mean that there are large numbers of pregnant women not covered by our health system (public or private)? These cast a shadow on the claim of near 100% institutional deliveries. The administration has to take note of this.

Unfortunately, there are other disturbing trends as well. The cesarean section rates have skyrocketed in recent years with rates above 50% in 4 districts. Among vaginal deliveries, the rate of episiotomy also remains high, at about 90% in primies. There does not seem to be any perceptible change in the provision of antenatal classes or labour companions. All these are happening despite attempts by the Kerala Federation of Obstetrics and Gynecology (KFOG) to conduct workshops on emergency obstetric care and safe labour practices. Obviously, more concerted efforts are required to improve the maternity care in our state. The KFOG is willing to continue its efforts to improve maternity care as is evidenced by this ongoing CRMD despite the lack of support from some quarters. Once again, we are publishing our recommendations in this edition. We hope that it will evoke a better response this time.

V. P. Paily
State coordinator,
Confidential Review of Maternal Deaths

Preface

(First Edition - 2004-05)

Maternal death is considered a double tragedy, for, in about 70% of cases, the fetus or newborn also dies perinatally. Even when the fetus survives, its future is often bleak due to the absence of a caring mother. Successful birth and a surviving progeny is a requirement for the survival of the species. In that sense, the woman who consents to get pregnant and reproduce is ensuring the continuation of the species, performing a service to mankind. If, during this process, she is made to suffer physical hurt or loss of life, it could easily be considered a human rights issue. Society and government have a responsibility to ensure the safety of pregnant women.

Unfortunately, child-bearing and child-rearing continue to be a major hazard for women all over the world. In most civilizations, women have a pivotal role in the family. A woman's death or disability has a profound influence on her spouse, their children and society at large. The gravity of the incident doubles when one realizes that most of these deaths are not only due to factors beyond her control but that most are preventable. Hence, maternal death is not merely a health issue; it is a social injustice and a violation of fundamental human rights.

Unequal distribution and utilization of resources around the world has resulted in a wide disparity in income levels and standards of living between geographic regions, resulting in a crude differentiation of the world into developed and developing countries. Just like other health indices, maternal mortality is high in these developing countries. In most regions of Africa, Latin America and Asia, maternal mortality ratios are unacceptably high. India, despite experiencing an economic renaissance currently, is one of 51 countries in the world where measures to reduce maternal deaths are painfully slow and rather ineffective. It is estimated that out of each lakh (100,000) deliveries in India, 407 women die - a figure which existed 50 years ago in the west. This is a result of nothing

but blatant social negligence, in a country where the economic growth rate is around 8%.

Kerala has enjoyed health indices much better than what is prevalent in many other Indian States and in many of the countries that became independent alongside India. Accurate statistical data are not available for the period prior to India's independence but whatever data are available seem to indicate better figures for Kerala compared with the rest of India even pre-1947. Currently a girl born in Kerala has a five-fold chance of reaching her fifth birthday and is likely to live 20 years longer than her counterpart in Uttar Pradesh. Maternal mortality also has started to decline rapidly and seems to be about 50 (out of every 100,000 deliveries), a figure that does not exist in any other Indian State.

Kerala's obstetricians and gynaecologists under the banner of the Kerala Federation of Obstetrics and Gynaecology (KFOG) felt it our moral responsibility to try to reduce the maternal mortality ratio in our State. The Confidential Review of Maternal Deaths (CRMD) was started with this objective. This book compiles the experience of the first two years and adds some recommendations for future practice.

This first two years' experience has revealed that there are still many avoidable maternal deaths occurring. They require concerted efforts involving the improvement of transportation, improved training of caregivers, enhancing facilities at hospitals and increasing the availability of blood and components. The community's attitude and involvement also have to change. There are still segments of Kerala society that do not receive antenatal care. We have put down some recommendations based upon the data gathered during the first two years. These recommendations will need wider discussion to evolve a plan of action. Only then will there be the desired impact on maternal mortality within the State.

Kerala's relatively low maternal mortality rates are often attributed to the higher rate of literacy within Kerala, especially among girls. Education was widely promoted by the rulers of Kerala's erstwhile princely States, and also various religious groups through the establishment of schools and colleges throughout the State. A big boost to the social fabric of Kerala society was also given by the Land Reforms Act of 1957 which brought financial security to many families in the lower strata of society. As higher education positively influenced the health-seeking behaviour of Kerala society, more and more hospitals were started within the State. Initially, these were built by the government but with increasing financial independence, private medical care became more prevalent . Today, approximately 70% of all reported deliveries within the State occur in the private sector. Parallel to these changes in the health care delivery system, there was an improvement in the maternal mortality ratio in Kerala and the current figure is believed to be below 50 deaths for every 100,000 deliveries. But before we can boast that we are a civilized society, we must reduce this to single-digit figure within the next decade, making it on par with the other health indices in Kerala. To achieve that, we have to know why mothers die in our State. This book presents the data we could gather through confidential review of maternal deaths in Kerala. There was input from many senior practicing obstetricians and allied specialists in the analysis of the cause of death and the recommendations for managing common conditions. We hope that this book will generate an awareness of the problems and pave the way for further improvement

V P Paily

V Rajasekharan Nair

Acknowledgements

Confidential Review of Maternal Deaths (CRMD) is the flagship project of the Kerala Federation of Obstetrics & Gynecology and has been successfully continuing the review process since 2004 because of the dedicated efforts of many colleagues across the state. We are grateful to all of them for their time and commitment to this venture.

This review process had full support from the Government of Kerala right from its inception. The services of Sri. Rajeev Sadanandan, the past Additional Chief secretary (Health) needs special mention as he issued the goverment order making reporting of deaths mandatory and streamlined the audit process along with DHS and NHM. He also formed a core committee including DHS, DME, NHM and KFOG and he himself chaired the monthly meetings to review the whole proceedings. The present Principal Secretary Health Dr. Rajan Khobragade is continuing the work with great enthusiasm. We are grateful to the entire team at the department of health for the wholehearted support. But we would like to specially mention the support given by the Director of Health Services, Director of Medical Education and their team for supporting this venture. We thank the state demographer and team for allowing us to use the data of births and deaths. Special thanks are due to Dr.Sandeep and Dr.Sreehari for their continued support for the audit process. It was the National Health Mission which provided the funds for the training programme. We would like to specially mention the services of the State Mission Director Dr. Beena IAS and Sri. Kesavendra IAS and the current Mission Director Dr. Rathan U Kelkar IAS.

Along with the large number of obstetric assessors in analyzing the causes, the nonobstetrician assessors of Trivandrum, Thrissur, Kozhikode, Kottayam and Aluva were involved in reviewing medical causes of maternal deaths. Their professional expertise in the analysis

and contributions to the chapters in this book are gratefully acknowledged.

We are grateful to the obstetric colleagues across the state, senior as well as middle level, for reviewing the anonymised case records and attending the quarterly meetings to discuss the final cause of death. This was a voluntary work , taken up by the obstetricians with great sincerity to work for a noble cause. They have also dedicated their valuable time and attention for writing the chapters in this book. They have gracefully accepted the alterations in the text made by the editors of this book. The support from senior colleagues like, Dr. Lalitha, Dr. Samantha Bhadran and late Dr. Mrs. Elizabeth Iype was a great boon to the process of CRMD.

The Quality Standards initiative was introduced with the help and support of NICE team, NHM and Govt. of Kerala. The obstetricians played a major role as trainers in disseminating the programme all over the state along with EmOCALS workshops. The ORRT was introduced with help from the RAALS (Rajagiri Academy of Advanced Life Support) team and training was completed in all the districts inspite of the pandemic. We have identified captains from among the obstetricians in each district to audit the deaths and near misses along with the RCH officer who coordinates the monthly MDNMSR meetings. We appreciate the support provided by the District Medical Officer of each district in providing us with the information related to all maternal deaths. We gratefully acknowledge the tireless efforts of all the obstetricians and the supporting team which has helped to bring down the MMR in our state.

CRMD is possible only if the case records are available for review. We are grateful to the obstetricians as well as the hospital administrators who have been prompt in sending the documents. We would like to acknowledge the support of all the office bearers of the Kerala Federation without whose cooperation, this venture would not have been possible.

Dr. Sheela Paily has been instrumental in tracking the records and keeping the statistics. She has spent her valuable time to make the necessary corrections of the whole book. No words can express our gratitude for her time and dedication.

We are also grateful to Dr. Gwyneth Lewis, Dr. Matthews Mathai and Sri Rajeev Sadanandan who have written the foreword for the book and Sir Sabarathnam Arulkumaran and Dr. Rajan Khobregade who wrote the messages. We are greatly obliged to Hon. Health Minister Smt. Veena George for releasing the book officially.

The previous editions of the book Why Mothers Die had been designed and printed by Mr. David Smriti Design and this book is also an end product of Smriti. We express our sincere thanks to Mr. David for the design and Anaswara offset Kochi for printing.

The whole proceedings of the audit process, receiving, compiling, photocopying and sending to the assessors have been done by Mrs. Jolly and Mr. Varkey of TOGS Office. We gratefully acknowledge their sincerity and hard work.

The support of our families and colleagues is gratefully acknowledged.

Finally we remember with reverence all the pregnant women who lost their lives and their families. Our effort is to learn lessons from these tragic losses so that the future generations will benefit.

V P Paily, K Ambujam, Betsy Thomas

On behalf of the Editorial board

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ACRONYMS USED AND THEIR EXPANSIONS

ABG	Arterial Blood Gas
ACC	American College of Cardiology
ACEI	Angiotensin Converting Enzyme Inhibitors
ACES	Abdominal and Cardiac Evaluation with Sonography in shock
ACLS	Acute Cardiac Life Support
ACN	Acute Cortical Necrosis
ACPO	Acute Colonic Pseudo Obstruction
ACOG	American College of Obstetricians and Gynecologists
ACS	Acute Coronary Syndrome
ADAMTS	A Disintegrin and Metalloproteinase with a Thrombospondin Type
ADPKD	Autosomal Dominant Polycystic Kidney Disease
ADE	Antibody Dependent Enhancement
AED	Antiepileptic Drugs
AF	Atrial Fibrillation
AFE	Amniotic Fluid Embolism
AFLP	Acute Fatty Liver of Pregnancy
AFP	Alpha Feto Protein
AFV	Amniotic Fluid Volume
Ag	Antigen
AHA	American Heart Association
AKI	Acute Kidney Injury
ALSO	Acute Life Support in Obstetrics
ALT	Alanine Amino Transferase
AMA	Anti Mitochondrial Antibody
AMBU	Artificial Manual Breathing Unit
AMI	Acute Myocardial Infarction
AML	Acute Myeloid leukemia
AMR	Anti Microbial Resistance
AMTSL	Active Management of Third Stage of Labour
APLA	Anti Phospho Lipid Antibody
APH	Ante Partum Hemorrhage
APS	Antiphospholipid Antibody Syndrome
AR	Aortic Regurgitation
ARB	Angiotensin Receptor Blocker
ARDS	Acute Respiratory Distress Syndrome
ARF	Acute Renal Failure
ARM	Artificial Rupture of Membranes
ART	Assisted Reproductive Technology
AS	Aortic Stenosis
ASA	American Society of Anesthesiologists
ASD	Atrial Septal Defect
ASHA	Accredited social health activist
AST	Aspartate Amino Transferase
ATN	Acute Tubular Necrosis
AVM	Arterio Venous Malformation
AVR	Aortic Valve Replacement
BLS	Basic life support
BMI	Body Mass Index
BMV	Balloon Mitral Valvotomy (PTMC & BMV are same)
BOH	Bad Obstetric History
BTP	Benign Thrombocytopenia of Pregnancy
BUN	Blood Urea Nitrogen
CAB	Compression, Airway, Breathing
CAD	Coronary Artery Disease
CBC	Complete Blood Count
CCR	Cardio Cerebral Resuscitation
CECT	Contrast Enhanced Computed Tomography
CEMD	Confidential Enquiry into Maternal Deaths
CFT	Clot formation time
CGN	Chronic Glomerulo Nephritis
CHD	Congenital Heart Disease
CHF	Congestive Heart Failure
CI Clamp	Common Iliac Clamp
CKD	Chronic Kidney Disease
CLD	Chronic Liver Disease
CME	Continuing Medical Education
CMV	Cytomegalo Virus
COA	Coarctation Of Aorta
COPD	Chronic Obstructive Pulmonary Disease
COVID 19	Corona Virus Disease 2019
CPAP	Continuous Positive Airway Pressure

CPCR	Cardio Pulmonary and Cerebral Resuscitation
CPN	Chronic Pyelo Nephritis
CPK	Creatinine Phosphokinase
CPR	Cardio Pulmonary Resuscitation
CRD	Congo Red Dot
CRE	Carbapenam Resistant Enterobacteriaceae
CRMD	Confidential Review of Maternal Deaths
CRP	C- Reactive Protein
CSF	Cerebrospinal Fluid
CSLTC	Covid Second Line Treatment Centre
CTG	Cardio Toco Graph
C- TMA	Complement Mediated Thrombotic Micro Angiopathy
CVP	Central Venous Pressure
CVD	Cadio Vascular Disease
CVS	Cardio Vascular System
CVT	Cerebral Venous Thrombosis
DBP	Diastolic Blood Pressure
DC	Direct Current
D&E	Dilatation and Evacuation
DF	Dengue Fever
DHF	Dengue Hemorrhagic Fever
DHS	Director of Health Services
DIC	Disseminated Intravascular Coagulation
DKA	Diabetic Keto Acidosis
DMO	District Medical Officer
DNS	Dextrose Normal Saline
DSS	Dengue Shock Syndrome
DVT	Deep Vein Thrombosis
EAS	Extra Amniotic Saline
EASI	Extra Amniotic Saline Infusion
ECC	External Cardiac Compression
ECMO	Extra Corporeal Membrane Oxygenation
EDD	Expected Date of Delivery
EEG	Electro Encephalogram
EF	Ejection Fraction
EFM	Electronic Fetal Monitoring
EMOCALS	Emergency Obstetric Care and basic Life Support
EPO	Erythropoietin
ERCP	Endoscopic Retrograde Cholangio Pancreatography
ESBL	Extended Spectrum Beta Lactamases
ESM	Ejection Systolic Murmer
ETT	Endo Tracheal Tube
FAST	Focussed Assessment with Sonology for Trauma
FBS	Fasting Blood Sugar
FDP	Fibrin degradation products
FFP	Fresh Frozen Plasma
FH	Fetal Heart
FHR	Fetal Heart Rate
FIGO	International Federation of Obstetrics & Gynecology
FMF	Fetal Medicine Foundation
FOCUS	Focused Cardiac Ultrasound
FOGSI	Federation of Obstetric and Gynaecological Societies of India
FRC	Functional Residual Capacity
FTND	Full Term Normal Delivery
GA	General Anesthesia
GBS	Group B Streptococcus
GCS	Glasgow Coma Scale
GDM	Gestational Diabetes Mellitus
GFR	Glomerular Filtration Rate
GGTP	Gamma glutamyltrans peptidase
GO	Government Order
GTCS	Generalised Tonic Clonic Seizures
HAV	Hepatitis A virus
HBeAg	Hepatitis B early Antigen
HBV	Hepatitis B Virus
HCt	Hematocrit
HCV	Hepatitis C Virus
HCW	Health Care Worker
HDN	Hemolytic Disease of the Newborn
HDP	Hypertensive Disorders of Pregnancy
HELLP	Hemolysis Elevated Liver enzymes and Low Platelets
HEV	Hepatitis E Virus
HF	Heart Failure
HFNC	High Flow Nasal Cannula
HG	Hyperemesis gravidarum
HICC	Hospital Infection Control Committee
HIV	Human Immunodeficiency Virus
HOCM	Hypertrophic Obstructive Cardio Myopathy
HSE	Herpes Simplex Encephalitis
HSV	Herpes Simplex Virus
HTN	Hypertension
HUS	Hemolytic Uremic Syndrome
IBD	Inflammatory Bowel Disease
ICD	Inter Coastal Drain
ICD MM	International Classification of Diseases - Maternal Mortality
ICH	Intra Cerebral Hemorrhage
ICM	International Confederation of Midwives
ICP	Intra Cranial Pressure
ICP	Idiopathic cholestasis of pregnancy
ICU	Intensive Care Unit
IE	Infective Endocarditis
ILI	Influenza Like Illness
IM	Intra Muscular
INR	International Normalised Ratio

IPPR	Intermittent Positive Pressure Respiration
IPPV	Intermittent Positive Pressure Ventilation
ISSHP	International Society for Study of Hypertension in Pregnancy
ITP	Idiopathic Thrombocytopenic Purpura
IUCD.	Intra Uterine Copper Device
IUD	Intra Uterine Death
IUGR	Intra Uterine Growth Restriction
IV	Intra Venous
IVC	Inferior Vena Cava
IVF	In Vitro Fertilization
JCI	Joint Commission International
JPHN	Junior Public Health Nurse
JSY	Janani SurakshaYojana
JVP	Jugular Venous Pressure
KFOG	Kerala Federation of Obstetrics & Gynecology
LASA	Look Alike and Sound Alike drug
LCHAD	Long Chain 3 Hydroxy Acyl Coenzyme Dehydrogenase
LDH	Lactate Dehydrogenase
LFT	Liver Function Tests
LHI.	Lady Health Inspector
LHS	Lady Health Supervisor
LMA.	Laryngeal Mask Airway
LMP	Last Menstrual Period
LMWH	Low Molecular Weight Heparin
LP	Lumbar Puncture
LSCS	Lower Segment Cesarean Section
LV	Left Ventricle
LVEF	Left Ventricular Ejection Fraction
MAHA	Micro Angiopathic Hemolytic Anemia
MAP	Mean Arterial Pressure
MAST	Military Anti Shock Trousers
MBRACE	Mothers and Babies: Reducing Risk through Audits and Confidential Enquiry
MCF	Massive Clot Firmness
MCM	Major Congenital Malformation
MCT	Mobile Cardiac Telemetry
MCTD	Mixed Connective Tissue Disease
MDG	Millennium Development Goal
MDNMSR	Maternal Death and Near Miss Surveillance and Response
MEOWS	Modified Early Obstetric Warning Signs
MFMC	Maternal Fetal Medicine Committee
MMR	Maternal Mortality Ratio
MNM	Maternal Near Miss
MODS	Multiple Organ Dysfunction Syndrome
MOET	Managing Obstetric Emergencies and Trauma
MOF	Multiorgan Failure
MOH	Massive Obstetric Haemorrhage
MOU	Memorandum of Understanding
MR	Mitral Regurgitation
MRI	Magnetic Resonance Imaging
MRSA	Methicillin Resistant Staphylococcus Aureus
MRV	Magnetic Resonance Venogram
MS	Mitral Stenosis
MSSA	Methicillin Sensitive Staphylococcus Aureus
MTCT	Mother To Child Transmission
MTP	Massive Transfusion Protocols
MTP	Medical Termination of Pregnancy
MV	Mitral Valve
MVP	Mitral Valve Prolapse
NAFLD	Non Alcaholic Fatty Liver Disease
NASG	Non pneumatic Anti Shock Garment
NIBP	Non Invasive Blood Pressure (Monitor)
NIV	Non Invasive Ventilation
NS	Normal Saline
NST	Non Stress Test
NSAID	Non Steroidal Anti Inflammatory Drug
NT	Nuchal Translucency
NYHA	New York Heart Association
OGTT	Oral Glucose Tolerance Test
OHSS	Ovarian Hyperstimulation Syndrome
ORRT	Obstetric Rapid Response Team
PA	Pulmonary Artery
PABC	Pregnancy-associated Breast cancer
PAH	Pulmonary Artery Hypertension
PAPP- A	Pregnancy Associated Plasma Protein A
PAS	Placenta Accreta Spectrum
PBM	Patient Blood Management
PCOD	Poly Cystic Ovarian Disease
PCR	Polymerase Chain Reaction
PCV	Packed Cell Volume
PDA	Patent Ductus Arteriosus
PDPH	Post Dural Puncture Headache
PE	Pre Eclampsia
PEX	Plasma Exchange
PFT	Pulmonary Function Test
PG E1	Prostaglandin E 1
PG E2	Prostaglandin E 2
PHC	Primary health centre
PIH	Pregnancy Induced Hypertension
PK-PD	Pharmacokinetic Pharmacodynamic
PLGF	Placental Growth Factor
PND	Paroxysmal Nocturnal Dyspnea
POC	Point of Care
POCSO	Protection Of Children against

	Sexual Offences
POCUS	Point of Care Ultrasound
PPBS	Postprandial Blood Sugar
PPCM	Peri Partum Cardio Myopathy
PPH	Post PartumHemorrhage, Primary Pulmonary Hypertension
PPROM.	Preterm Premature Rupture of Membranes
PPS	Postpartum sterilisation
PR	Pulmonary Regurgitation
PR- AKI	Pregnancy Related Acute Kidney Injury
PRBC	Packed Red Blood Cell
PRES	Posterior Reversible Encephalopathy Syndrome
PROM	Premature Rupture Of Membranes
PS	Pulmonary Stenosis
PSQ4D	Primary Screening Questionnaire for Depression
PSS	Primary Sjogren's syndrome
PSVT	Paroxysmal Supraventricular Tachycardia
PT	Prothrombin Time
PTMC	Percutaneous Trans Mitral Commissurotomy
PTT	Partial Thromboplastin Time
qSOFA	Quick Sequential Organ Failure Assessment
RA	Rheumatoid arthritis
RBBB	Right Bundle Branch Block
RCH Officer	Reproductive and Child Health Officer
RCOG	Royal College of obstetricians and gynaecologists
RCVS	Reversible Cerebral Vasoconstriction Syndrome
RFT	Renal Fuction Tests
RHD	Rheumatic Heart Disease
RL	Ringer Lactate
RMC	Respectful Maternity Care
ROM	Rupture Of Membranes
ROSC	Return Of Spontaneous Circulation
ROTEM	Rotational Thromboelastography
RRT	Renal Replacement Therapy
RSOV	Ruptured Sinus Of Valsalva
RTA	Road Traffic Accident
RUQ	Right Upper Quadrant
RUSH	Rapid Ultrasound in shock
RV	Right Ventricle
RVSP	Right Ventricular Systolic Pressure
SAB	Sub Arachnoid Block
SAG	Saline Adenine Glucose Mannitol
SAMM	Severe Acute Maternal Morbidity
SCD	Sickle-cell Disease
SE	Status Epilepticus
SEARO	South East Asia Regional Office(of WHO)
SFH	Symphisio Fundal Height
SGOT	Serum Glutamic Oxaloacetic Transaminase
SGPT	Serum Glutamic Pyruvic Transaminase
SIRS	Systemic Inflammatory Response Syndrome
SLE	Systemic Lupus Erythematosus
SMA	Superior Mesenteric Artery
SMFM	Society of Maternal Fetal Medicine
SOFA	Sequential Organ Failure Assessment
SPACE	Sampling Perfection with Application Optimised Contrast
SSc	Systemic Sclerosis
SSC.	Surviving Sepsis Campaign
SUDEP	Sudden Unexpected Death in Epilepsy Syndrome
TBM	Tuberculous Meningitis
TC	Total Count
TEG	ThromboElastoGraphy
TMA	Thrombotic Micro Angiopathy
TOF	Tetralogy of Fallot
TOF	Time of Flight
TR	Tricuspid Regurgitation
TRALI	Transfusion Associated Lung Injury
TSBA	Total Serum Bile Aacid
TSH	Thyroid Stimulating Hormone
TTP	Thrombotic Thrombocytopenic Purpura
TVS	Trans Vaginal Scan
TVUAC	Trans Vaginal Uterine Artery Clamp
UDCA	UrsoDeoxyCholic Acid
UFH	Unfractionated Heparin
UK	United Kingdom
UMN	Upper Motor Neuron
USG	Ultrasonogram
UTI	Urinary Tract Infection
UTPI	Uterine Artery Pulsatility Index
VS	Vital Signs
VSD	Ventricular Septal Defect
VT	Ventricular Tachycardia
VTE	Venous Thrombo Embolism
VUR	Vesico Ureteral Reflux
VWF	Von Willebrand Factor
WHO	World Health Organisation

PART 1

BACKGROUND AND RELEVANCE

CHAPTER

01

Background and Continuing Relevance

Editors

The background of the start of Confidential Review of Maternal Deaths –Kerala (CRMD) was described in the earlier editions of "Why Mothers Die" and is briefly covered in the "Overview and Executive summary" later in these pages. Hence it is not repeated here.

Is there relevance to continue the process of CRMD? The answer is a big yes. Audit and follow up action is essential for every health care setting, more so in the case of maternal health. The maternity care needed for a particular community will be unique to that setting. Lessons have to be learned based on the realities of that community and solutions have to be worked out taking into account the factors prevalent locally. This is possible only by local audit and follow up action.

Even in the span of 16 years of the CRMD, we have realised the changing landscape of maternity care. While hemorrhage and hypertension still continue to lead the causes of maternal deaths, respiratory and viral diseases vary in different years. Suicide is increasing at an alarming rate. The pattern of sepsis changes. Only on regular and close follow up we will be able to keep track on this and act appropriately.

The other reason to continue audit is to evolve strategies to tackle this problem. Only when the nature and magnitude of the problems are identified we will work hard to find solutions. Management of hemorrhage is a typical example. Placenta previa accreta was a nightmare when we

started CRMD. But out of necessity to control the bleeding we invented the aorta clamp. Similarly for tackling atonic PPH we developed 'Transvaginal uterine artery clamps (TVUAC)' and the 'Suction cannula (Samartha Ram and Vasudeva Panicker)'

Auditing is a dynamic process. There is the need to continue it if we have to address the newer challenges that come up. CRMD will have to continue even if we achieve single digit MMR.

CHAPTER

02

How does the system work?

Editors

Confidential review of maternal deaths (CRMD) is a voluntary effort of the Kerala Federation of Obstetrics and Gynecology (KFOG) with full support of the government of Kerala. The government of Kerala by order 'GO (Rt) 1108/2010/H&FWD dtd 25.3.10' streamlined the reporting process. All deaths in the government and private sector are to be reported to the State coordinator of Confidential Review of Maternal Deaths with the specified forms duly filled and the anonymised copies of the case records.

There are four forms to be filled in each case.

Form A: This contains the identifying details of the deceased like the name, age, hospital number, cause of death etc. There are four copies of form A of which one will be forwarded to the CRMD coordinator.

Form B: This does not have the personal identity of the patient like the name or hospital number, name of the treating doctor or hospital.

This form is basically to give the medical details of the deceased, the history, treatment received, progress of the case and final outcome. This will be supplemented by photocopies of the case records which are anonymised (masking the name, number etc. while taking the copy).

Looking through form B and all the case records, the assessors arrive at the possible cause of death and also whether it was preventable or not. The aim of the assessment is to learn lessons from the analysis of the case and make recommendations regarding possible alternatives in management

that would have made a different outcome. Any positive aspects of the management also will be commented on by the assessors.

Form C: This is filled by the doctor treating the patient and will be handed over to the team from DMO's office visiting the institution for audit. The team will have members from the health service and representative from the KFOG. The team will go into the details and arrive at their conclusion and put it down in form C. Copy of this form will be shared with the State coordinator of CRMD.

Form D: This is a confidential document filled by the treating doctor and handed over directly to the State coordinator. This can have confidential information to be shared only with the State coordinator. The treating doctor can share thoughts or information which harms him/her if made public, but will help the State coordinator in arriving at the correct diagnosis.

The audit process

Once the forms reach the state coordinator, he/she will separate out the form A and the rest of the forms. A code number is generated and forms B, C and D are marked with code number. Form A is filed separately. The state coordinator or chair of the maternal fetal medicine committee will study the case and make a summary. Also two or three copies of the form B and case records will be made. The assessor to whom the case is to be sent is identified keeping in mind that a case for analysis goes to assessors located away from where the case was treated.

Reviews are usually done every three months. The venue will be rotated between the north, south and middle of the state. If the case had nonobstetric problems, opinion from a concerned specialist will be sought. There are special forms for the assessors to enter their findings.

In the quarterly meetings of the assessors each case summary and report of the assessors will be presented without revealing the identity of the case. After deliberations of all the members, a possible diagnosis regarding cause of death will be entered. The committee will also provide an opinion regarding preventable factors etc. These will be compiled for publication.

As the publication in the form of "Why Mothers Die" in the book format was getting delayed, we decided to publish snippets as learning points after such quarterly meetings. This was published in the Kerala Federation journal.

Once we started the district level audit of maternal deaths and near misses, the quarterly report of the CRMD began to be discussed in the MDNMSR meetings of the district. Even here the identity of the deceased will not be revealed.

Near miss audit

In the chapter on near miss audit the details are discussed.

MDNMSR

The present audit format has changed. While the CRMD is to continue as in the past, a summary of the deaths will be presented in the MDNMSR meeting by the RCH officer on the basis of the audit conducted by the DMO's team. Here also, anonymity will be maintained.

After extracting the data and before publication of the findings, all the case records will be destroyed. Of late we have encouraged junior obstetricians as well as senior post graduate students also to attend the quarterly meeting of the assessors. The idea is for the younger generation of obstetricians to have first-hand knowledge about the process so that it will be continued.

We want to state again that all assessors and executive committee members give their services free. There is no TA or DA paid. Even the postal charges are borne by them. Many of them acknowledge that this is a learning experience for them.

CHAPTER

03

Definitions used

Editors

Maternal Death

"Maternal death" is defined as the death of a woman while pregnant or within 42 days of the end of pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes. For the purpose of this study, late maternal deaths occurring after 42 days of termination of pregnancy but before the end of one year have not been considered in the analysis. **Maternal Mortality Ratio** is calculated as the number of maternal deaths divided by the total number of live births multiplied by 100,000.

$$\frac{\text{Number of maternal deaths} \times 100{,}000}{\text{Total number of live births}}$$

Four types of maternal deaths are noted:

1. **Direct:** Deaths resulting from obstetric complications of the pregnant state (pregnancy, labour and puerperium), from interventions, omissions, incorrect treatment, or from a chain of events resulting from any of the above.
2. **Indirect:** Deaths resulting from a previously existing disease or a dis-

ease that developed during pregnancy and was not due to direct obstetric causes, but which was aggravated by the physiological effects of pregnancy e.g. heart disease complicating pregnancy.

3. **Coincidental (Fortuitous):** Deaths from unrelated causes that happen to occur during pregnancy or puerperium e.g. a motor vehicle accident.

4. **Late Maternal Death:** Death occurring between 42 days and one year after abortion, miscarriage or delivery that is due to direct or indirect maternal causes.

   (This study does not include late maternal deaths.)

Suboptimal Care

The term "suboptimal care" is used where it is felt that a different management strategy would have resulted in a different outcome. In the British confidential enquiry report, the term used is "substandard care."

The British report subdivides suboptimal care into "Major" and "Minor."

1. **Major:** A different management strategy would reasonably have been expected to alter the outcome.
2. **Minor:** A different management might have made a difference but the mother's survival was unlikely in any case.

In this report, we have not tried to classify suboptimal care into these two categories of Major and Minor. However, in the assessment of individual cases, we have tried to indicate whether suboptimal care was present.

Who is a Maternal Near Miss (MNM)?

A woman who survives life threatening conditions during pregnancy, abortion, and childbirth or within 42 days of pregnancy termination, irrespective of receiving emergency medical/surgical interventions, is called Maternal Near Miss.

PART 2

IN SUMMARY

CHAPTER

04

a. The Data

Deepthy M, Prameela Menon,
Betsy Thomas, Megha Jayaprakash,

" The highest tribute to the dead is not grief , but gratitude."

(Some of the tables are incomplete, especially the ones related to 2019-20. This is due to the difficulty to get the data from various departments, because of pre occupation with covid 19 related activities.)

Paying our tribute to all the unfortunate mothers who lost their lives during parturition and related events, we are presenting this statistical data.

The most often asked question after a maternal death is, why and how? The whole purpose of CRMD is also the same-to analyse the death and find out the cause and the chain of events which led to the death. In this third edition, we are dealing with a 10 year period unlike the previous two editions which were covering two and four years each. The many developments that happened in this ten year period in the fields of health, education, transportation services etc. will be reflected in the statistics.

TOTAL NUMBER OF DEATHS

The main aim of the maternal fetal medicine committee of KFOG was to achieve a MMR of 30 by the year 2020. The total number of deaths over the period 2010 – 2020 is shown in the table below. Compared to the previous 4 year data, the total number has been more or less the same but it showed a gradual reduction during 2013 – 16 period. Even though it showed a minimal rise again during 17 and 18, it was very heartening to see that in 2019-20, the MMR dropped below 30.

The causes of death are given separately. If a particular case was seen by the CRMD and the team doing the facility based audit (from DMO's office), the cause of death assigned by CRMD was taken for our data. Similarly if a case was in the list of CRMD as well as the list of Director of Health Services, to avoid double counting it was included only in the CRMD list.

Table 1 Maternal deaths over the years 2010 April 1st to 2020 March 31st

	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	Total
CRMD	113	85	101	112	117	106	80	138	122	102	1076
DHS list - Not analysed by CRMD	73	53	47	65	38	48	49	45	38	31	487
Total	186	138	148	177	155	154	129	183	160	133	1563

Fig-1. Births , Deaths, MMR

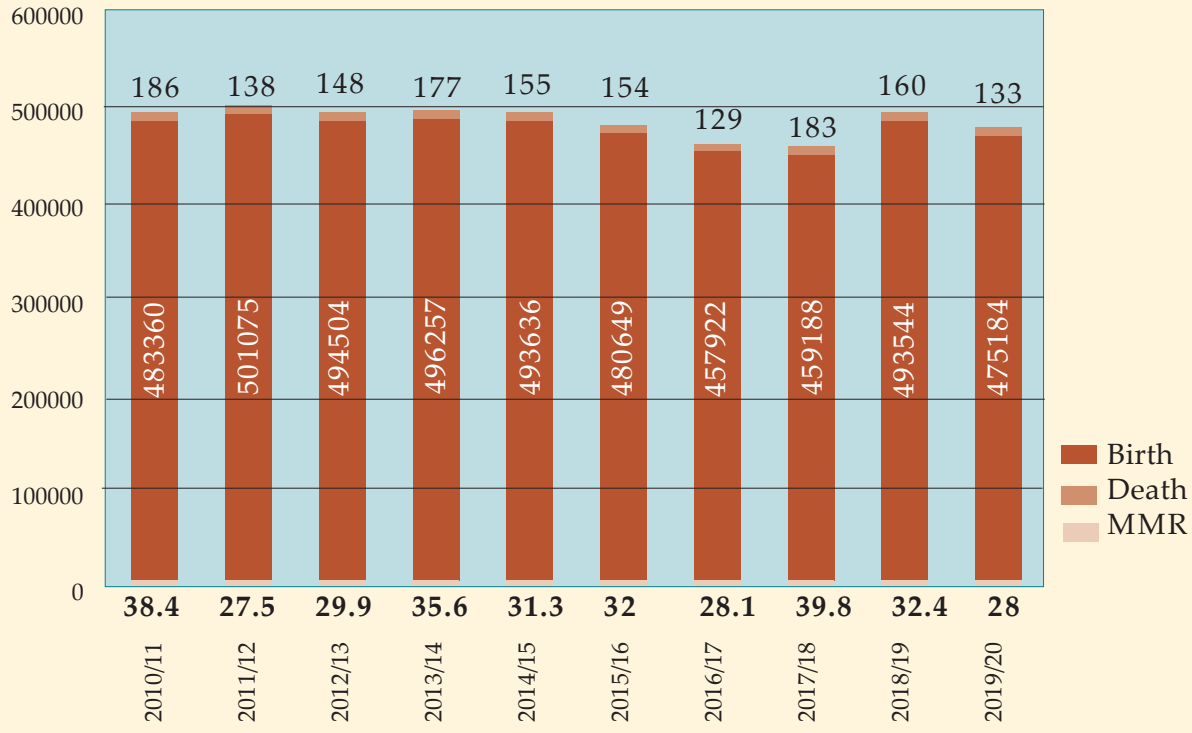
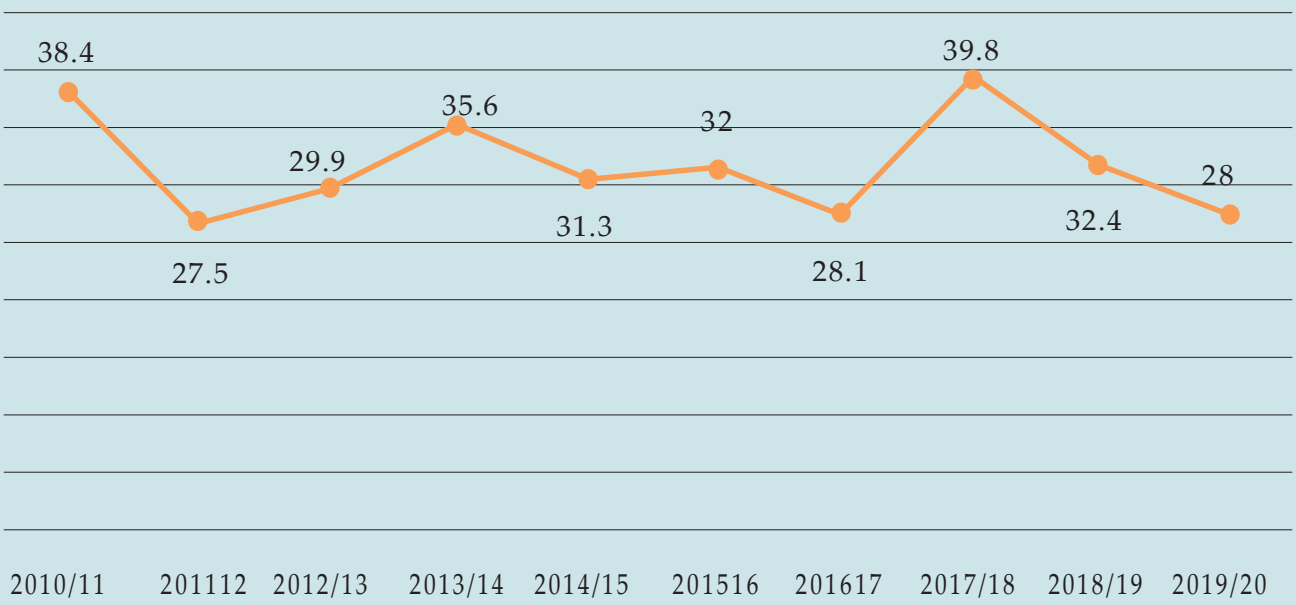


Table 2. Births and Deaths

year	2010/11	201112	2012/13	2013/14	2014/15	201516	201617	2017/18	2018/19	2019/20
Total births	483360	501075	494504	496257	493636	480649	457922	459188	493544	475184
Total deaths	186	138	148	177	155	154	129	183	160	133
MMR	**38.4**	**27.5**	**29.9**	**35.6**	**31.3**	**32**	**28.1**	**39.8**	**32.4**	**28**

Fig 2. Mat deaths / 100000 births



MMR for the period 2010-2020

In interpreting the cause of death the primary cause is taken into consideration even though the final cause also may be relevant, eg. A patient who had atonic PPH and later obstetric hysterectomy, recovered but died after a few days due to pulmonary embolism; we have taken the stand that it should be included under PPH as it was the primary cause which set the ball rolling .

It is disheartening to know that in spite of all the focused efforts, PPH still remains as the major killer in all the years under analysis except in 2015-16 when respiratory causes came as the leading cause and in 2019 suicide topped the list. Hypertensive diseases came in the second place in most of the years. Sepsis, thromboembolic disorders, respiratory causes and viral diseases were in the first few positions. A disturbing feature is the increase in suicide among pregnant women. It has come up even to the first position in 2019; it stresses the importance of mental health along with the physical health of the pregnant woman

Table 3. Consolidated list of causes of maternal deaths.

	2010-11		2011-12		2012 -13		2013 - 14		2014 -15		2015 -16		2016 -17		2017 -18		2018 -19		2019 -2020	
	CRMD	NA*	CRMD	NA	CRMD	DHS	CRMD	NA	CRMD	NA	CRMD	NA	CRMD	NA	CRMD	NA	CRMD	NA	CRMD	NA
Haemorrhage	23	8	20	11	24	4	17	7	20	4	10	3	13	5	24	2	21	nil	17	nil
Hypertensive diseases	16	4	14	5	14	5	8	8	8	nil	13		9	2	12	3	7	6	5	2
Sepsis	4	nil	6	3	7	2	16	nil	7	2	3	2	10	2	10	1	6	1	5	3
Septic abortion	2	nil	2	1	2	nil	2	nil	3	nil	2		nil		3		6	nil	Nil	nil
Respiratory and viral	21	14	3	2	3	nil	9	2	7	5	17	2	6	2	19	1	4	3	6	2
Neurological causes	8	3	8	7	9	5	7	4	7	1	13	4	6	1	7	1	10	1	5	1
Heart Diseases	7	6	6	1	5	nil	9	5	7	1	6		5	1	13	6	12	3	5	3
Suicide	3	9	2	6	8	6	8	6	12	6	7	12	8	6	7	7	5	3	19	4
Amniotic fluid embolism	7	2	4	nil	5	2	4	5	7	6	10	2	4	7	10	5	5	5	3	2
Thrombo embolism	4	nil	6	5	2	4	7	1	9	nil	9	1	3	3	4	6	6	2	6	nil
Liver diseases	1	nil	3	nil	5	3	4	nil	5	nil	2		2		4	1	9	nil	6	nil
Anesthesia related	2	nil	nil	nil	nil	nil	nil	nil	Nil	nil	1		1		3		8	nil	1	nil
Renal diseases	1	2	nil	nil	1	nil	1	1	2	nil	1	1	nil	1	1		nil	1	Nil	nil
Less common causes	10	5	6	3	10	10	11	3	14	1	7	11	5	9	11	3	10	4	14	1
Early pregnancy causes:																				
Ectopic	nil	3	1	nil	1	nil	nil	1	2	nil	1		3		nil		3		2	
Hyperemesis	nil		1		nil		2		1		1		1		2				Nil	
Abortions excluding septic abortions	nil		nil		nil		nil		Nil		nil								2	
Unknown	4	17	3	9	5	6	7	22	6	12	3	10	4	10	8	9	10	9	6	13
Total	**113**	**73**	**85**	**53**	**101**	**47**	**112**	**65**	**117**	**38**	**106**	**48**	**80**	**49**	**138**	**45**	**122**	**38**	**102**	**31**

*NA Not analysed by CRMD as case records not available

EPIDEMIOLOGICAL ASPECTS

District wise distribution of deaths

The district wise distribution of deaths is shown below. Compared to the previous years,it is a welcome change that the reporting from all the districts has become more uniform. But the alarming rates in Malappuram and Palakkad show the importance of more dedicated strengthening of health care facilities, transport systems, ambulance services as well as blood bank facilities in these two districts. Also we have to note that the number of deliveries is higher in Malappuram district.

Table 4. District wise distribution of deaths

District	2010/11	11/12	12/13	13/14	14/15	15 /16	16/17	17/18	18/19	19/20
Alappuzha	1	7	3	7	7	9	7	4	9	3
Kozhikkode	10	15	7	11	17	1	7	24	20	11
Ernakulam	23	11	6	15	8	7	5	12	5	12
Idukki	6	3	4	7	nil	4	6	9	3	5
Kannur	8	11	10	14	9	4	13	10	7	6
Kasaragod	9	4	5	13	7	11	8	7	7	9
Kollam	28	16	6	13	15	8	6	14	9	10
Kottayam	6	6	9	7	6	9	9	6	4	13
Malappuram	27	25	39	28	29	35	21	31	43	25
Palakkad	30	13	14	16	21	19	18	24	18	12
Pathanamthitta	2	5	5	9	3	2	1	2	3	1
Thrissur	15	6	14	15	12	13	9	12	16	7
Thiruvananthapuram	10	10	19	14	11	15	13	23	8	13
Wayanad	11	6	7	8	10	4	4	4	8	6
Unknown								1		
Total	**186**	**138**	**148**	**177**	**155**	**154**	**129**	**183**	**160**	**133**

AGE AT DEATH

The majority of deaths occurred between the age 20 and 35. Unlike in many other northern states of India the number of child marriages and teenage pregnancies is less in Kerala. But it has to be noted that one third of the deaths occurred in the age group 30-35 which shows the higher risk associated with late child bearing .

Table 5. Age distribution

	2010/11	11/12	12/13	13/14	13/15	15/16	16/17	17/18	18/19	19/20
Age 19 & below	4	6	6	7	7	3	7	9	2	4
20 -29	70	56	69	73	67	66	50	71	68	52
30 -35	32	18	20	25	37	25	18	45	41	35
36 -39	5	4	5	6	6	11	4	12	6	9
40 &above	2	1	1	1	nil	1	1	1	5	2

Religion

Table 6. Religion wise distribution.

Religion	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20
Hindu	54	38	48	48	68	54	37	71	54	40
Muslim	30	30	29	35	33	32	32	52	48	35
Christian	20	7	7	19	14	14	10	13	20	15
Tribe	3	2	3	3	2	1	1	2		
Unknown	6	8	14	7	1	5				12
Total	**113**	**85**	**101**	**112**	**118**	**106**	**80**	**138**	**122**	**102**

The religion wise distribution roughly reflects the pattern in Kerala's general population .

Educational status of the Deceased

The higher literacy rate of the state is reflected in this table. Majority had atleast upto secondary level of education. But the data is grossly incomplete. Often these data are lacking in case sheets. It is always better to have a page dedicated to the social factors like education, income, occupation as well as the distance from the nearest healthcare facilities etc in all antenatal records.

Table 7. Educational status of the deceased

Educational Status	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20
Primary	8	14	9	8	13	19	11	11	9	
Secondary	26	17	21	14	22	14	15	29	26	
Graduate	10	4	6	8	7	10	10	10	18	
Professional		6	1	5	1		2	1	3	
Unknown	71	44								
Nil										

Educational status of husband

Again it shows the importance of education. As the couples are more educated, there will be more awareness on health care, more earning capacity and better access to healthcare facility; hence reduced mortality and morbidity.

Table 8. Educational Status of husband

Educational Status	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20
Primary	7	11	10	11	13	15	10	16	11	
Secondary	24	16	18	17	20	19	14	27	17	
Graduate	5	2	4	3	5	6	6	6	17	
professional	1	1	1	5	1	nil	2		5	
Unknown	78									

Occupation of the deceased

The data is clearly lacking in most of the charts, most of them were unemployed, again which indicates the socio-economic status of the family.

Table 9. Occupation of the deceased

Occupation	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20
House Wife				35	45					
Teacher	2	2	1		3	1	4	2	4	
Nurse	2	3	4	4	2	4	2	2	2	
Manual Labour	2		3	1	2		1		11	
Other Jobs	2	1	1	3	1	3	3	7	11	
Unknown										

Occupation of husband

Most of them were manual labourers reflecting the poor paying capacity of their family.

Table 10. Occupation of the husband

Occupation	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20
Manual labour	13	13	8	23	29	17	19	24	20	
Driver	5	2	6	3	4	4	2	9	4	
Gulf Employed	9	5	3	4	4	6	2	8	8	
Agriculture		1	1				1			
Business	7	2	8	3	8	4	2	1	2	
professional	8		3	3	3	2	3	4	10	
Other jobs	4	10	4	8	2	3	3	3	6	
Unknown	69	52	78							
Total										

Place of death and referral

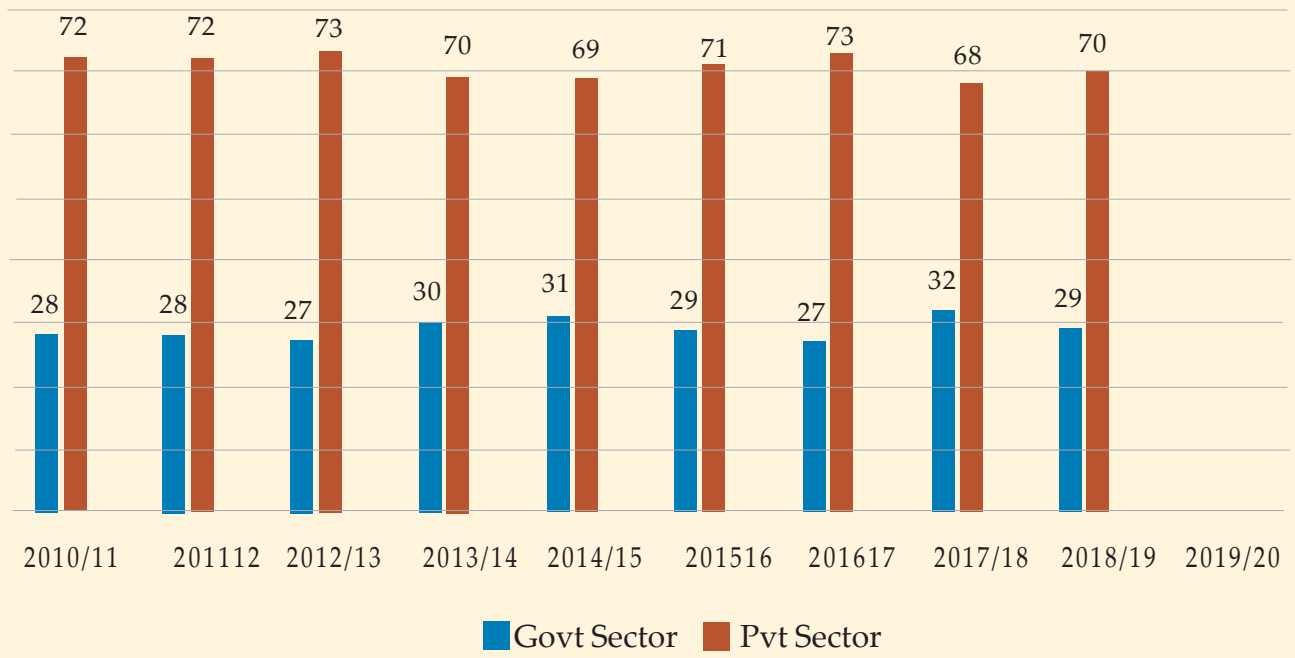
The place of death shows equal incidence at government and private sector with majority occurring in tertiary care hospitals. With increasing number of medical colleges in private sector and more government hospitals getting elevated to the level of tertiary care , this data is not surprising. Primary health centres do not cater to deliveries. Taluk and district hospitals, inspite of shortage of facilities, cater to a lot of economically backward people.

Percentage of delivery in public & private sector

Table 11. Percentage of Delivery in publice and Private Hospitals

Year	Public	Private
2010/11	28	72
11/12	28	72
12/13	27	73
13/14	30	70
14/15	31	69
15/16	29	71
16/17	27	73
17/18	32	68
18/19	29	70

Fig-3. **Percentage of deliveries - each sector**



While referring patients in the government sector, the hierarchical pattern of referral from community heathcentre to Taluk hospital to District hospital can lead to loss of precious time. It is recommended that the referring hospital should verify whether the receiving hospital has facilities to tackle the problem in hand before sending the patient. A preferred referral protocol is mentioned in the chapter on " obstetric services in the periphery". Referral was more from private sector than govt sector.

Table 12. Place of death

	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20
Total deaths analysed	113	85	101	112	117	106	80	138	122	102
Govt. hosp	44	41	43	51	65	46	42	84	54	49
Pvt. hosp	56	37	45	50	43	47	31	47	60	31

Table 13. Pattern of Referral

	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20
Total deaths analysed	**113**	**85**	**101**	112	118	106	80	138	122	102
Referred cases	63	56	65	71	74	77	46	68	75	42
Pvt. hosp	45	32	39	41	42	45	32	38	58	28
Govt. hosp	18	24	26	30	32	32	14	30	17	14

TYPE OF DELIVERY

A very sad trend is the increasing rate of Cesarean deliveries in our state which is equal in both government and private sector. It comes to nearly 50% of total number of deliveries.

Maximum number of deaths were after cesarean that too emergency CS. Most often it is considered as the easiest surgery but these statistics should be a real eye opener. **'Do it less and do it right'** should be the principle. It does not imply that cesarean is always the direct cause but there were other underlying risk factors in most of them.

Table 14. Mode of Delivery

	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20
Cesarean	45	36	36	43	38	36	30	50	51	33
Vaginal delivery	30	24	27	28	29	26	19	35	22	23
Vacuum delivery	5	2	4	3	4	6	3	5	5	1
Forceps	1	1	2	1	3	1	1	2	nil	Nil
In labour (undelivered)	6	4	6	3		6	3	4	1	2
Ectopic	1	1	1		2	1	3	nil	3	2
Scar rupture					1					
Abortion	3	4	4	2	8	3	4	7	8	6
Hysterotomy					1		1	4	1	1
Rupture	1									2
Antenatal	21	11	21	32	31	27	15	31	27	32
Unknown		2				nil	1		4	
Total	**113**	**85**	**101**	**112**	**117**	**106**	**80**	**138**	**122**	**102**

Table 15. Cesarean rates distribution between government and private hospitals

	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20
CS rate for the whole state	39	39	40	40	41	42	41	40	41	
Govt hosp	40	39	39	38	40	41	41	40	40	
Pvt hosp	38	39	40	41	41	42	42	41	41	

DEATHS AT HOME

Inspite of the claim that Kerala has attained close to 100% institutional deliveries, there were significant number of home deliveries especially in Malappuram, Palakkad, Wayanad and Idukki districts. Whether it is due to the lack of health care facilities or a fashion trend of attaining natural birth, there should be strict vigilance as most of the time deliveries are attended by untrained people leading to more mortality and morbidity

Table 16. Number of deliveries at home in each district

District	2017/18	2018/19
Trivandrum	26	20
Kollam	33	17
Pathanamthitta	18	23
Alappuzha	21	10
Kottayam	5	12
Idukki	60	59
Ernakulam	26	14
Thrissur	9	29
Palakkad	66	49
Malappuram	215	241
Kozhikode	12	20
Wayanad	152	87
Kannur	75	17
Kasaragod	22	22
Kerala –Total	**740**	**620**

Table 17. Maternal deaths at home

	CRMD	DHS
2010/11	• Unknown cause – 3 • Home delivery & PPH - 1 • Ca Breast -1	? TB -1
2011/12	Nil	CVT -1
2012/13	• 24wks gestation, vomiting and collapsed -1 • 11wks gestation – collapsed-1 • Unknown -1	• Eclampsia -2, • home delivery &PPH -1, • postpartum collapse -1, • unknown -2
2013/14	Heart disease -1	• PPH -1 • Unknown -2 • Pul. Embolism -1
2014/15	• AN, sudden collapse • Post CS 13th day ?PE	nil
2015/16	Nil	2
2016/17	Nil	
2017/18	Unknown -1	• Aneurysm rupture 1 • PE. DVT -1
2018/19	ITP -1	nil

b. Overview and Executive summary

This edition of Why Mothers Die covers the period 2010 to 2020 and follows the previous edition by nine years. The philosophy followed in this edition is the same as in previous edition to bring out a compilation of the facts related to maternal deaths in Kerala with the emphasis on what has been done and what can still be done to avert future maternal deaths in this part of the world. We believe that it will have relevance not only to the state of Kerala but other parts of India and beyond. This book is the outcome of concerted efforts of the obstetricians and non- obstetrician colleagues of Kerala with full support from government of Kerala. The way the audit is conducted is described in the first edition of this book. But a peep into the beginning of Confidential Review of Maternal Deaths (CRMD) in Kerala will be relevant here.

Confidential review of maternal deaths in Kerala is a unique exercise, the parallels of which are difficult to find in other parts of the world. The key players are the Department of Health of Government of Kerala and the Kerala Federation of Obstetrics and Gynecology (KFOG). It is not easy to have a partnership of such diverse groups – one a government department controlled by the beaurocrats under the guidance of political leadership and the other an organisation of highly specialised medical professionals primarily concerned about their own speciality. But what brought together these unlikely partners was a keen desire and commitment to see that all avoidable maternal deaths are prevented.

Even before the confidential review process was started in Kerala, the health department under the government, had started to audit maternal deaths and this is still being continued. But it is more like a facility based audit done under the District Medical Officer of Health. The audit is not confidential and it is often felt that all the facts may not be revealed even

though there is promise that no punishment will be awarded on the basis of the enquiry findings. Still we feel that the facility based audit with all its short comings, should continue. The very fact that audit will be done, would lead to some improvement in care and maintenance of records.

The Kerala Federation of Obstetrics and Gynecology was started in 2002. One of its declared objectives was to strive to reduce maternal deaths. It was felt that confidential audit of maternal deaths was the way forward to find out the modifiable factors to focus on. Fortunately in 2003, World Health Organisation's South East Asia Regional Office (SEARO) organised a workshop in Delhi on the needs of maternal death audit and the ways to implement it. The senior editor of this book participated in that and on return persuaded KFOG and the State government to start the confidential review of maternal deaths in Kerala.

The process of confidential review was new to everyone in the state – both at the government level and the KFOG. Fortunately SEARO supported a workshop in Trivandrum in 2003 in which faculty deputed by WHO participated. The state government gave full support to the process and that is how CRMD was started in Kerala.

Health Care Delivery System

Unlike in the United Kingdom where the CRMD (in fact CEMD; Confidential Enquiry into Maternal Deaths) has been practiced since early 1950's, the process faces some unique challenges in Kerala. While health care delivery in the UK was almost totally under the National Health Service (NHS), in Kerala (and the majority of Indian states) it is a mixed bag. Curative health care is delivered by the government and by private hospitals; the ratio will vary between the states. Health insurance was very meagre about 20 years ago and even if the woman had joined an insurance scheme, it would not cover maternity care. This resulted in mostly out of pocket expenses for maternity care in the private sector. Inspite of this about 60 to 70% deliveries take place under the private sector. There was concern that private hospital management teams would not co-operate with the audit process. In reality there was no such resistance from them.

Maternity care under the government sector is also fragmented. There are mainly two streams of health care under the government – the teaching hospitals under the Director of Medical Education (DME) and the hospitals under the Director of Health Services (DHS). The state Health Secretary oversees these two sections. Since the Health Secretary supported the CRMD right from the beginning many potential administrative hurdles could be overcome.

The audit is done by practising obstetricians selected from the different sections of health care – the teaching and non- teaching hospitals under the government and private hospitals. More details of the way the system works are given in the first edition of the book.

Changes in the audit process

Even though this is a follow up volume of the previous two editions, there are several changes in the way Maternal Mortality Ratio (MMR) is calculated for this edition - the annual death rate is compiled from April first to March 31st of the following year to bring the MMR calculation in line with the practice by the government. In the previous two editions we used the calendar year – January 1st to 31st December.

Another change implemented is regarding suicide deaths. Previously suicide deaths were not used to calculate MMR as they were considered fortuitous (incidental). Since the publication of the second edition, WHO and CEMD of United Kingdom (UK) changed the policy and started to calculate MMR taking suicides as a direct cause of maternal deaths. We also have changed accordingly. This will make a huge jump in the MMR as a

significant number of suicides were reported in the last few years.

Steps taken by KFOG to improve maternity care

The 10 years covered in this book saw several steps taken by our federation (KFOG) to address the causes of maternal deaths.

EMOCALS

To prepare the obstetricians and nurses in tackling unexpected emergencies, the Emergency Obstetric Care and Life Support (EMOCALS) training was started by KFOG with financial support from the government. This two day course had a curriculum similar to the training module of the course ALSO (Acute Life Support in Obstetrics) in the UK, Australia and other countries. We modified the contents to suit the needs of our set up. This certified training course was a two day programme for doctors (EMOCALS-D). With some modifications a similar course was developed for nurses (EMOCALS -N).

Tie up with NICE International and the project "Quality Standards in Obstetric Care"

Our efforts received a boost when Mr.Rajeev Sadanandan became the Principal Secretary Health and Dr.Beena Vijayan the State Mission Director of National Rural Health Mission. Sri.Rajeev Sadanandan brought the NICE International of UK to work with KFOG and govt.of Kerala. A new project was put together with technical advice from NICE, administrative support from govt.of Kerala and financial support from National Health Mission. KFOG was the executive wing of the project christened **Quality Standards in Obstetric Care**. The project was a game changer in our approach to address the causes of maternal deaths in Kerala. It depended heavily on the findings published in the first two editions of the book 'Why Mothers Die'- Kerala. With guidance from NICE International KFOG could easily take the standards of care for managing hemorrhage and hypertension to the obstetricians of the entire state. The details of the Quality Standards Project as a sequel to the Emergency Obstetric Care and Life Support are described in separate chapters of this book.

Declaration by government - Achieve MMR of 30 by 2020

The Govt. of Kerala came forward to declare a goal of achieving MMR of 30 by 2020. All obstetric care givers rallied round KFOG and department of Health of Kerala government to work for this one point agenda of MMR of 30 by the year 2020.

We are glad to report that as per available data, in the year ending 31st March 2020, the MMR of Kerala was 28 per 100,000 births

Decentralisation and MDNMSR

It was thought that to keep the peripheral obstetricians and health workers actively involved in the mission, a decentralisation of the audit process was necessary. We decided to have monthly meetings of the maternity care providers at the district level under the aegis of the district collector. Maternal deaths as well as near miss cases of the previous month were to be reviewed. To continue to have the advantage of confidential review of maternal deaths, anonymity was maintained in the discussion of maternal deaths. The whole process was called "Maternal Death and Near Miss Surveillance and Response (MDNMSR)". Health workers at the district level took up the move very enthusiastically. The Kerala Federation identified captains, vice captains and chairpersons at the district level. Regular monthly reviews conducted at the state capital by the health secretary and officers gave the impetus for the RCH (Reproductive and Child Health) officers at the district level who were the convenors of the MDNMSR meetings. A sort of healthy competition

evolved between the districts as the activities were shared on social media. The process continued until the novel Corona virus pandemic struck the state resulting in the lockdown and cessation of all these activities.

Obstetric Rapid Response Team (ORRT)

Analysis of the circumstances of maternal deaths revealed that the actions that can make a difference are very time sensitive. If we take the example of PPH, immediate steps must be taken within minutes by the person in the labour room to stop the bleeding. This brought up the need for an obstetric rapid response team (ORRT) in every hospital. The government accepted our suggestions. With the help of critical care specialists (of Rajagiri Academy of Life Support-RALS, Aluva) we drew up a training programme for labour room doctors and nurses. The aim was to have at least one person who had the training to be present in the labour room or somewhere else in the same building round the clock. A large number of doctors and nurses had to be trained, considering the rapid turnover among post graduates and nurses serving in the labour rooms. We started district level trainings supported by the government. The details are given in the chapter on ORRT in this book.

Near Miss Review

For nearly a decade now it has been realised that audit of maternal deaths alone may not be enough to identify the problems that lead to maternal mortality. A preventative strategy has to look at near miss events as well. Just because they do not lead to deaths, such events should not escape close scrutiny. In fact auditing such events will be less threatening to the care givers because most of the time they would have ended on a happy note. In Kerala, we started audit of near miss events about five years ago as a pilot project involving all the government medical colleges. The details are available in the chapter on near miss reviews by Dr. Resmi et al in this book. In fact MDNMSR at the district level is primarily to study the near miss cases at the district level.

In the next few pages we will give a summary of the entire volume (Executive Summary) with additional inputs from the editorial team wherever relevant. We hope that you will find the book helpful in day to day obstetric practice and will help to prevent maternal deaths.

Executive Summary

Table 1 : Maternal deaths over the years 2010 April 1st to 2020 March 31st

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
Deaths analysed by CRMD	113	85	101	112	117	106	80	138	122	102	1076
Not analysed	73	53	47	65	38	48	49	45	38	31	487
Total	186	138	148	177	155	154	129	183	160	133	1563

Table 2: The causes of maternal deaths in Kerala are summarised in the table.

Causes of maternal deaths	2010/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	Total
PPH	23	20	24	17	20	10	13	24	21	17	**189**
Hypertensive disorders	16	14	14	8	8	13	9	12	7	5	**106**
Sepsis	4	6	7	16	7	3	10	10	6	5	**74**
Septic abortions	2	2	2	2	3	2	nil	3	6	nil	**22**
Respiratory and Viral dis.	21	3	3	9	7	17	6	19	4	6	**95**
Neurological causes	8	8	9	7	7	13	6	7	10	5	**80**
Cardiac diseases	7	6	5	9	7	6	5	13	12	5	**75**
Suicide	3	2	8	8	12	7	8	7	5	19	**79**
AFE	7	4	5	4	7	10	4	10	5	3	**59**
Pulmonary Embolism	4	6	2	7	9	9	3	4	6	6	**56**
Liver diseases	1	3	5	4	5	2	2	4	9	6	**41**
Anesthetic causes	2	nil	nil	nil	nil	1	1	3	8	1	**16**
Renal Diseases	1	nil	1	1	2	1	nil	1	nil	nil	**7**
Less common causes	10	6	10	11	14	7	5	11	10	14	**98**
Early Pregnancy causes											
Ectopic/ scar pregnancy	nil	1	1	nil	2	1	3	nil	3	2	**13**
Hyperemesis	nil	1		2	1	1	1	2			**8**
Abortion(excluding septic abortions)	nil	nil	nil	nil	nil	nil	nil			2	**2**
Unknown	4	3	5	7	6	3	4	8	10	6	**56**
total	113	85	101	112	117	106	80	138	122	102	**1076**

Hemorrhage

It bothers us that the leading causes of maternal deaths remain more or less the same, even though the numbers have come down. Hemorrhage contributes to maximum number of maternal deaths. This is unfortunate since the methods to arrest the bleeding effectively and promptly have been developed in Kerala by clamps (V P Paily) and suction cannula (Samartha Ram and Vasudeva Panicker). Delay in dissemination of the technology costs lives. Those of us who have started using these new methods to arrest bleeding can vouch for usefulness and ability to arrest further progression to shock, DIC (Disseminated intravascular Coagulation) and death. We feel that repeated training sessions are the only way to get these methods adopted on a large scale.

There is overall improvement in tackling the consequences of PPH. Blood and blood products are available. New methods of testing for coagulation defects are available. Yet we have not been able to address the issue of PPH. We feel that teaching centres should take the lead. The various O&G societies in the state should update their members regarding these cheap but lifesaving innovations. Government has a responsibility to propagate these technologies and provide them to the delivery points whether in public or private sector.

Another innovation that has revolutionised the management of placenta accreta spectrum (PAS) is the aorta clamp. It is heartening that more and more centres have started to use it for managing placenta accreta spectrum. A comprehensive approach to pick up cases of PAS early and manage it as per standard guidelines is still not universally followed.

Hypertension

Hypertension still remains the second commonest cause of maternal deaths in Kerala. In the case of management of hypertension no major breakthrough has happened. But if the Quality Standards recommendations for hypertension were followed, many of the maternal deaths could have been averted. Control of acute hypertension of preeclampsia should receive more priority over magnesium sulphate for its anticonvulsant effect. Intravenous labetalol and oral nicardia are the two agents available. These are effective as well. What is needed is adoption by all the antenatal clinics and delivery points.

Suicide

It is shocking to see that suicide is one of the leading medical causes of maternal mortality, as is mentioned in the chapter on mental diseases and suicides. We are in the dark regarding the factors that lead so many young women to end their lives by suicide. The pattern is very different from the standard causes of suicides mentioned in the text books. Many such deaths occur in early pregnancy. There are a significant number who are unmarried or the pregnancy is a result of extramarital contacts. Social media plays a major role in creating the circumstances that lead to these tragic deaths. At CRMD we are unable to know all the factors that lead to suicide as there are no case records. This is an area where many departments under the government, like Social and Family welfare, Education and youth affairs in addition to Ministry of health should pitch in to analyse the cases and come out with recommendations to address the menace.

Sepsis

There have been a lot of improvements in the last ten years in terms of facilities in our government hospitals. But has there been adequate improvement in terms of aseptic practices? Unless

top priority is given to basic requirements the share of sepsis in maternal deaths will continue to go up. There seems to be a false sense of safety in the newer antibiotics.

This is an area where local administrators are the key players. Since hospital administration is slowly taken over by non-medical personnel, unless the obstetrician steps in and guide them, enough resources will not be provided for cleanliness and asepsis. There is the need to emphasize these points while future obstetric practitioners are being trained.

Heart Disease

A significant number of mothers die due to heart disease in pregnancy. It turns out to be the commonest non-obstetric cause of maternal deaths just as it is reported from the United Kingdom. The current year is an exception because of the unprecedented rise of respiratory and viral infections due to Covid 19. The type of heart diseases also has changed from mostly valvular heart diseases when CRMD was started in 2004 to more of cardiomyopathy and survivors of operated congenital heart disease. This change brings with it a need for appropriate anticoagulants. We have to anticipate the need for specialists in obstetric medicine, a specialty just starting to develop in India.

Amniotic Fluid Embolism(AFE)

This nightmare for all obstetricians has remained fairly steady. This is inspite of a much higher rate of induction of labour. On the basis of clinical experience it is fairly certain that hyperstimulation is associated with AFE. With increasing induction rate a rise in AFE cases was to be expected. Its absence can be due to several reasons. The total cesarean rates have gone up across the state. The threshold for cesarean section has gone down. Prolonged uterine stimulation and trying to achieve vaginal delivery is no more practised. In addition to this we hope that more people would have abandoned use of smooth muscle relaxants like drotaverine and epidosin in late labour. Whatever be the reason, it is a relief that AFE cases have not risen in these years.

In addition we have made an attempt to train more and more labour room staff in resuscitation of women in labour in case an acute episode like AFE develops.

Pulmonary Embolism

The number of cases of pulmonary embolism has also remained fairly stable inspite of the rapid rise in cesarean rates.

Our experience in the past had been to see pulmonary embolism in association with cesarean delivery. The policy of liberal use of low molecular weight heparin could have played a role in preventing escalation of pulmonary embolism rates. In addition, we have always promoted early ambulation after cesarean delivery which also prevents deep vein thrombosis.

Neurological causes

A significant number of cases belonged to neurological causes. Cerebral thrombosis and intracranial hemorrhage (intracerebral and subarachnoid) will constitute more than 60% of neurological causes. Measures to prevent postpartum cerebral venous thrombosis and aggressive approach to control high blood pressure will help in reducing the neurological causes of maternal deaths.

Liver diseases

Liver diseases have a lot of overlap with diseases involving other systems. Acute fatty liver of pregnancy as well as HELLP syndrome may overlap with hypertension, renal disorders and even hematological disorders as causes of maternal

deaths. Thankfully the numbers have not shown an increase during this period.

Anesthetic causes

It is a relief to note that anesthesia related causes were rare and whenever they occurred there was prompt response from our anesthesiology colleagues to find out the exact reason for the problem and to suggest remedies. Support from senior anesthesiologists of the state has always been reassuring to the obstetricians.

Renal diseases in pregnancy

Fortunately contribution from renal diseases to maternal deaths has not been significant. This is a welcome change compared with earlier years when many mothers were lost due to acute renal injury. Aggressive approach to correct blood loss and timely fluid resuscitation are the keys to prevent acute renal injury. In case acute renal injury occurs, prompt initiation of replacement therapy will help to prevent deterioration to chronic renal failure and death.

Respiratory and Viral Diseases

Usually respiratory causes are not significant contributors to maternal deaths. Unfortunately during the period of this review we had the H1N1 influenza hitting us hard and taking away nearly thirty mothers. While writing this, we are struggling from the impact of Covid 19 pandemic which has already taken away about 50 maternal lives. It is worrying that as of today, we cannot claim to be free of this pandemic and its impact on pregnancy. Fortunately, the international community has started to vaccinate the pregnant women and we too have been permitted by the government to do so. A massive public relations exercise is required to see that at least 70% of our pregnant women get vaccinated soon.

Less Common causes

Some of the cases which are common contributors to maternal mortality are not seen to be important in Kerala. A typical example is criminal/septic abortion. But there are other causes which appear in clusters, an example being sickle cell disease. These facts point to the need for constant vigilance in monitoring maternal deaths taking into account diversity of the population we are dealing with. Regular updates of the causative factors must be available to practitioners.

Response following the audit

In early 2000, WHO came out with the suggestion that audit of maternal death cannot be seen as an end point, but the concerned agencies should respond to the findings and preventive action should follow- in other words there should be appropriate actions in response to the findings.

From the beginning of CRMD, we followed these principles. Some of the chapters in this book were added because of this philosophy. Chapters on antibiotics, fluid resuscitation, antenatal and intrapartum care, postnatal care, blood and blood products, disseminated intravascular coagulation etc were added to highlight the importance of these in the management.

Problems faced by special groups are addressed in the chapters on teenage pregnancies obstetric care in the periphery, early pregnancy problems etc.

Training Programmes

In the early days of CRMD itself we realised that training of health workers and updating them on the recent developments are essential steps to reduce MMR. The training had to be given not only to the obstetricians but nurses, midwives and nursing assistants. The fact that obstetric care is provided by government and private hospitals of

varying levels and facilities made the task difficult. However, under the banner of the obstetric and gynaecological societies distributed across the state and with support from the government of Kerala and National Rural Health Mission these programmes were initiated. Such training sessions were conducted in all the districts,

The need for a structured training with certification of trainers as is done in many developed countries was initiated in Kerala. We called the project Emergency Obstetric Care and Life Support(EMOCALS).

The trainings were conducted with pre-test and post-test and certificates were issued to only those securing 70% marks. Separate syllabus was formed for doctors and nurses.

Following on the success of the EMOCALS came the project of Quality Standards in Obstetric care with support from Government of Kerala and NICE (I)(National Institute of Health and Care Excellence International).

To disseminate the facts identified by audit to the practising obstetricians, administrators and policy makers, we came out with the books "Why Mothers Die-Kerala". However, the turnaround time for the observations to reach the practitioners was very long. Hence we started to publish the findings of the quarterly audits of maternal deaths as snippets. These were published in the Kerala Journal of Obstetrics and Gynecology and sent to individual members of the Kerala Federation of Obstetrics and Gynecology.

Actions taken – Developing partnership

The Kerala Federation had followed this philosophy that audit is meaningless without appropriate follow up action based on the findings. Hence we developed partnership with different agencies to achieve our goal, but the most important partner was the department of health, Kerala. We were fortunate to maintain a good working relationship with department of health and its hierarchy including the political bosses. This helped us to make sure that the remedial steps proposed by us could be implemented among the government and private hospitals. In addition we could be partners with the National Health Mission's Kerala State forum. At the same time close links with the Obstetric and Gynecological societies across Kerala helped us to reach the peripheral obstetricians.

The liaison with the government and the department of health helped us to reach out to the nurses and nursing assistants in the delivery points under the government. Links with the obstetricians in the private hospitals helped us to reach out to the nursing staff of their hospitals. In addition a close tie up with the district health administrators helped us to reach out to the public health nurses and ASHA workers. On the whole, a team work could be established with the medical personnel involved in the obstetric care across the state.

Recommendations by KFOG to government

1.Staffing

One of the first such recommendations was related to the inadequate staffing and facilities in the periphery. We could impress upon the government to ensure minimum manpower requirements at the delivery points. We suggested that every delivery centre should have at least two obstetricians and preferably three so that even if one is on leave the services will continue to be available. Government reduced the number of delivery points and redeployed qualified obstetricians from centres without deliveries. The single obstetrician centres in the private also became rare. However, we admit that this transformation has not happened all over the state.

There are still one obstetrician centres in the remote areas of the state. We should appreciate the service they are doing in such difficult circumstances.

2. Blood bank facilities

The second recommendation from our side related to the non availability of blood and blood products in the delivery points. There were districts without even one blood bank. But the situation has improved dramatically. Government made a policy decision to provide blood storage facility in every delivery point. Most of the private centres had such facilities for blood and blood products.

3. Transportation of sick mothers

The third aspect we highlighted was the inadequacies of transport facilities. Attempts to streamline ambulance services across the state have been continually thwarted. At present we have no organised state wide ambulance service. We would still repeat our demand that maternity transport should be made free and easily available to every pregnant woman. Other less developed states have already established such networks. This remains a sore point regarding Kerala Health System.

4. Minimum standard of care

The fourth issue highlighted by us was the lack of minimum standards in the delivery centres. This applies to facilities and manpower. The availability of manpower in terms of obstetricians was mentioned above. Closely linked to this is the provision of basic facilities like clean room, piped water, facilities for the babies, attached theatre etc.

The government of India's drive through "Laqshya project"was a welcome move in this respect. But even before that , when the "Quality standards in obstetric care project" was implemented, the government of Kerala agreed to provide disposable presterilized delivery kits to all delivery points. This contained absorbant mats to help in assessing blood loss. The private hospitals also adopted this policy very quickly.

Audit and Response have to be a dynamic process

Maternal death audit and response have to be a dynamic process, and should adapt to changing situations. In the short history of CRMD this is obvious. When we started it was felt enough to address the leading causes of maternal deaths at that time, viz hemorrhage and hypertension. The situation rapidly changed. Soon we had to address the problem of high cesarean section rates and consequent high incidence of placenta accreta spectrum. Prostaglandins came into the field as a blessing for induction of labour as well as for manageing PPH. But along with that came issues related to hyperstimulation. Newer diseases came, like H1N1 and now the pandemic Covid19. The high incidence of suicide is baffling and requires multidisciplinary analysis and input. Only a dynamic system which can adapt and improvise can help in addressing the tragedy of maternal deaths. The obstetric community under the umbrella of KFOG realised this from the beginning. The partnership with government was fruitful. But new challenges demand new strategies. The system of Confidential Review of Maternal Deaths by KFOG has shown its vibrancy and adaptability since its inception and we believe that it is the way forward.

V P Paily

On behalf of Editorial Board

c. Key Recommendations

To the Government

1. The government has to take the lead in conducting and supporting the activities related to maternity care. It has declared its determination to strive for an MMR of 30 by year 2020 and 20 by the year 2030. But there are different segments of the government who have to work in cohesion to achieve this. Department of Health, government of Kerala has to take the lead in bringing together the different departments under the State and Central governments. This includes the National Health Mission, Health department of government of India, the department of Medical education (DME) and the department coming under the Director of health services(DHS). The target should be made clear and periodic interaction between the different departments should be arranged.

2. **Ambulance service:** Those outside Kerala cannot believe that we do not have a centrally controlled, well organised ambulance service. There is need for co-ordinating the ambulance service which is now fragmented under different administrators. It should change. The ambulance service should become like the fire and rescue services. It should be made the right of the citizens to get transport arranged especially for maternity services.

3. **Insurance services:** Most of the insurance companies do not cover maternity care. This should change. The government has to take the lead.

4. **Data collection and retrieval** of anonymised case records has always been a problem for CRMD. Even though different forms have been prepared, many people do not follow it. The reporting does not happen in some cases. We would urge the government to make sure that the data are sent to KFOG electronically and without delay. The forms need some modifications as well.

5. **Blood bank**: A lot of improvement has occurred in the availability of blood and blood products. But a lot more need to be done. The government has to take the lead and ensure that availability of blood and components is ensured even for the peripheral hospitals – private and public.

6. **Make essential drugs and equipments available**: Availability and pricing of drugs and equipments needed for maternity care should be monitored by the government. Whenever companies change policies based only on their profit, and not taking into account the need of the patient community, the government has to intervene. For example alpha methyl dopa is not available as the concerned company has stopped production. The practitioners were left with more expensive alternatives; government should exert pressure on the concerned companies against such policies.

7. **Manpower**: The delivery centres under the government, especially the ones in the periphery suffer from manpower shortage. A formula of having three obstetricians is essential for such centres. Only then a 24 hour service can be provided allowing for "leaves" of the employees. The obstetricians in such centres have to liaise closely with the field staff like ASHA workers and Junior Public Health Nurse. Health education has to be a major responsibility of the peripheral obstetrician and time has to be found for that. To provide 24 hour delivery service, at least three obstetricians are essential in such centres.

8. **Training:** Training and updating is essential to provide appropriate obstetric care especially in the periphery. This applies to small private hospitals as well. As 70% of deliveries take place in the private sector, training of the private obstetricians has to be taken as the responsibility of the government. As in the past, the practical solution will be to use the services of the organisations like KFOG and local O&G societies. Government can support these organisations by providing training materials like mannequins and newer instruments like TVUAC and suction cannula.

There is an urgent need to focus on training of all staff in the delivery centres on the ways to arrest PPH at the first recognition by using TVUAC or suction cannula. A dedicated series of workshops is the only possible way to train all heath care workers. Government has to take the lead as private and government healthcare workers are to be trained. It may be possible to get funds from NHM or outside agencies like UNICEF. But the initiative has to come from the government.

Local Self Government

Now that the administrative control of peripheral hospitals has been transferred to the local self-government agencies, they have to ensure that needs of the maternity services are looked after well. Specifically, to arrange for transportation, and to make blood and blood products available, the support of the local self-government is essential.

Hospital Management

This has more relevance to the smaller private hospitals. A sort of healthy competitive spirit between such hospitals will be helpful. If the government comes forward with accreditation of hospitals, the private hospital management should ensure that they get accredited. It will help in attracting more patients as well.

Professional organisations

KFOG has taken keen interest so far and should continue to support all activities that will help to reduce maternal mortality. All the activities initiated by KFOG like EMOCALS, Quality Standards, ORRT and MDNMSR have helped in achieving the goal and have to be continued. All the member societies of KFOG have to be encouraged to get involved in this mission.

Training sessions have been the forte of KFOG. For this, support of other specialties like anesthesiology, critical care & neonatology is essential. Already there is a very healthy trend in this. It has to be nurtured more.

KFOG has to join hands with the government and the National Health Mission to bring about the culture of accreditation of delivery points. It should encourage its members to persuade their hospital management to go for accreditation.

Obstetricians

The obstetricians themselves have great responsibility in working towards saving mothers. They have to be regularly updated about new developments that will help to avoid maternal deaths. A culture of safety and preparedness for safe management of obstetric complications should be nurtured. This may involve participation in academic programmes and MDNMSR of the district. Emergency preparedness of the labour room should be maintained. This needs a team building. The nurses and nursing assistants have to be updated on recent developments. Assignment of specific duties to different categories of staff will ensure that the emergency preparedness is maintained.

A line of referral communication has to be developed so that complicated cases can be referred on time.

Obstetricians have to ensure that in case of maternal deaths the forms are duly filled and sent to the concerned authorities.

V P Paily,
Prameela Menon
Deepthy M.
(On behalf of Editorial Board)

PART 3

CAUSES AND SOLUTIONS

CHAPTER

05

Obstetric Hemorrhage

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Editor's note:

The decade covered by this edition of "**Why Mothers Die**" has seen phenomenal changes in the management of hemorrhage as a cause of maternal death. Most of that relates to two types of hemorrhage – the placenta accreta spectrum and atonic PPH. The major new development in the management of placenta accreta spectrum was the atraumatic common iliac artery (aorta) clamp. It is described in detail in the chapter on placenta accreta spectrum. The same clamp can be used in any situation of atonic or traumatic PPH to temporarily arrest the bleeding by clamping the lower end of aorta. The speed with which a pregnant woman will go into shock, metabolic acidosis, Disseminated Intravascular Coagulation (DIC) and cardiac arrest as a result of bleeding from placenta previa accreta or atonic PPH is amazing. Only those who have experienced it will be able to appreciate the importance of arresting the bleeding at the very beginning. The aorta clamp has revolutionized the management of placenta accreta spectrum. We would urge readers to consider its use in any case of severe pelvic bleeding. It will help to continue further surgery in a dry field, be it ligation of vessels, hysterectomy or repair of a rent in the bladder, uterus or vagina.

Bleeding from an atonic uterus demands immediate action, failing which the patient will deteriorate rapidly. Standard and well known methods such as bimanual compression, packing, condom tamponade, Bakri Balloon etc. are all known to fail on occasion. The transvaginal uterine artery clamp (TVUAC) was developed to tackle this problem. If properly applied it blocks the uterine arteries at the level of the isthmus. Attention to details of the technique is important in order to achieve the desired effect (described under (TVUAC) in this chapter). If done properly, the blood supply to uterus will be controlled. The clamp can be kept for about 20 to 30 minutes by which time the bleeding from placental sinuses would have stopped.

The uterine tone may be reduced when the uterine arteries are blocked. As long as there is no bleeding, the lack of uterine tone should not be a concern. When the blood supply is reestablished on removal of the clamps, the tone will return.

The concern in using TVUAC for a longer period is the possibility of ureteric compression by the clamps. With a urinary catheter in situ the urine output can be measured. Absence of urine output will indicate bilateral ureteric obstruction. Alternatively, a dialated renal pelvis on an ultrasound scan may indicate ureteric oclusion. Our own experience suggests that the use of TVUAC significantly reduces the need for further surgical procedures.

If there is excessive bleeding in spite of TVUAC, one can consider the suction cannula promoted by Dr. Samartha Ram and Dr. Vasudeva Panicker. This may become necessary in those with ovarian artery as the major source of blood supply to the placental site. The suction cannula will make the uterine wall collapse on to the cannula making the myometrium rigid and thus blocking the blood vessels passing through it.

We feel that the recent developments described in this chapter have made PPH more manageable even in resource poor settings. Proper training of healthcare workers is crucial to achieve this goal.

V P Paily

Key Summary points

- Obstetric hemorrhage continues to be the leading cause of maternal death in the period reviewed (April 2010 to March 2020). Of the various types of hemorrhage atonic PPH is the most significant. There is an increasing incidence of placenta accreta spectrum.
- Most of the women who developed PPH, did not have any identifiable risk factors.
- Active management of third stage of labour should be practiced in all women in labour including cesarean section and should be documented. Unfortunately this is not being followed.
- Internal hemorrhage following cesarean section and relaparotomy was observed in some cases. Ensuring proper technique by securing the angles separately and attaining complete hemostasis at the bladder base and underneath the rectus sheath can avoid a relaparotomy. For patients in DIC, use midline vertical incision for cesarean section/laparotomy. Insert a wide bore drain before closing the abdomen.
- When a patient is referred to a higher centre, adequate steps should be taken to reduce bleeding until she reaches the higher centre. This means having an intravenous line with oxytocin flowing, another with IV fluids, rectal misoprostol and condom tamponade along with NASG in atonic PPH. It is observed that condom tamponade is used less often during referrals. Alternatively, transvaginal uterine artery clamps or suction cannula can be applied during transit.
- Traumatic PPH should be tackled from the primary care facility as far as possible and when referred, effective uterine and vaginal packing is advisable.
- It was noted that in deaths due to hemorrhage in Placenta accreta, timely diagnosis of accreta placenta was not made and hence was managed without adequate preparation and planning. With a previous cesarean scar, placenta accreta should be diagnosed at 20 weeks and reconfirmed at 32 weeks with a dedicated ultrasound and Colour Doppler if required.
- Major degrees of placenta previa should be managed in a tertiary care centre with facilities for massive transfusion.

Key Recommendations

1. Women with known risk factors for obstetric hemorrhage should be delivered in centres with facilities for blood transfusion, laboratory work up and surgical procedures.
2. Active management of third stage of labour (AMTSL) must be routinely followed and documented.
3. Since PPH is not predictable in every case, all women in labour should have an intravenous (IV) line.
4. All labour rooms should have dedicated cervical inspection sets, TVUAC sets, suction cannula sets and well equipped and maintained PPH Box.
5. Postpartum patient should be closely monitored for at least 2 hours after delivery. In addition to recording pulse and BP, the uterus should be palpated to make sure that it is hard and contracted and the bleeding is within normal limits. It is desirable to shift the patient to the postnatal ward only after she is stable and has passed urine. Same is applicable to patients undergoing cesarean section.
6. Initial management of PPH includes early recognition followed by prompt resuscitation and immediate steps to arrest the bleeding. The cause of bleeding should be identified.
7. When planning to refer to a higher centre, properly applied TVUAC clamps, suction cannula, condom tamponade or effective

packing should be done depending on the type of PPH along with IV Fluids, NASG and a proper reference letter. The receiving centre should be informed telephonically in advance.

8. Timely decision for surgical management especially for obstetric hysterectomy should be taken and not as a last resort.
9. Ongoing bleeding can lead to DIC and hence prompt replacement of blood and components must be ensured.
10. All the steps taken to manage PPH should be systematically documented.
11. All patients managed for PPH should be carefully monitored in High Dependency Unit
12. In anterior placenta previa with a previous cesarean scar, possibility of placenta previa accreta should be considered and managed accordingly.
13. Clinical audit programme should be regularly practiced in each centre. Audit should include near miss cases and positive aspects of management have to be appreciated.

Introduction

It is of great concern that hemorrhage remains the leading cause of maternal death in the years under review (April 2010 to March 2020). This is in spite of near total hospital deliveries, very good antenatal coverage, improvement in blood transfusion facilities, and many developments in technology to arrest the bleeding. No doubt the whole problem has to be looked at from different angles to identify steps that will help to address this issue. We have to see the types of hemorrhage, the critical time of recognition, the immediate actions taken and whether there were lapses. We should also identify the players who could have made a difference. The aim should be to find out the steps that can be taken to prevent maternal death, faced with a similar situation in the future. Unfortunately, the necessary details are not available in all the cases. However, we will try on the basis of available evidence from the CRMD, to suggest practical steps aimed at avoiding death due to obstetric hemorrhage.

Summary of Findings

Obstetric hemorrhage continues to be the biggest killer every year in the last decade except in 2015 - 16, when hypertension and neurological causes took the front seat. Out of the total 1076 deaths analyzed during the 10 year period, 189 deaths were due to obstetric hemorrhage accounting for 17.56%.

Fig: 1 Contribution of Obstetric hemorrhage to maternal death over the years 2004 to 2019/20.

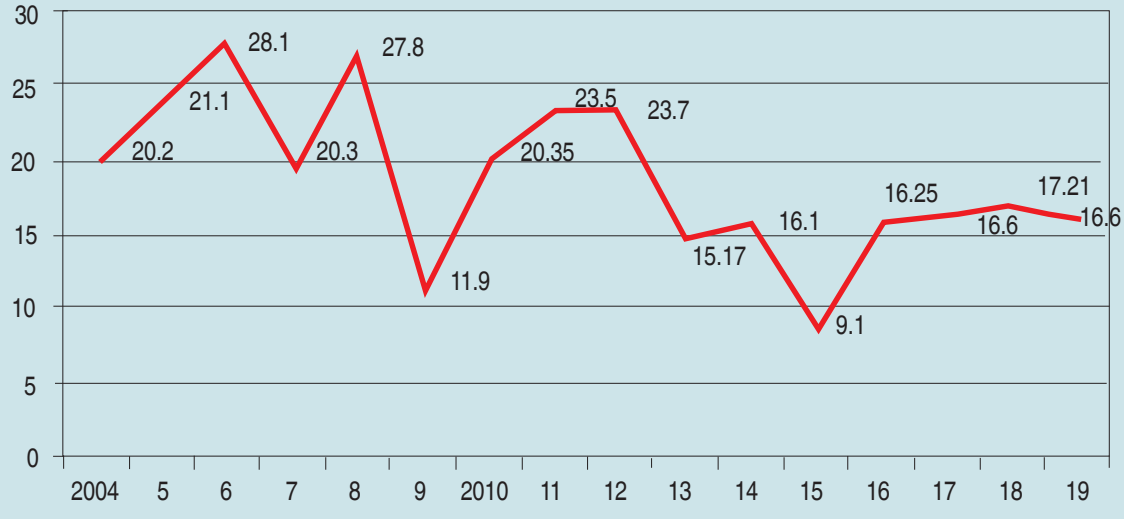


Table 1: Age distribution of Obstetric hemorrhage deaths

Age	2010/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	Total
19 &below	nil	2	1				1	1			5
20 -29	15	12	15	13	10	7	9	13	12	8	114
30 -35	8	4	5	3	8	3	3	6	6	7	53
36 & above		2	3	1	2			4	3	2	17
Total	**23**	**20**	**24**	**17**	**20**	**10**	**13**	**24**	**21**	**17**	**189**

This table shows that majority of the PPH deaths are in the age group 20-29. Maximum delivery rate in the state also belongs to this age group.

Table 2: Parity Score at the time of admission (P_0 becomes primiparous after delivery.)

	2010	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	Total
P0	8	9	7	8	4	4	6	10	6	8	70
P1	9	5	11	7	9	3	3	9	8	5	69
P2	3	4	2	2	4	3	2	3	3	4	30
P3 &above	3	2	4		3		2	2	4		20
Total deaths due to PPH	**23**	**20**	**24**	**17**	**20**	**10**	**13**	**24**	**21**	**17**	**189**

This table shows that MMR is high in Primis and Para 2.This reflects the parity distribution of women in labour.

Table 3: Type of Obstetric hemorrhage

	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/2020	Total
Atonic	12	12	12	5	6	7	8	6	11	8	87(46%
Traumatic	8(3R)	7	5(1R)	10	10(2R)	3(1R)	4(1R)	9(1R)	6	6(3R)	68(35.9)
APH	2		4	1	1			2	1	2	13 (6.8)
Atonic + Traumatic					2		1	2			5 (2.6)
Placenta accreta	1	1	3	1				5	2	1	14 (7.40)
Inversion uterus					1						1 (0.52)
Lower segment PPH									1		1(0.52)
Total	**23**	**20**	**24**	**17**	**20**	**10**	**13**	**24**	**21**	**17**	**189**

R – Rupture uterus

This table shows that nearly 50% of the PPH deaths were due to atonic PPH. This stresses the importance of AMTSL. It is worrying that almost 7% was due to placenta accreta spectrum...

Table 4: Mode of delivery

	2010/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	Total
Total no of PPH	**23**	**20**	**24**	**17**	**20**	**10**	**13**	**24**	**21**	**17**	**189**
Vaginal spontaneous	13	12	11	7	12	5	9	9	9	9	**96**
Instrumental	4		2	3	3	3	2	4	3		**24**
Cesarean section	6	8	10	7	4	2	2	10	6	6	**61**
undelivered			1					1	2		**4**
Rupture					1				1	2	**4**

About one-third of the PPH deaths were after cesarean section. This shows the importance of practicing safe cesarean section technique and postoperative monitoring. Most of these deaths were due to intraperitoneal hemorrhage.

Table 5: Induction of labour (These observations may not be accurate)

	2010/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Total PPH deaths	23	20	24	17	20	10	13	24	21	17
Induced	7	6	6	6	7	3	5	6	6	4
Oxytocin augmentation	3	2	2	3	9	5	1	3	8	3

ABRUPTIO PLACENTA

Antepartum hemorrhage complicates about 6% of pregnancies and is detrimental to both mother and fetus. Abruptio placenta is one of the causes of APH and may occur as a sudden and unexpected obstetric emergency. The placental separation causes bleeding which may be concealed, revealed or mixed. The risk factors are hypertensive disorders, advanced maternal age and parity, trauma to the abdomen and folic acid deficiency.

The triad of sudden onset of abdominal pain, bleeding per vagina and tense tender uterus constitute the main diagnostic criteria. The diagnosis is usually clinical. An ultrasound examination is useful in determining the placental location and will help to rule out placenta previa. However, the sensitivity of ultrasound in visualizing placental abruption is low. During the acute phase of placental abruption, the hemorrhage is isoechoic and difficult to distinguish from the surrounding placental tissue. In severe cases, the woman can present in a state of shock, coagulopathy, renal failure and intrauterine death of the fetus. The amount of blood loss may often be underestimated in concealed variety. The typical classical features like a woody uterus may be absent when the placenta is posterior.

The management depends on the gestational age and the condition of the mother and fetus. Definitive management is termination of pregnancy. Maternal or fetal compromise calls for immediate cesarean delivery unless the woman is in advanced labour. In mild cases vaginal delivery may be attempted with continuous CTG

monitoring. If fetus is dead, the abruption is more severe and so delivery should be hastened. If labour is prolonged even with a dead fetus, cesarean should be considered for fear of maternal complications. Coagulation profile should be monitored very closely. Blood bank should be alerted for availability of blood and components. If coagulopathy is suspected, a midline vertical incision is ideal to open up the abdomen for cesarean section. PPH should be anticipated and so active management of third stage of labour should be practised. A couvelaire change by itself is not an indication for obstetric hysterectomy.

Learning from Examples

Example 1

27 year old,gravida 3, Para1, live 1, abortion 1, a known case of frontal lobe epilepsy on Levipil with expected date of delivery (EDD) on 7th was admitted on 6th. She was induced with misoprostol 2 doses. On 7th at 4.15 am, on vaginal examination, cervix was 4-5 cm dilated. ARM was done and liquor was blood stained. She delivered at 4.45 am. Baby was asphyxiated. She developed PPH and showed abnormal behaviour. Soon she developed DIC and was referred to medical college hospital where she reached at 7am in shock. She was resuscitated and shifted to operation theatre. Suction cannula was applied. Blood components were given. Though decision was taken for obstetric hysterectomy, she went into cardiac arrest at 10.15 am and death was declared at 11 am.

Learning points

1. Abruption is a sudden and unexpected obstetric emergency. Immediate management is securing vascular access and hastening delivery. Though the above patient delivered in half an hour, she developed PPH and its complications.
2. Abruption predisposed to atonic PPH and DIC. Aggressive management in the form of volume replacement, blood transfusion and steps to arrest bleeding was lacking.
3. Abnormal behaviour was due to cerebral hypoxia.
4. At the higher centre, she was resuscitated and initial management was by suction cannula, which can be used only as an initial measure. If the patient is in DIC, transvaginal uterine artery clamp may be a better option to reduce bleeding than suction cannula. Once the patient has gone into shock, surgical management should be considered and obstetric hysterectomy performed as a lifesaving procedure.
5. Aggressive management at the primary centre might have made a difference in the outcome.

Example 2

22 year old primigravida with EDD on 15th was admitted on 6th with a BP 140/90 mmHg. Started on tab.nicardia and investigations were sent. On vaginal examination, cervix felt unfavourable, hence induction was planned. She started leaking at 6.30 pm on the same day and progressed fast. Fetal bradycardia at 8.40pm. On vaginal examination, cervix was fully dilated and she delivered at 9.05 pm., a 3.09 kg fresh still born fetus. Retroplacental clots 350 gms. At 9.20pm, bleeding started, uterus was atonic. Intravenous fluids were started, followed by blood transfusion. She was referred to a tertiary care centre. Her condition worsened on the way and she was taken to a local hospital where death was declared.

Learning Points

- Abruption was severe enough to cause fresh still birth. She developed atonic PPH soon after delivery. Again PPH drill was not followed. Steps to arrest bleeding were not aggressive.
- Surgical management should have been done once medical methods failed. Correction of DIC along with measures to arrest bleeding should have been done from the same centre. Help

from senior obstetrician should be sought in such situations to save lives.

- Referral of a bleeding patient should be as per protocol with intravenous fluids, oxytocin and measures to stop the bleeding on the way, Nonpneumatic Antishock Garment (NASG) and if possible in an ICU ambulance with a proper reference letter and the referral centre informed in advance. The measures to stop the bleeding in such a setting can be tranvaginal uterine artery clamp.

Example 3

A 33 year old gravida 3, 1st FTND, 2nd LSCS. EDD July 16th. Hypertension detected on June 20th. Started antihypertensives and she was sent home. One week later, patient reported with pain abdomen,when her BP was 210/140 mm Hg. She was given labetalol intravenously and Magsulph also was started. On vaginal examination, os was closed. Suddenly patient became breathless with frothy vomitus, bilateral crepitations++, SpO2- 82%. She was given inj. deriphylline, lasix, and hydrocortisone and was referred to medical college. She died on the way. Postmortem report showed evidence of abruptio placenta and pulmonary edema.

Learning Points

1. When severe hypertension was detected at 36 weeks, she should have been admitted and evaluated or referred. All the relevant investigations should have been sent and termination of pregnancy considered.

2. Hypertension induced pulmonary edema at full term is an acute medical emergency with poor prognosis.

3. Resuscitation of the patient, management of pulmonary edema and an immediate cesarean section done from the same centre would have made a difference in the outcome.

PLACENTA PREVIA

The term "placenta previa" is used when the placenta lies directly over the internal os; when the edge lies within two centimeters of the internal os it is called low lying placenta. While the precise etiology of placenta previa is not known, previous studies have elucidated predictive factors such as high maternal age, twin pregnancies, previous cesarean section, previous uterine scar, grandmultiparity and ART pregnancies.

Prevention, early recognition and treatment of anemia during the antenatal period are recommended whenever placenta previa is diagnosed. Placenta has to be localized and it should be mentioned in the midpregnancy routine fetal anomaly scan. For pregnancies more than 16 weeks of gestation the term low-lying placenta is used when the placental edge is less than 20 mm from the internal os on transabdominal or transvaginal scanning (TVS). If the placenta is anterior, in the case of previous cesarean section one has to look for evidence of placenta accreta spectrum also. A follow-up ultrasound examination including a TVS with Doppler is recommended at 32 weeks of gestation to diagnose persistent low-lying placenta and/or placenta previa accreta. In women with a persistent placenta previa at 32 weeks of gestation who remain asymptomatic, an additional TVS is recommended at around 36 weeks of gestation to decide about mode of delivery. Women should be counseled regarding the risk of preterm labour, hemorrhage and the need of emergency transport to hospital and blood transfusion.

Timing of delivery should be tailored according to antenatal symptoms. As an unplanned preterm delivery may be required any time, a course of corticosteroids for fetal lung maturity may be administered at about 32 weeks. For women presenting with uncomplicated placenta previa, delivery should be considered electively between 36+0 and 37+0 weeks of gestation. In case of history of vaginal bleeding and risk factors of preterm

labour, cesarean section should be planned between 34+ to 36+6 weeks.

In women with a third trimester asymptomatic low-lying placenta the mode of delivery should be based on the clinical background, the woman's preferences and supplemented by ultrasound findings, including the distance between the placental edge and the fetal head position relative to the leading edge of the placenta on transvaginal scan. Vaginal delivery can be contemplated if the placenta is anterior and more than 2 cm away from the os. Indications for blood transfusion and hysterectomy should be reviewed.

Placenta previa and anterior low-lying placenta carry a higher risk of massive obstetric hemorrhage and hysterectomy. So delivery should be arranged in a hospital with blood bank facilities. Cesarean section for a woman with placenta previa should be carried out as an elective procedure by a senior obstetrician. Regional anesthesia is considered safe and is associated with lower risk of hemorrhage than general anesthesia unless it is an emergency for profuse bleeding. PRBC, FFP, and cryo-precipitate or fibrinogen concentrate are to be kept ready in blood bank. Consider vertical skin and/or uterine incisions when the fetus is in a transverse lie to avoid the placenta, particularly in preterm cesarean section. Localize the placenta preoperatively to optimise uterine incision. It is advisable to avoid cutting through the placenta in anterior placenta previa as it may lead to fetal exsanguination; either go below or above the edge. Control hemorrhage using uterotonic agents, bilateral uterine artery ligation and hemostatic sutures in the placental bed. Early recourse to hysterectomy is recommended if conservative medical and surgical interventions prove ineffective.

Learning from Examples

Example 1

27 year old, gravida3, para2 with EDD on 9th May. She had two previous cesarean deliveries. She was diagnosed to have central placenta previa. She was admitted on 16th March at 9.18 am (32+5 weeks) with history of fall in bathroom at 5 am, followed by altered sensorium. Patient was gasping on arrival, was in shock and soon developed cardiac arrest. She was resuscitated. USG showed hemoperitoneum and intrauterine death. It was diagnosed as rupture uterus and proceeded with laparotomy. Placenta was seen protruding through the previous scar and bladder was found opened up as it was densely adhered to the scar.

Classical cesarean followed by total hysterectomy was done. Massive transfusion was given. She was managed in ICU with ventilator support and ionotropes. She developed cardiac arrest and expired at 1.35 pm.

Learning Points

1. Adherent placenta was not suspected and diagnosed. The placenta had penetrated the scar and produced hemoperitoneum.
2. In all previous cesarean sections with placenta previa, if anterior, a colour Doppler USS should be done to rule out placenta accreta.
3. Once placenta accreta is diagnosed, patient should be referred to a higher centre if there is no facility to tackle it locally.

Example 2

27 year old, 3rd gravida, para 1, Live 1, abortion 1, with EDD on 28th August was diagnosed to have anterior placenta previa with breech presentation. During her antenatal visit on 28th July, at 36 weeks, she collapsed suddenly. Suspected internal bleeding and referred to medical college hospital where she reached in a dead state.

Learning Points

1. Placenta accreta was not diagnosed. If diagnosed could have referred early to a higher centre.
2. An immediate laparotomy and obstetric hysterectomy with resuscitation done at the same centre could have saved life. In this situation it would have been ideal to seek the help of another senior obstetrician and tackle at the same centre provided blood and blood products were available.
3. Placenta previa, if accreta needs to be terminated at the optimum time between 34 to 36 weeks depending on the extent of invasion. A systematic planned approach is needed making use of vascular clamps and the help of a urologist in a tertiary care centre. (See chapter on Placenta Accreta Spectrum).

Atonic PPH

Unfortunately atonic PPH still dominates the scene (nearly 50 % of all hemorrhage deaths). There were situations where this could be anticipated. However, in the majority of cases of atonic PPH, it was unpredictable. This highlights the importance of being prepared to tackle atonic PPH in every delivery, be it normal vaginal, instrumental or cesarean. Routine practice of preventive measures like active management of third stage of labour (AMTSL) becomes critical.

Learning from examples

Example 1

21 year old primigravida, EDD on 28th was admitted on 26th. Induced with oral PgE1 on 29th at 9am. At 4.10 pm, cervix fully dilated, thick meconium present. Vacuum delivery at 4.17 pm, baby 3.45 kg. AMTSL done. Patient developed atonic PPH by 4.25 pm. Medical management tried. Condom Tamponade applied. BP 150/110 mm Hg. I V labetalol given. Fluid resuscitation was followed by I pint PRBC. By 5 pm- urine 200 ml., Pulse 120/mt. BP not recordable. Referred to tertiary care where she reached in shock. Resuscitated and did emergency obstetric hysterectomy. Postoperatively she was on ventilator. LFT and RFT deranged. Acute kidney injury was managed by repeated dialysis. Her condition progressively worsened, developed sepsis, DIC and expired on 10thJune.

Learning Points

1. Once PPH developed, medical management tried. BP of 150/110 was probably due to the uterotonics. Soon she went into shock, which means volume replacement was not adequate.
2. Measures to arrest bleeding should be started along with resuscitation. Here condom tamponade was tried.
3. A transvaginal uterine artery clamp would have helped to arrest the bleeding and prevent the patient going into shock.
4. When condom tamponade failed, the next step is surgical management. Conservative methods should be tried first and obstetric hysterectomy considered as a lifesaving procedure. The steps to arrest bleeding should be attempted at the same centre as valuable time is lost when the patient is being referred.
5. The referral should be as per the protocol, Oxytocin drip, blood transfusion, condom tamponade, NASG and with a well written reference letter and preferably in an ICU ambulance.
6. At the higher centre, everything possible was done, but by that time the patient had gone into shock compromising renal function. Eventually, she developed sepsis and DIC.
7. It is the initial management which is crucial. All obstetricians should be trained in surgical management of atonic PPH.

Example 2

A 30 year old 3rd gravida, 1st FTND 11 years back, 1 abortion, EDC on January 8th. Had GDM and was on metformin. Hypertension detected near term. She was admitted on 6th and was induced with PgE1 sublingual at 11 pm and augmented with oxytocin next day at 6am. She progressed well and delivered at 10.55am. Baby 3.8 kg. She developed PPH after one hour. Carboprost and tranexamic acid given. Traumatic PPH was ruled out. Lower segment was flabby. Condom tamponade tried. I unit PRBC started and referred to medical college where she reached at 2.30 pm in shock. She was resuscitated and vaginal exploration done. Developed Ventricular tachycardia. Proceeded with obstetric hysterectomy as uterus was atonic and shifted to ICU. She had cardiac arrest and expired on 7th at 8.40 pm.

Learning Points

1. Mechanical methods should always be tried first for induction of labour. Sublingual misoprostol is against the recommendation by KFOG. Misoprostol softens the lower segment and is a cause for lower segment PPH. This is more with vaginal administration of misoprostol. Oral PGE1 50 microgm is recommended for this.
2. GDM with macrosomia is a risk factor for PPH. So in addition to 5 units slow IV, 10 units oxytocin IM and 20 units oxytocin infusion at a rate of 60 drops/minute was also indicated.
3. Condom tamponade will not be effective in lower segment PPH. The arrest of bleeding can be achieved by using Transvaginal uterine artery clamp. Another alternative is tight packing. Suction cannula may be less effective. Arrest of bleeding should be our prime concern.
4. Transporting a bleeding patient worsens the condition of the patient unless done in an ICU ambulance.
5. On arrival in the higher centre, valuable time was lost in vaginal exploration. However, later on an obstetric hysterectomy was done.

Example 3

A 33 year old G4P3L3 at 37 weeks, admitted in a private hospital at 2.50pm with labour pains. On vaginal examination - cervix soft, 75% effaced, 2 cm dilated, membranes +, vertex at -3. She was started on oxytocin (1 unit). Delivered at 5.13pm, oxytocin drip 20 units started, methergin given. At 5.45pm developed atonic PPH. Medical management tried, uterine massage, bimanual compression given. No cervical tears or lacerations. As blood was not available, referred to Medical college by 6.15 pm, where she died.

Learning Points

1. No need to induce or augment labour especially when multigravida comes in early labour.
2. AMTSL has to be practiced in every case. Once PPH develops, manage vigorously.
3. TVUAC (transvaginal uterine artery clamp), and suction cannula are the first aid measures in PPH.
4. Medical management has to be tried with the recommended drugs and doses.
5. Our responsibility does not end by referring. Stabilize the patient before referral, ensure safe transit, inform the higher centre in advance and accompany whenever possible.

Example 4

A 34 year old primigravida, GDM on diet control at 39 weeks, cesarean section done in second stage at 9:16 am for fetal distress, baby 3.3 kg. Following cesarean section, developed torrential bleeding and DIC and was referred to Medical College where she reached 2 ½ hours later. On admission, patient drowsy, in shock, blood stained urine 300 ml, pallor +++,

bleeding continuing. Resuscitated with blood and components, intubated, and sutured the cervical and vaginal tears. Laparotomy done at 2:45pm - 2 litres of blood in the peritoneal cavity, bleeding from left uterine artery, same secured. B –lynch sutures applied, and right internal iliac artery ligated. Left internal iliac artery was difficult to reach. She developed pulmonary edema and Acute Renal Failure (ARF) and died at 6: 30 am next day.

Learning Points

1. Anticipate problems in second stage cesarean.
2. Extension of angle to involve uterine artery is common especially so in second stage cesarean, so be on the lookout for such problems before closing the abdomen.
3. Suturing cervical and vaginal tears in a post cesarean PPH patient in shock and DIC is challenging. If possible use blood components and correct DIC. Transvaginal uterine artery clamp can be considered in this setting.
4. Obstetric hysterectomy should be resorted to early, in cases of PPH in shock and DIC and not Brace sutures or stepwise devascularization.
5. Internal iliac artery ligation is for traumatic PPH and not atonic PPH and not advisable for patients with DIC.

PPH Traumatic

The number of cases of traumatic PPH was less but still significant. As can be expected with a high cesarean delivery rate, traumatic PPH related to cesarean section was found to be high. The chapter on cesarean delivery will highlight the technical modifications to prevent this type of PPH. For the same reason and because of low rates of vaginal instrumental deliveries, vaginal and cervical trauma leading to PPH was considerably less.

Learning from Examples

Example 1.

35 year gravida 3 para1, EDD on June 20th. Admitted on 9th June with mild pains. On the next day oxytocin drip started at 11.40 am. ARM at 4.30 pm. Delivered at 5.07 pm by vacuum. Baby 2.5 kg. IV Methergine given. Patient developed profuse bleeding. Uterotonics given. Suspected cervical tear, and as she was not cooperative tear was sutured under general anesthesia in theater. Uterus was contracted.Vaginal bleeding noted at 6pm., BP 80/60 mm Hg., pulse 140/ minute. She was referred to MCH, where she reached in irreversible shock. Resuscitated. Uterus was found contracted. Death at 9 pm.

Learning Points

1. Being a multigravida there was no indication for induction with oxytocin 11 days prior to EDC.
2. IV methergine is not recommended now a days. Instead five units oxytocin is given IV as slow bolus followed by 10 units oxytocin IM.
3. After instrumental delivery, thorough inspection of the genital tract is mandatory to rule out cervical tear and vaginal lacerations.
4. Traumatic PPH is best tackled in the theatre under anesthesia with good light, deep retractors and good assistants. In the above case somehow the suturing was ineffective.
5. Tight packing of the vagina after suturing will help to prevent further bleeding.
6. In intractable traumatic PPH there is a place for internal iliac artery ligation followed by suturing the vaginal lacerations.

7. In transporting a patient with traumatic PPH, tight and effective packing along with IV fluids and NASG will help her to reach the higher centre in a better state.

Rupture uterus

There were 12 cases of rupture uterus reported during this period. Two of them were due to rupture of previous cesarean scar. Three of the 12 had instrumental deliveries with cervical tear extending upwards. In two of these, this upward extension was not recognized at the primary centre. In two cases the rupture was diagnosed at autopsy only. Rupture due to placenta accreta was not included in this series of rupture uterus.

One patient was brought in at 24 weeks of pregnancy and died soon after. Rupture uterus was suspected but was not confirmed. She had a laparoscopic myomectomy and had conceived soon after that. This case is not included in this series of rupture uterus as confirmation was not possible, but the circumstances strongly points to that possibility

Lower segment PPH

A new entity which we would like to call "lower segment PPH" is evolving. It has characteristics different from atonic and traumatic types of PPH and hence the need to designate it separate from the other two classical types. We feel that this is the result of some steps that are now established in modern obstetric practice – induction with mechanical methods and prostaglandin ripening and the use of smooth muscle relaxant agents late in labour with the hope that it will speed up the process of labour. We suspect, but have no proof to establish, that the much more prolonged second stage of labour recommended from some quarters (four hours in primi and three hours in multi) also will contribute to this new entity of PPH.

Typically the bleeding is continuous and of fresh blood. The upper segment will remain contracted and there may not be any obvious lacerations in the perineum, vagina or cervix. A ballooned out lower segment is easily appreciated. Blood may come out of the cervical canal either in bouts or continuously. A history of use of vaginal prostaglandin is almost always present. The clinical features make diagnosis fairly easy. It is worth checking whether drugs like drotaverin, epidosin or hyoscine were used late in labour. It is important to specifically ask about it because in some hospitals this has been included as a routine to be administered by nurses without an order from the doctors.

The first aid to stop the bleeding is to apply transvaginal uterine artery clamps (described later in this chapter). Alternative approach will be to use packing of the lower segment or Bakri balloon. We are not sure whether the condom tamponade will help in this situation.

The pathophysiology is easy to understand. The prostaglandins (E1 &E2) make the lower segment, cervix, and upper vagina edematous, congested and easy to tear. With the passage of the fetus and the resultant stretching, lacerations occur easily resulting in bleeding. If smooth muscle relaxants like drotaverin, valethamate or hyoscine had been used, that interferes with the contraction of the vessel walls and thrombus formation which are nature's safeguards against ongoing bleeding.

Definitive treatment is to apply pressure as described above with the use of packs after the initial use of transvaginal uterine artery clamps.

Obstetric hysterectomy

Table 6: PPH cases undergoing Obstetric hysterectomy

Year	PPH deaths	Obstetric hysterectomy
2010/11	23	13
11/12	20	7
12/13	24	10
13/14	17	7
14/15	20	9
15/16	10	6
16/17	13	7
17/18	24	12
18/19	21	8
19/20	17	9
Total	**189**	**88**

This table shows that in 46.5% of PPH deaths women had undergone obstetric hysterectomy. The reasons for hysterectomy varied. They included placenta accreta spectrum, cesarean complications, rupture of uterus, uncontrolled bleeding as happens with DIC etc. The following points have relevance in obstetric hysterectomy. .:

1. Midline vertical incision for patients in DIC
2. Simultaneous correction of coagulation defects
3. Double ligature of vascular pedicles
4. Inspect under Rectus sheath for bleeders
5. Intraperitoneal drain
6. Subtotal hysterectomy as far as possible.

Table 7: Relaparotomy after primary surgery

Year	Relaparotomy
2010/11	5
2011/12	5
12/13	5
13/14	6
14/15	3
15/16	3
16/17	3
17/18	5
18/19	4
19/20	7
Total	**46**

In a significant number (table 7) relaparotomy had to be done after primary surgery because of suspected intraperitoneal bleed. This emphasizes the importance of securing all bleeding points during primary surgery.

New Thoughts on Management of PPH

A paradigm shift is required in all aspects of PPH management – preparedness, prevention, diagnosis (estimation of blood loss), immediate response (first aid) and definitive management.

Preparedness

PPH has to be expected in every delivery – vaginal or cesarean. If excess blood loss is promptly recognized and appropriate action taken, the vast majority can be prevented from progressing to PPH. However, it is only prudent to ensure availability of blood if there are risk factors like multiple pregnancy, hydramnios, macrosomia, or past history of PPH.

The other, and all too often neglected aspect of preparedness, is in ensuring the availability of adequate light and instruments like cervical inspection set. The light should be such that it can be adjusted to illuminate deep inside the vagina. Cervical inspection set should have appropriate sized retractors and sponge holding forceps. They should be of sufficient length and width to expose the dilated birth canal soon after delivery.

PPH box is another requirement. It should contain items which are immediately required to attend to bleeding patient— items like cannula of size 16G, syringes, blood collection tubes for labs, sticky tape, elastic tubing or arm band to make the veins prominent for venipuncture, small scissors to cut plaster, intravenous set, intravenous fluids like normal saline etc. The contents of the box should be checked by the head nurse at fixed intervals and the dates displayed.

Often the excuse mentioned in not keeping a PPH box is that the labour room has a crash cart. The crash cart will be opened only when the patient has collapsed, an event which we want to prevent.

Prevention - Active Management of Third Stage of Labour (AMTSL)

The main points of AMTSL developed and practised by the Quality Standard project of Kerala, a joint venture of Kerala Health Services, KFOG and NICE International are mentioned here:

1. Administer 5 units of oxytocin diluted to 5ml with sterile water or saline and give intravenously as a bolus, taking about five seconds, at the delivery of the anterior shoulder or within one minute of delivery of fetus, after excluding multiple pregnancy.
2. Administer 10 units of oxytocin IM.
3. If the patient has risk for PPH (e.g.: operative delivery, prolonged labour etc.)or is found to have excess bleeding, give intravenous oxytocin as drip 20 units in 500 ml at the rate of about 60 drops per minute.
4. Wait for about one minute for cord clamping and cutting if the fetus is in good condition. In case the fetus needs immediate resuscitation, clamp and cut the cord as soon as possible and hand over the fetus for resuscitation.
5. Try to deliver the placenta without waiting for the conventional signs of placental separation. For this ensure that the uterus is well contracted; push the contracted uterus upwards and apply traction on the umbilical cord. If the placenta is not yielding check whether it is trapped by the cervix in which case it may be delivered by traction on the edge of the placenta. If there is no bleeding one may wait up to 30 minutes trying to deliver the placenta every five minutes by controlled cord traction. If still not delivered, consider manual removal of placenta.

Carbetocin

The new oxytocic drug in the market is carbetocin. It has the advantage that stringent thermal control is not required for storage. It is reported to be an effective oxytocic agent and should be considered for use in atonic PPH. We have not started using it as it is not yet freely available and hence cannot comment on its usefulness.

Estimation of blood loss and diagnosing PPH

Clinical estimation of blood loss is almost always an underestimation. Some sort of objective measurement is ideal. Inspection of soaked mops is not practical, as in most labour rooms pads rather than mops are used to mop the blood. Suction for blood is not regularly used in most labour rooms. Collection of blood in tailed plastic or rubber

devices like Kelly's pads is useful but not widely available. We have found the absorbent mat kept under the buttocks a suitable way of assessing blood loss by checking the weight difference before and after use. There is the risk of amniotic fluid mixing with blood and making the estimate erroneous. To some extend this is overcome by putting a new absorbent mat after the fetus is out, by which time liquor would have drained off. The weight gain of the second mat in grams is converted to millilitres and taken as the measure of blood loss. Loss of blood from episiotomy site can be assessed by mopping it up separately prior to delivery of the fetus and adding to the weight gain of the second mat.

Immediate response when PPH is observed

Just like any bleeding during surgery, the first reflex action of the obstetrician should be to stop the bleeding. Most of the mnemonics taught for management of PPH (e.g.: the 4 Ts) ignore the fundamental principle of the need to arrest the bleeding as the first response. To some extent this would have been due to the nonavailability of practical steps to stop bleeding from an atonic uterus. The first aids suggested were either to use bimanual compression of uterus or aortic compression. Both these steps are difficult to execute effectively in a conscious patient soon after delivery, especially if she is obese. We have developed techniques to overcome this problem. They are the transvaginal uterine artery clamps and the aortic/ common iliac artery clamps that can be used when the abdomen is already opened.

Transvaginal uterine artery clamps

This modified sponge holder, with right angled bend about 2cm from the tip and the blades keeping a distance of about 5 mm between them even when the clamp is closed to the maximum is specially devised to occlude the uterine arteries transvaginally (Fig 2).

The application is easy and can be done without any anesthesia. The operator pulls the anterior and posterior lips of the cervix and applies the clamp with one blade going into the cervical canal and the other at the lateral fornix of vagina. Upward pressure on the fornix will allow the tip of the uterine artery clamps to advance by about 1.5 cm to reach up to the level of the isthmus of the uterus where the uterine artery after joining the side of the uterus ascends up. It is possible that the ureters may also get occluded but blocking the ureters for a few minutes is non-consequential. Because of the gap between the blades, compression damage of the edematous tissues will be minimized.

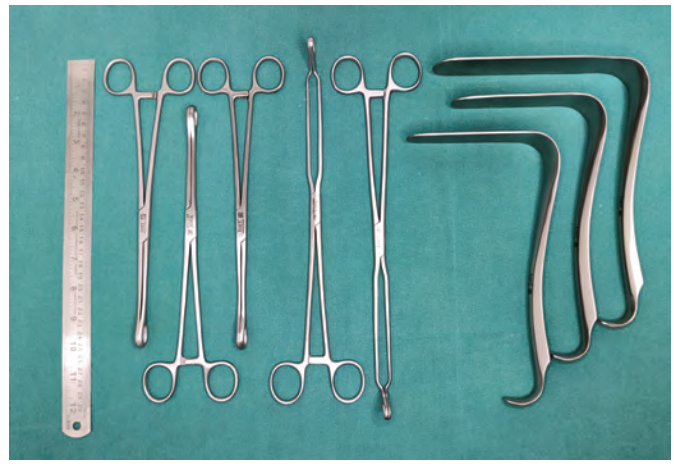


Fig: 2 : TVUAC set

One should realize that when both uterine arteries are occluded, the uterus may remain flabby. This should not be of concern, as long as the patient is not bleeding.

Suction cannula for PPH

Dr.Samartha Ram presented the idea that in atonic PPH, if a cannula is inserted inside the uterine cavity and sufficient negative pressrure is created, the uterine walls will collapse on to the cannula making the muscular walls rigid. Blood vessels passing through the myometrium will get constricted by the rigid myometrium and the bleeding will stop. He developed cannulas of different sizes and shapes. Later Dr. Vasudeva Panicker brought out a cannula which was 12mm

in diameter and 25 cm long. In the distal 12cm of the tube there are multiple holes on the sides. Both varieties are used in different parts of Kerala.

The cannula is introduced into the uterine cavity through the vagina to reach the fundus and is connected to a suction apparatus, and negative pressure of 650 -700 mm mercury is produced. The negative suction results in aspiration of all the blood collected in the uterine cavity. The quantity of blood sucked varies from 50 -300 ml. When the collected blood is completely sucked out, the bleeding ceases usually. The suction is maintained for 30 minutes. Then the cannula is taken out slowly after releasing the suction. The uterus is well contracted by this time. The inner surface of the uterine cavity gets strongly sucked by the cannula. All the bleeding vessels including arterioles and sinusoids get permanently closed due to clot formation within 30 -40 minutes. This is a very simple, safe, sure and inexpensive technique to control PPH. Instead of using suction machine, a mechanical suction unit of Ventouse can be used. If recurrence of bleeding occurs the suction is applied for 10 minutes every hour for three hours. The cannula can be kept in position even upto 24 hours if recurrence of bleeding is expected.

Cannula removal: When negative pressure is applied, the soft cervical tissue get sucked into the perforations of cervical portion of the cannula and become adherent. For the same reason cannula cannot be removed easily after completion of the procedure. The cannula can be removed after gentle separation of these adhesions with finger manipulation. Rough separation of adhesions results in cervical injury and bleeding. Cannula should not be removed immediately after stopping negative pressure.

Aortic / Common iliac artery clamp to stop bleeding

The second conventional recommendation, other than bimanual compression of uterus, is to apply aortic compression. As was stated earlier, this is not easy, nor effective, especially when the patient is obese. We have developed an atraumatic clamp which can be used to compress the aorta directly when the abdomen is open. This was originally developed to occlude the common iliac arteries while doing surgery for placenta previa accreta(described in detail in the section on placenta previa accreta). However, it can be used in any situation where the abdomen is open and bleeding from the genital tract has to be arrested. In day to day obstetric practice, such occasions are likely to come up during cesarean section or when PPH is recognized and the patient is in shock and DIC. The clamps can be applied without dissecting and isolating the vessel, which is a requirement for most of the other vascular clamps. In obstetric emergencies, such dissection in the retro peritoneum close to the vena cava can be dangerous. In developing the clamp, the aim was to develop an instrument that can be used by an obstetrician.

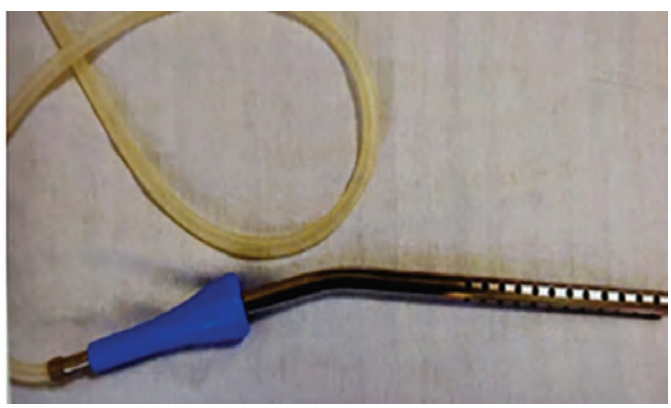


Fig 3 Vasudeva Panicker's Cannula

Fig 4 Samartha Ram's Cannula

Other new approaches to stop the bleeding - Tranexamic acid

TXA (Tranexamic acid) should be administered at a fixed dose of 1 g in 10 mL (100 mg/mL) IV at 1 mL per minute (administered over 10 minutes), with a second dose of 1 g IV if bleeding continues after 30 minutes. It is recommended that TXA should preferably be administered within three hours of the onset of bleeding.

Further management of PPH -

The PPH Drill

Once PPH has been identified, and steps taken immediately to arrest the bleeding ordinarily there will be no further bleeding. However, if bleeding persists, further management may be considered under four headings (note the acronym CRMD - C – Call for help, R –Resuscitation, M – Monitoring and investigation, and D – Deal with bleeding).

In hospitals with Obstetric Rapid Response Team (ORRT)the team may be alerted. The team member will help in management in a systematic way (See the chapter on ORRT).

1. Call for help
   - Call experienced obstetricians
   - Alert Anesthesiologist
   - Alert blood transfusion service
   - Call more staff – nursing/paramedics
2. Resuscitation
   - IV access (16G Cannula x 2)
   - Head down tilt
   - Oxygen by mask at 8 litres/minute
   - Transfuse blood as soon as possible
   - Keep the woman warm
   - Until blood is available, infuse (as rapidly as required) **Crystalloid** (e.g.: Normal saline and Ringer lactate(maximum 2 litres), **Colloid**(Hydroxy Ethyl Starch preferred) maximum one litre.
3. Monitoring and Investigation
   - Blood for cross match
   - Full blood count
   - Coagulation screen
   - Continuous pulse and blood pressure monitoring (using pulse oximeter, ECG and automated BP recording)
   - Foley catheter to monitor urine output
   - Central venous pressure monitoring (once appropriately experienced staff available for insertion)
   - Consider transfer to Intensive therapy unit
4. Deal with Bleeding
   - The commonest cause of primary PPH is uterine atony. However, careful clinical examination must be carried out with the patient in lithotomy position and with good light to exclude traumatic PPH and retained products. A cervical inspection set must be kept ready in all labour wards.
   - Evaluate the 4 Ts of PPH

     Tone - Atonic uterus

     Tissue - Retained products (placenta, membranes, clots)

     Trauma- Vaginal/cervical lacerations, hematoma, rupture uterus

     Thrombin - Coagulation failure

When uterine atony is the cause of bleeding, the following measures should be taken.

- Transvaginal uterine artery clamp or suction cannula should be used to stop the bleeding.
- Repeat the dose of methergine and oxytocin.

  Methergine 0.2 mg IM, may be repeated every 30 minutes up to five doses (i.e. total 1mg). Oxytocin infusion 20 units in 500 ml of normal saline at a rate that it controls the uterine atony (about 60 to 90 drops/min).

- Carboprost 0.25 mg IM (may be repeated every 15 minutes up to a maximum of 8 doses).
- Rectal misoprost 600 μg may be used, is found to be less effective compared to oxytocin, but is useful while transferring the patient to other centre.
- Ensure bladder is empty (Foley catheter –leave in situ).
- Condom/ Balloon tamponade. Smaller centres should transfer the patient at least at this stage to tertiary care centres. Before transferring it is worthwhile to try condom tamponade or packing and Nonpneumatic Anti Shock Garment (NASG).(see below).

Uterine Packing

Uterine packing can be effective in controlling PPH if performed correctly. After holding the cervix with ring forceps, thick rolls of gauze or surgical mops is fed into the uterus over the operators fingers which are inserted along the posterior wall of the vagina into the uterine cavity.

Condom tamponade to control Postpartum hemorrhage.

Hydrostatic balloon tamponade using a catheter fitted with a condom to control massive postpartum bleeding was first reported from Dhaka, Bangladesh. In an observational study during 2000 to 2001, 23 women with PPH due to uterine atony with uncontrolled bleeding despite administration of uterotonics had the condom catheter placed and the bleeding was reported to have stopped within 15 mts[1]. Oxytocin IV drip was continued and condom catheter was removed after 24 to 48 hours. No further intervention was necessary. We have tried this method in many atonic PPH patients with very good results.

Steps

- Keep the bladder empty by Foley's catheter.
- Insert a sterile catheter into the condom (plastic catheter like Nelaton's or Ryle's tube), preferable to use two condoms one inside the other and tie it tightly at the neck of the condom. It should be sufficiently tight to prevent leakage but at the same time not too tight to occlude the lumen of the catheter. Catheter should project about 4" inside the condom. An additional plastic catheter outside the condom (with the tip at 1" lower level) tied to the other catheter will drain any collected blood beside the distended condom and warn about ongoing bleeding. Insert the condom inside the uterine cavity up to fundus by holding the tip of the catheter gently with the sponge holding forceps.
- Pack the cervix and vagina to prevent the condom from slipping down.
- Give 15^0 head down tilt.
- Connect the catheter (the one with tip inside the condom) to a saline set and fill the condom with 300 to 500 ml of saline.
- Maintain the uterine contraction by continuous oxytocin drip and abdominal binder.
- Condom is kept in place for about 24 hours. While removing let out the fluid stepwise, 100 ml per hour.
- Bakri Balloon[2] - This is an alternative to condom tamponade. The advantage is that it is sturdier and hence can be used in traumatic PPH situations like vaginal lacerations. The 60 ml syringe and three way adapter is part of the set and helps to distend the balloon upto 300 to 400ml capacity. The central lumen will allow collected blood inside the uterus to drain out.

Surgical Methods

- If conservative measures fail to control hemorrhage, initiate surgical methods to arrest bleeding. At laparotomy, direct intra myometrial injection of carboprost 0.5mg can be given.

Surgical steps to arrest bleeding from atonic uterus

The steps that we would consider are -

- Stepwise devascularization
  - Bilateral uterine artery ligation
  - Bilateral ligation of the anastomosing branch of the ovarian artery close to the cornua.
- Brace stitch
- Internal iliac artery ligation
- Obstetric hysterectomy

Stepwise devascularization

This was promoted by Abd Rabbo from Egypt[3]. He recommended sequential tying of the ascending branch of uterine arteries at the isthmus, the descending cervical branches, and the anastomosing branches of uterine artery with the ovarian artery close to the cornual region.

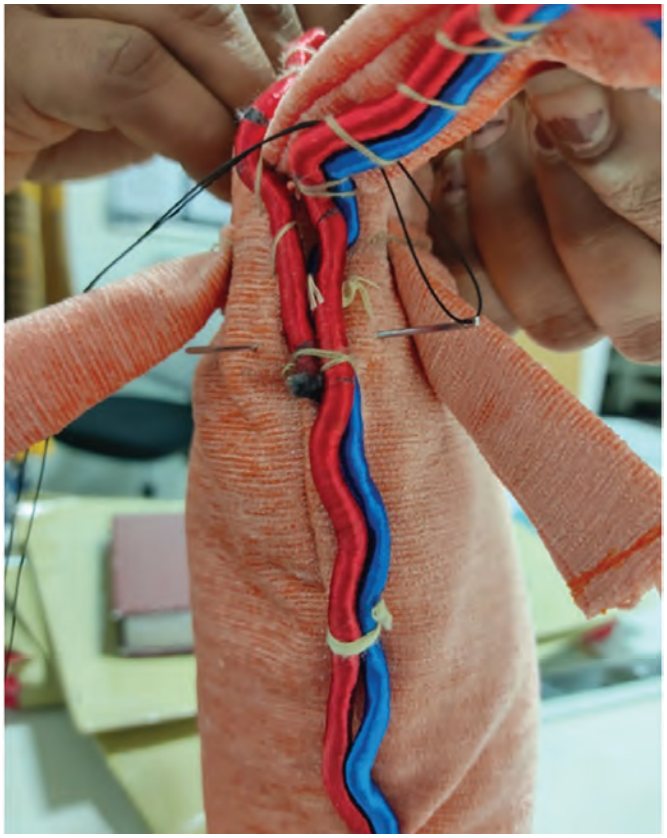
In practice, the sequence we have been following is –

1. Bilateral uterine arteries (ascending branch) on both sides
2. Bilateral anastomosing branches at the cornual region.
3. Descending cervical branch of the uterine arteries

1. For uterine artery ligation, the uterus is exteriorized, bladder is pushed down, the suture is passed from front to back about 2 cm medial to the edge of the isthmus. The suture is then brought back to the front, lateral to the uterine artery and vein but medial to the round ligament. Transillumination at the point will help to avoid accidental injury to the vessels when needle is passed from front to back. One should take care to avoid injury to the bowels.

2 Tying the anastomosing branch of the uterine artery and the ovarian artery

They meet at the cornual region. One should make sure that the horizontal terminal branches of the ovarian artery in the broad ligament and the ascending terminal part of the uterine artery are included in the ligature without damaging the tube. The suture should go through the myometrium.



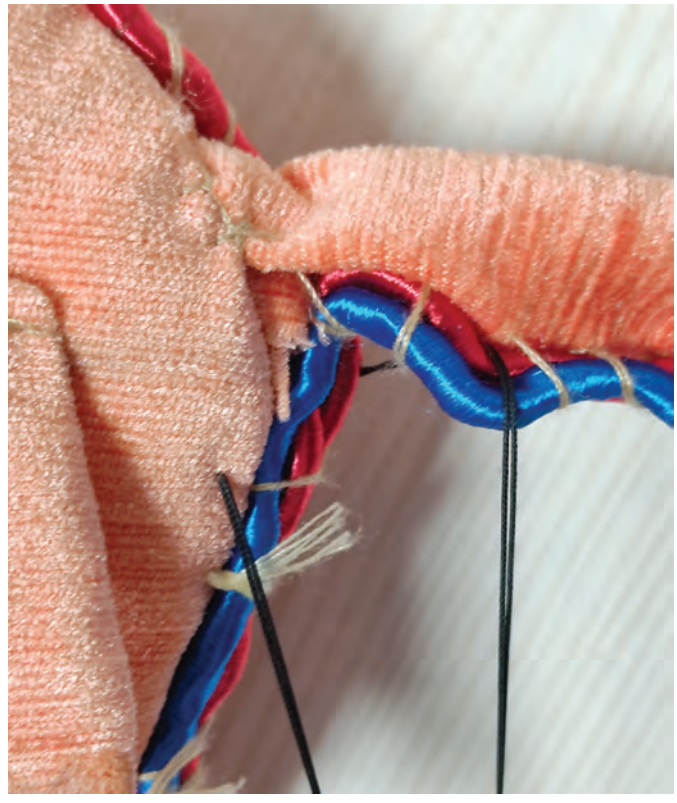


Fig 5 & 6 : Demonstration of cornual stitch to occlude anastomosing branch of uterine and ovarian arteries

3. Descending cervical branch of the uterine arteries

These need to be tied only in case there is bleeding from the lower segment or the cervix. For this, one has to push down the bladder really well and ensure that ureter is protected.

Brace stitch

The concept of brace stitch was brought in by B Lynch[4]. Since then there were many modifications. A simple but effective modification is by Hayman, Arulkumaran and Steer [5]. We find this simple and easy. No. 1 vicryl or similar delayed absorbable suture material is used. The stitch is taken first at the level of the isthmus, 2cm medial to the lateral border of the uterus and is made to run over the fundus medial to the insertion of the tubes. Once the same suture is taken on the other side, the assistant compresses the uterus and the surgeon ties the suture over the fundus, making sure that it is really tight. The brace stitches will help to keep the walls of the uterine body compressed anteroposteriorly thus occluding the arcuate arteries.

Internal iliac artery ligation

The occasions to tie the internal iliac arteries have come down drastically after the stepwise devascularisation and brace stitches became popular. These days we seldom do it for atonic PPH; instead it will be useful in traumatic PPH involving cervix or vagina.

There are two approaches to internal iliac arteries – the broad ligament approach and the direct approach.

Broad ligament approach

Here, one extends the incision on uterovesical fold of peritoneum (what is usually put for cesarean section) and extend it laterally to the pelvic brim where the external iliac artery is identified by its pulsation. By blunt dissection one can trace the external iliac artery cranially to reach the common iliac artery. The dissection is then extended medially to identify the internal iliac artery. About 2-3 cms below the origin of the internal iliac artery, the vessel is isolated by running an artery tip on either side. The vessel can be gently lifted up with Babcock forceps and a right angled clamp (Mixter) is passed under the vessel to get a suture passed underneath it. The suture usually used is 1 zero delayed absorbable like Vicryl.

One has to take care that the veins lying close to the artery is not injured.

Direct approach

We usually resort to the direct approach when internal iliac artery ligation is needed after hysterectomy. The vessel is identified by tracing down from bifurcation of common iliac artery. The peritoneum over the internal iliac artery is incised and the vessel is isolated and ligated as in the broad ligament approach.

Obstetric Hysterectomy

During obstetric hysterectomy (preferably subtotal except in problems like cervical tear) arresting the bleeding at the earliest is crucial. If the situation allows, a second obstetrician should also be involved in the decision for hysterectomy. Adopt "clamp, cut and drop" technique. Pedicles can be ligated after the uterine arteries are clamped or even after removal of the uterus. Double ligatures have to be used for the pedicles. The seemingly avascular tissues which are cut during the procedure are also to be ligated.

Promoting the concept of 4th stage of labour

There is no universal agreement regarding the duration of 4th stage of labour. We have proposed it as two hours after complete delivery of the placenta. This stage needs close monitoring of the patient, as unrecognized bleeding during this stage has led to maternal death. Recording of pulse and blood pressure alone will not be enough to pick up the bleeding early. We insist that in addition to the above, the observer should check whether the uterus is contracted and also whether there is any abnormal bleeding per vagina. For making this observation systematic, we recommend that these points be marked in the observation sheet using a stamp which has the points to be noted.

Time After delivery	Half hour	One hour	One and half hour	Two hour
PULSE				
BP				
UTERINE FUNDUS				
BLEEDING				

Fig: 7 : Stamp to enter 4th Stage findings. (Alternatively, this can be printed at the back of partogram)

When there is shortage of staff (nurses), the fourth stage observations are usually ignored or compromised. It is possible to instruct the companion of the patient to observe these points and alert the nursing staff if any abnormality is found – another valid reason to allow a companion in labour room!

Reactionary and Secondary Hemorrhage

This has assumed significance with the large number of cases reported post cesarean with intraperitoneal bleeding. In 35 out of 61cesarean associated PPH deaths relaparotomy was done (see the table).

Table 8. Number of cases of relaparotomy in cesarean associated PPH deaths

year	Cesarean associated PPH	who had relaparotomy following cesarean
2010/11	6	3
11/12	8	4
12/13	10	4
13/14	7	4
14/15	4	3
15/16	2	1
16/17	2	1
17/18	10	5
18/19	6	4
19/20	6	6
Total	61	35

Add to this the large number of women saved by relaparotomy after cesarean delivery and the magnitude of the problem will become obvious. Almost all these cases had bleeding from the angle of cesarean wounds. That is why we emphasize the need for modifying the technique of angle closure in cesarean wound. Separate box stitches are to be taken on both angles before the running stitch is taken to approximate the edges. A ragged wound at the angles with receding vessels is the usual reason for failure to secure the bleeders. The operator should look for any irregular extension of the wound and approximate the edges. The torn vessels may remain in spasm and unless one deliberately looks for them, they are likely to be missed.

These points about cesarean wound closure will be re-emphasized in the chapter on cesarean section.

Transportation of the patient to tertiary care: Non pneumatic Anti Shock Garment (NASG,The Life Wrap).

Many patients succumb, especially in the developing countries, on the way to higher centres. We looked at the transportation need of those who died due to PPH (Table 9).

Table 9. Referred cases

Year	PPH deaths	Referred cases from Periphery
2010/11	23	18
11/12	20	16
12/13	24	19
13/14	17	15
14/15	19	14
15/16	10	6
16/17	13	11
17/18	23	10
18/19	21	10
19/20	17	9

One hundred and nineteen(119) out of 189 died after referral to a higher centre. They either died after reaching the higher centre or on the way. We feel that there are two ways to address this issue. First of all the need for referral should come down. If the team at the primary centre can stop the bleeding promptly emergency transportation may not be needed. With measures like TVUAC and suction cannula, PPH can be arrested promptly. The second aspect relates to the ambulance service. Efficient and safe ambulance service will ensure that the patient reaches the higher centre in better condition. In addition easy availability of blood and blood products and wider utilization of techniques like antishock garments are steps to be considered urgently.

NASG

For women suffering from uncontrollable PPH, a method to reverse the shock, and stabilize the patient for safe transport to a comprehensive obstetric care facility could be lifesaving. One method to manage PPH is the use of a non-pneumatic anti-shock garment (NASG). The NASG is a lightweight neoprene garment that is made up of five segments that close tightly with Velcro. The NASG applies pressure to the lower body and abdomen, thereby stabilizing vital signs and resolving hypovolemic shock. When fitted correctly, the NASG shifts blood from lower extremities into circulation thus maintaining perfusion of the vital organs.

Operating steps

- Place NASG under woman
- Close segments 1 tightly around the ankles
- Close segments 2 tightly around each calf
- Close segments 3 tightly around each thigh
- Leave knees free
- Close segment 4 around pelvis
- Close segment 5 with pressure ball over the umbilicus
- Finish closing the NASG using segment 6
- Segments 1, 2, 3 can be applied by two persons simultaneously, segments 4, 5, 6 should only be applied by one.

The NASG is very simple to apply and training in application is rapid. After applying NASG she can be safely transported to a referral hospital for emergency obstetrical care.

The abdominal panel stretches so that external uterine massage or compression can be accomplished. The majority of the pressure exerted by the device is in the abdomen, retro-peritoneum, and pelvis, reducing hemorrhage immediately upon application. The design permits perineal access for performing vaginal procedures. Laparotomy also can be performed by simply opening the abdominal segment immediately prior to beginning surgery, and then replacing this segment when surgery is completed; removal of the device for surgery is not necessary.

When and how to remove

NASG can be removed when hemorrhage is less than 50 ml /hour, pulse rate less than 100/minute and systolic BP between 90-100 mm of Hg for two hours. The removal of each segment is in the same order of its application and is incremental. Vital signs are monitored for fifteen minutes to ensure hemodynamic stability before proceeding to subsequent segments. If pulse rate rises by 20 / minute and BP falls by 20 mm of Hg, the released segments have to be reapplied.

After using, NASG can be disinfected, washed and dried and stored in labour room for further use in emergencies.

Fig: 8 NASG

The NASG device is simple, cheap and reusable. It is easy to teach its usage. The investment required is also not heavy. What is preventing its wide spread usage in Kerala is the lack of a co-ordinated effort from an agency like the government. The Tamil Nadu government has promoted the use of NASG as a government policy and procured and supplied it widely in the government hospitals. Colleagues in Tamil Nadu talk highly about the use of NASG and its advantages. However, one has to accept that most of these are based on subjective impressions and not objective studies. WHO also has started to recommend it based on studies from other countries. It is time that the government of Kerala considers large scale purchase and supply to at least all the government hospitals. Such a move at the central level is essential to ensure compliance. When a peripheral hospital refers a patient with a NASG already applied the receiving centre should be able to give a replacement. Washing and upkeep of the garment has to be done on a regular basis.

Massive Transfusion Protocol (MTP)

We feel that there is no other specialty except accident and emergency department, which may be in need of massive blood transfusion without prior warning. Hence it is imperative that each labour room has a massive transfusion protocol which can be activated when the need unexpectedly arises. There are established guidelines available in other countries which can be adapted to suit our requirements.

All too often the obstetrician and his team will have to spend their time and efforts in co-ordinating and ensuring the supply of blood and blood products. When others look into this aspect, the obstetric team can focus on steps to stop the bleeding and resuscitating the patient. MTP mimics whole blood during massive transfusion by transfusing packed red blood cells (PRBCs), platelets, and fresh frozen plasma (FFP), with fresh frozen plasma supplying the coagulation factors. Many experts advocate for a 1:1:1 ratio of FFP, platelets, and PRBCs. The use of cryoprecipitate, fibrinogen concentrate, and recombinant factor VIIIa have been used with mixed results.

Targets of resuscitation in the setting of massive transfusion include:

- Mean arterial pressure (MAP) of 60 to 65 mm Hg
- Core temperature greater than 35$^{R''}$ C
- Hemoglobin 7 to 9 g/dL
- Platelets greater than 50,000
- INR less than 1.5
- Fibrinogen greater than 1.5 to 2 g/L
- pH 7.35 to 7.45

Complications of Massive Transfusion Protocol

Major complications of massive transfusion are hypothermia, metabolic alkalosis, hypocalcemia, and hyperkalemia. Non-fatal complications are seen in more than 50% of patients when more than 5 units of blood products are transfused. The traditional complications of blood transfusion like transfusion related acute lung injury (TRALI) and transfusion associated circulatory overload (TACO) are also to be kept in mind .

Quality Standards to avoid deaths due to PPH (See chapter on Quality Standards in Obstetric Care)

1. Follow active management of third stage of labour
2. Observe fourth stage of labour (two hours) systematically.
3. If hypotension occurred in spite of intravenous fluid administration, use blood and blood products as appropriate.
4. Those who needed blood transfusion, be observed for at least 24 hours in intensive care/ high dependency units.
5. Identify placenta previa accreta by routine scan at 32 weeks for all previous cesareans and refer to higher centres.

Conclusions

PPH unfortunately still leads the causes of maternal deaths in the developing countries. We have to think and act differently to tackle this menace. The steps mentioned here convey the message that aggressive approach to stop the bleeding should be the first step. This, we believe, will help to prevent many maternal deaths due to hemorrhage.

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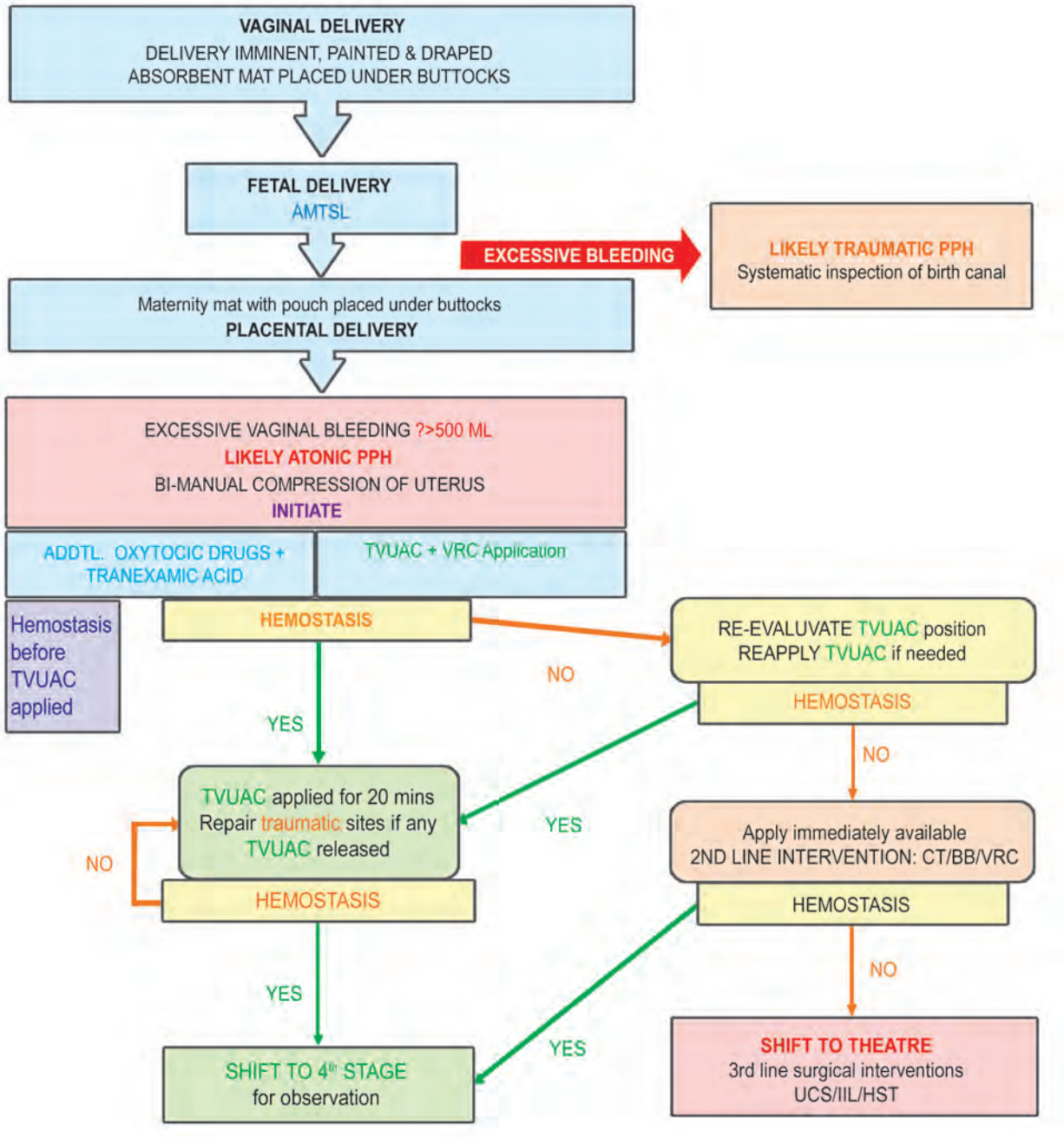
(See annexure for flow chart on PPH management)

Annexure

Flow chart on PPH management



AMTSL Active Management of Third Stage of Labour
TVUAC Trans Vaginal Uterine Artery Clamp
VRC Vacuum Retraction Cannula
CT Condom Tamponade
BB Bakri Balloon
UCS Uterine Compression Sutures
Hst Hysterectomy
IIL Internal Iliac Ligation

CHAPTER

06

Placenta Accreta Spectrum

(Abnormally Invading Placenta)

V P Paily, C P Vijayan,
R Beenakumary, Kunjamma Roy

Editors Note

The authors have given a brief description of a strategy to safely manage this life threatening condition- placenta accreta spectrum (PAS). The key element in the success story is the aorta/ common iliac artery clamp. It has helped to convert the nightmarish situation to a manageable one, though with some morbidity. The temporary occlusion of the aorta described here can be applied in other situations of life threatening bleeding from the pelvis or lower limb. Training is the key step. The government has to come out with directions to pick up the cases of placenta accreta spectrum early and manage in centres with the required facilities and manpower.

V P Paily

Outline

Key Summary Points

1. With the high cesarean rates in Kerala, incidence of PAS is bound to be high
2. In spite of all attempts to get every previous cesarean investigated for accreta placenta, surprise diagnosis of PAS is still occurring in the State.
3. All centres looking after pregnancies following cesarean section are not aware of the recent developments in the management of such cases.
4. Surgical skills to manage such difficult cases are not developed in most of the centres including some of the teaching centres.
5. It is observed that use of the aorta clamp makes a big difference in the outcome of placenta accreta spectrum
6. Leaving the placenta intact for autolysis is associated with about 25% risk of major complications like sepsis, reoperation and even death; hence this option should be taken with caution.
7. Methotrexate is not recommended for speeding up the autolysis.
8. Pregnancy on a cesarean scar and placenta previa accreta spectrum are a continuum. So if a scar pregnancy is diagnosed in early weeks, counseling for management should consider that if left alone it is likely to become a placenta accreta spectrum.
9. Ultrasound scan is ordinarily good enough to make a diagnosis of placenta previa accreta spectrum. MRI scan may be considered complementary, especially in posterior placenta accreta.

Key Recommendations

1. The training for safe management of placenta accreta spectrum should be given to obstetricians in all teaching centres and major hospitals.
2. Picking up potential cases of placenta accreta spectrum should be made the responsibility of all obstetricians looking after pregnancies following cesarean deliveries.
3. There should be a directive from the government that the care of the PAS patients should be only in centres with facilities to manage it.
4. Postoperative thromboprophylaxis should be used in all cases where aorta or common iliac artery is clamped during cesarean section..

The Background

In the first few years of CRMD Kerala, placenta accreta spectrum (PAS) was not a major contributor to maternal deaths. Still, we lost four mothers due to placenta previa (three of them with previous cesarean) in the first two years of CRMD and five mothers in the subsequent four years. The distressing aspect was that some of these deaths

occurred in the major hospitals attended by senior faculty. In other words, these appeared to be inevitable deaths under the available facilities in our state. We knew that PAS was going to develop as a major problem with the rise in cesarean section rates. The cesarean section rates were around 20% in the beginning of CRMD, but has risen to above 40% currently. With the rising numbers of cesareans, the numbers of PAS also increased. The saving factor was that most women in Kerala with a cesarean delivery limited further pregnancies to one or two. So, the rise in PAS numbers was not as bad as feared.

Still the number of PAS cases grew alarmingly. In many centres even if death was averted, severe morbidity like urinary tract injuries, shock and need for massive transfusion occurred. We had to work out strategies to safely tackle the PAS.

Literature search was not of much help. In the developed world they had already recognized the gravity of the situation. Their solution was to insist that such patients be treated only in designated centres and managed by specially trained multidisciplinary teams. Such teams include onco surgeon, vascular surgeon and urologist in addition to senior obstetricians and anesthesiologists. For additional support, they will have blood bank officer, large amount of blood and blood products and cell salvage machine. There was no scope of rising to such level of care in Kerala where deliveries were taking place in about five hundred centres and 70% of these centres were in the private sector. We had to evolve our own strategies to suit the prevailing situation.

As is well known, the primary problem in the management of PAS is the torrential bleeding that happens while attempting to separate the morbidly adherent placenta. If the placenta is percreta it would have formed adhesions to the bladder, ureter or parametrium predisposing to injury to the viscera. We concluded that the logical first step would be to control the blood flow to the placental site before attempting to remove the placenta. In many developed centres they had already started to do this with the help of interventional radiologist inserting intravascular balloons in the common iliac artery or aorta and inflating it after delivery of the fetus but before attempting placental removal. In some centres they tried bilateral internal iliac artery ligation after removing the fetus. We also tried this in the beginning but found it insufficient to control the bleeding. The reason for the failure of internal iliac artery ligation is the inferior epigastric artery which is not blocked by this procedure as it arises from the external iliac artery. The inferior epigastric artery which supplies the lower anterior abdominal wall develops collaterals with the placental and bladder vessels and continues to supply the placenta even after internal iliac artery ligation. This made us search for clamps to block the common iliac artery or aorta. The available vascular clamps needed dissection to isolate the concerned artery with the potential of complications like injury to major veins. It needed the help of vascular surgeons which also was difficult to arrange even in major centres in our state. Hence, we went on to develop an atraumatic clamp (Pailyaorta/common iliac artery clamp) which could be used by the obstetrician with average surgical skills.

The clamp is applied after gently lifting up the common iliac artery with Babcock forceps. This proved to be a big breakthrough in the management of PAS. While using this clamp, our colleagues at Kottayam Medical College, under the leadership of Professor Kunjamma Roy, fortuitously clamped the lower end of the aorta, mistaking it as common iliac artery. It was soon realised that this is a better option than bilateral clamping of the common iliac arteries.

The Paily aorta/common iliac artery clamp is a simple straight instrument which looks like an Allis forceps but with blunt tips which overlap and act as a guard to prevent the vessel slipping out of the clamp. (Fig.1.) The inside of the blades is smooth and even on maximum closure there is a gap of about 2mm between the blades to prevent crush injury to the vessel wall and vasovasorum of the

aortic wall. With the wider use of this clamp in different centres in Kerala, the anticipated hike in maternal mortality due to PAS did not occur. In fact, in the ten years under consideration (2010 to 2019) there were only 18 maternal deaths, almost all of them done in centres without timely use of this clamp. But PAS remains a major contributor to maternal morbidity (See the chapter on Near Miss cases by Dr. Resmi et al).

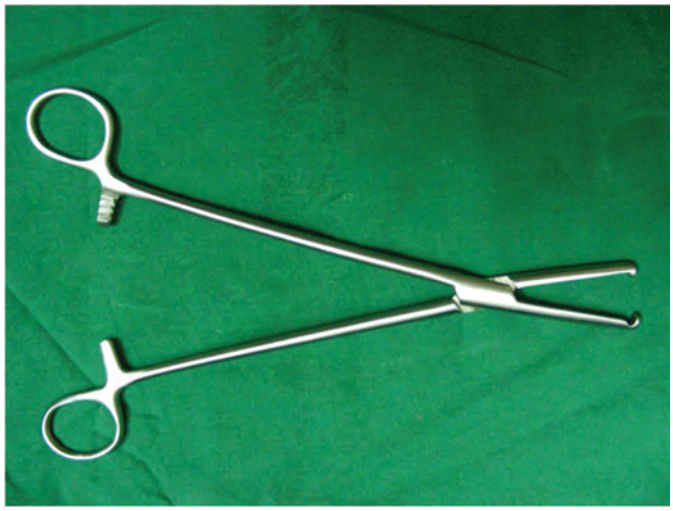


Fig.1.The Paily aorta/ common iliac artery clamp

What is Placenta accreta spectrum?

This is the new name suggested by FIGO (International Federation of Gynecology and Obstetrics) in 2018 for the group of conditions where the placental trophoblasts invade deeper than normal, ie the decidua. It used to be classified as placenta accreta, increta and percreta depending on the depth of invasion, but PAS includes all of them. But a grading of the degree of invasion is essential to indicate the severity of the problem and to compare the outcome of management between different centres. The FIGO consensus guidelines on placenta accreta spectrum disorders have come out with such a grading system which is reproduced here.

Grading of Placenta Accreta Spectrum

(Adapted from Jauniaux[1] et al,Int.Journal of GynecolObstet 2018;140:265 –273)

Grade 1. Normal adherence, complete separation at delivery

Grade 2A. Cesarean. No placental invasion seen through the surface of the uterus. Incomplete separation with uterotonics, needing manual removal.Part of placenta abnormally adherent.

Grade 2B. Vaginal delivery, manual removal of placenta required. Part of the placenta abnormally adherent.

Grade 3A. Cesarean.No placental tissue seen invading through the surface of uterus. Manual removal required. Entire placental bed abnormally adherent.

Grade 3B. Vaginal delivery. Manual removal. Entire placental bed abnormally adherent.

Grade 4. Cesarean.Placental tissue seen invading through serosa. But clear surgical plane exists between bladder and uterus to allow non traumatic bladder reflection.

Grade 5. Cesarean, Placental tissue invading through serosa with no surgical plane between bladder and placenta.

Grade 6. Cesarean.Placental tissue invading through serosa and infiltrating parametrium or any organ other than bladder.

Pathogenesis

Deeper invasion of the trophoblasts almost always occurs where there is defective interphase

between the decidua and myometrium, as happens over a scar on the uterine wall. In real life, the most common situation is when placental implantation occurs over a previous cesarean scar. More the number of previous cesarean sections, more the chance of placenta previa and PAS occurring in the subsequent pregnancy. Silver R M et al observed that, if the placenta is previa, the incidence of abnormally invading placenta will be 3.3% with one previous cesarean section, 11% with two previous cesareans, 40% with three and 61% with four and 67% with five previous cesarean sections[2].

Diagnosis

Ordinary 2D grayscale ultrasound scan is the most commonly employed tool to diagnose. It helps to diagnose the site of implantation and depth of invasion. Colour Doppler if available will help to assess the degree and extend of vascularity.

The diagnostic points to look for are –

1. Is the sonolucent layer between the placenta and uterine wall maintained?
2. Are there lacunae (lakes) inside the placental substance with turbulent flow.
3. Are there blood vessels bridging between uterus/placenta and the bladder.
4. Is the retroplacental myometrium thinned out (less than one millimeter)
5. Is there bulge of placenta into bladder cavity?

These findings may start to appear in the second trimester itself.

Picking up abnormally invading placenta (AIP) early is critical in planning the management. The first trimester scan itself will give a warning about the possibility and the couple should be counseled about the possibility of PAS. With the widespread practice of 20 week scan for anomalies, picking up a placenta previa accreta should be the standard. Discussion about potential problems should start and the need for delivery at centres with facilities to tackle the problem should be initiated.

The Kerala Federation of Obstetrics and Gynecology (KFOG) recommends that every pregnant woman with a previous cesarean delivery should have a scan done at 32 weeks of pregnancy specially aimed at finding the location of placenta and whether it is accreta or not. The recommendation is that if the placenta is overlying the uterine scar, such cases should be treated only in centres with facilities to tackle placenta accreta. We take MRI scan as complementary to ultrasound scan in the diagnosis of placenta accreta. This is especially valuable if the placenta is situated on the posterior wall of the uterus. The features to look for are similar to the ultrasound findings mentioned above.

How does placenta accreta present

A woman with placenta accreta can remain asymptomatic throughout pregnancy. However, it is a wrong notion that placenta accreta cases do not bleed during pregnancy. In fact, those cases of placenta accreta that present with antepartum hemorrhage have more predilection for bleeding during surgery as the lower segment may be more congested due to the possible bacterial invasion.

Counseling and preparation for delivery

It is important to forewarn the woman and family about the potential serious problems that can occur during cesarean delivery.

Excess bleeding which can progress to torrential unmanageable bleeding is the main threat. The second problem to be discussed is the possibility of injury to viscera like bladder and ureter. A sketch showing the uterus with the adjacent bladder and

the placenta in the area of the scar will help the woman and family understand the problem. One has to be factual in explaining the anticipated problems without frightening the woman and family. The need for massive transfusions, stay in the intensive care unit and urinary catheter insertion for a few days should be explained in advance.

The preoperative consent form should, in addition to the above points, mention the need for hysterectomy with conservation of ovaries.

Preparation for delivery

It is always desirable to have a planned cesarean section in these women. Since the chance of spontaneous onset of labour and presenting as an emergency is higher as the expected date of delivery approaches, a policy of elective cesarean section at 34 to 37 weeks is recommended. With a view to avoid neonatal ICU care for the baby, we prefer a policy of electively delivering between 36 -37 weeks. These women would have received antenatal corticosteroid for fetal lung maturity at 28 to 32 weeks. An additional single shot of 12mg betamethasone IM is recommended preoperatively

if the shots of betnesol were given more than two weeks earlier. Adequate amount of crossmatched blood and components should be reserved. We usually keep four units of cross matched packed RBCs and four units of plasma.

If the hemoglobin level is low (e.g.: below 11gms) antenatally, we build up the hemoglobin with parenteral iron if necessary.

Team building

The team to deal with the problem should be identified beforehand. In the West the practice is to direct all cases of placenta previa accreta to designated referral centres in the antenatal period itself. This may not work out in Kerala. There are about 500 delivery points of varying standards, about 70% under the private sector. It is an urgent necessity that patients with placenta previa accreta have their delivery only in centres with adequate facilities and trained manpower.

The team to carry out the surgery should include an experienced obstetrician and anesthesiologist. We usually have a urologist informed and on standby for help if urinary tract injury is not manageable by us.

Preparation for surgery

1. Verify that all the expertise anticipated are available.
2. Availability of resources confirmed (Urology tray, aorta clamps)
3. Co-ordination with blood bank
4. Availability of critical care services for the post-operative period.
5. Final discussion with Anesthesiology team.

The woman is prepared as for any other surgery. In cases known to have percreta placenta or lateral extension of placenta to broad ligament, we prefer to put ureteric catheters before start of surgery. This helps to identify the ureters during surgery so that inadvertent injury to the ureter can be prevented. A Foley catheter also is introduced. It is fixed in such a way that the inflated bulb is free to be moved around inside the bladder. This helps to identify the upper border of the bladder, before separating it from the surface of the bladder or uterus as the case may be.

We insert the ureteric catheter under epidural, and leave the distal end of the catheter outside the urethra to be pulled out at the end of surgery. The Foley catheter is left in situ for postoperative urinary drainage.

Intravenous lines have to be inserted first, we usually put two 14 or 16 G intravenous lines and a central line plus arterial catheter.

Anesthesia

Our preferred anesthesia is epidural with general or epidural with spinal anesthesia.

Surgical steps and postoperative care

The abdomen is prepared just as for any other laparotomy. We prefer the supine position with left lateral tilt. The preferred incision is vertical midline which may have to extend four to five centimeters above the umbilicus. As almost always there may be a previous scar on the anterior abdominal wall, one has to keep in mind the possibility of adhesions, especially for the bladder to be at a higher level.

Prior knowledge of the location of the placenta will help to avoid putting incision on the placental site. One should strive to keep away from the placental site as otherwise it can lead to profuse bleeding even before the fetus is delivered. Some even recommend the use of intraoperative ultrasound examination.

The incision on the uterus can be vertical or transverse. It can even be over the fundus, if the patient is for hysterectomy.

Once the uterus is incised and fetus handed over for resuscitation, bleeding from the uterine edges can be controlled with Green Armytage clamps. The obstetrician has to take a quick decision regarding further steps. The choices are

1. Hysterectomy with placenta in situ
2. Removal of placenta, excising any localized deeply invading area with the uterine wall and reconstructing the uterus.
3. To tie and cut the cord short and leave the placenta in situ for autolysis. Close the uterus as after any cesarean section.
4. If the morbid adhesion to uterine wall is localized and is not going through the muscle of the uterine wall, the placenta can be removed from that area by sharp dissection. Bleeding from that area can be stopped by tying off the feeder vessels to that area.

The choice should depend on the woman's wishes, need for further children, type of placental implantation etc. By and large we prefer hysterectomy unless the patient desires further pregnancies. It may be inevitable if the placental extrusion is over a large area and reconstruction of the uterus after removal of the placenta is difficult. Some authors recommend excision of the segment of bladder wall which is invaded by the placenta and reconstruct the bladder. We are not in favour of this step. We have found that almost always separation of the bladder from the placenta is possible even though it may leave behind a very thinned out bladder wall that needs reinforcing sutures. Post operatively catheter will have to be kept for a long period (eg:10 -14 days)

The steps of hysterectomy

Having got the fetus delivered, the cord is clamped and cut. The edges of uterine wound may bleed briskly. Green Armytage clamps can be applied to the uterine edges to temporarily arrest the bleeding. The volume of fluid in suction bottle is noted at this point so that subsequent addition can be considered as the amount of blood loss. In addition, a sterile double sided absorbent mat with central hole is kept on the abdomen to soak up any spilled blood from the operative field.

The uterus is exteriorized and pushed towards the foot end to expose the lower lumbar area.The small bowels are packed off to the right of the abdominal cavity and the sigmoid to the left. A broad Daever retractor towards the cranial side and two smaller ones to the sides will help to expose the vessels. One has to decide whether to block the lower end of the aorta or the two common iliac arteries.The vessels may be covered with fat with the peritoneum over it. No attempt should be made to dissect the vessels free of these..

One can clamp the lower end of the aorta or the common iliac arteries. The advantage of clamping

the aorta is that only one clamp is required. Some have expressed concern whether the clamp will damage the lumbar arteries arising from the posterior wall of the aorta. The clamp was applied on at least 79 patients in different centres in Kerala so far (personal communication). There was no incident of vessel injury or other complications related to clamp use. The alternative approach of clamping bilateral common iliac arteries was done on 49 patients in different institutions. Here also no clamp related injury was reported. The added advantage of clamping the common iliac arteries was that it will be easier to approach these vessels if the abdomen was opened by a transverse incision.

Whichever vessel is to be blocked is lifted up with a Babcock clamp first and then the clamp applied. Care has to be taken that the tip of the clamp goes beyond the vessel wall so that it does not pinch the vessel wall.

After the clamp application, one should palpate and confirm that the common iliac artery pulsations on both sides beyond the clamps have disappeared. Once the clamp is applied the time is announced loud and a person is entrusted to announce the elapsed time every five minutes. The surgeon has to be conscious of the time the clamp is in situ and try to proceed as fast as possible but should not compromise safety in an attempt to complete the surgery fast.

Clamps are then applied to both cornual pedicles so that the blood supply from upper aorta through ovarian arteries is also occluded. By sequential clamping one can take care of the upper pedicles up to the uterine arteries. At this point the Foley bulb is moved inside the bladder to outline the upper borders of the bladder. The uterovesical fold of peritoneum extending from the bladder to uterus is then picked up with Allis forceps and separated from the underlying tissue. If the placenta is percreta, there will be a thin layer of coagulum on the surface of the placenta giving it the look of the fetal surface of the placenta. One has to take care not to break this coagulum as otherwise it will start bleeding. If there are vessels seen crossing from bladder surface to placenta/uterus, they can be coagulated or tied.

Once the bladder has been separated below the level of the uterine arteries, the clamps can be applied on the side of the uterus. If a ureteric catheter had been inserted at the beginning, palpation of that catheter will reassure and help the surgeon to remain at a safe distance from the ureter.

Unlike in the usual hysterectomies, taking care of the uterine arteries does not guarantee cessation of bleeding. One has to patiently separate the bladder below the level of the extruded placenta. Once that has been achieved clamps can be put on both sides of the isthmus of the uterus and across the cervix, to remove the uterus with the placenta in situ. Palpating the lower part of the uterus from front to back will help one to find out whether the dissection has reached below the level of the placenta. We strongly recommend that the dissection should not be carried below that level to reach the vagina so as to do a total hysterectomy as it will lead to excessive bleeding from the bladder base and vagina. The cervical stump is closed with full thickness mattress stitches. The upper pedicles on the side of uterus are doubly secured.

Once the uterus is removed, the bladder base and surface of the vagina are searched for any bleeding vessels and taken care of.

The aorta clamp is then unclamped but left in position so that it can be reclamped if there is profuse bleeding from the bladder base. The total duration of application of the clamp occluding the aorta is noted down. The anesthesiologist is informed when clamp is released so that he can monitor for any change due to influx of metabolites from the lower part of the body when circulation is reestablished.

Once satisfactory hemostasis is achieved, a wide bore drain is kept at the bladder base and brought out through the anterior abdominal wall lateral to the inferior epigastric artery.

The total blood loss is noted by adding the collected amount in the suction bottles and the increase in the weight of the mops and the estimated blood loss if any spill is seen on the floor. The increase in weight of the absorbent mat kept on the abdomen after the fetus is removed is also added to calculate the total blood loss.

Postoperatively we give low molecular heparin as prophylaxis till the woman is ambulant. Antibiotics are given for 48hours.Continuous bladder drainage is kept for 48 hours and longer if the bladder wall was thinned out or torn.

The second option is to resect the part of the uterine wall with the adherent placenta and reconstruct the uterus. This should be possible when there is only focal accreta.

The third option is to leave the placenta in situ for autolysis. In this case one should not disturb the placenta at all. The cord is cut short and uterus is closed in layers. Subsequently there is risk of secondary postpartum hemorrhage, infection and need for relaparotomy. About 58% of women who had such a conservative approach had to have hysterectomy[3]. There used to be a widespread practice of giving methotrexate to the women managed conservatively with placenta left in situ. This was on the assumption that methotrexate will hasten the absorption of the placenta. It is now discouraged not only because it does not help in the resorption of the placenta but because it may lead to immune suppression and increase the risk of infection[4].

The fourth option of removing segmental accreta placenta and leaving the uterus intact should be considered only if there is need for future child bearing and the placental invasion is not deep into the uterine wall. Removal of the placental cotyledons will leave a raw area on the uterine wall. Brisk bleeding can occur. Stitches can be put around the area to control the bleeding. In these cases, we usually do prophylactic ligation of the uterine arteries on both sides.

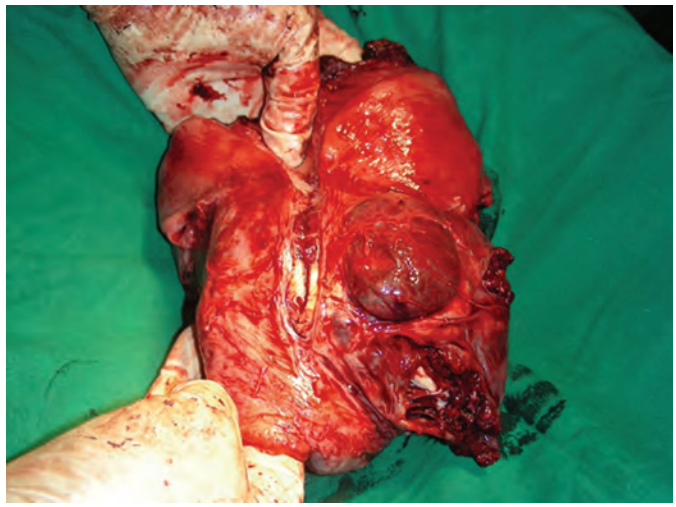


Fig.2.A percreta placenta specimen after subtotal hysterectomy

Post-operative Care

Given the extensive surgery, placenta accreta spectrum patients require intensive hemodynamic monitoring in the early postoperative period. This often is best provided in an intensive care unit setting to ensure hemodynamic stabilization. Close and frequent communication between the operative team and the immediate postoperative team is strongly encouraged. These patients are at particular risk of ongoing abdominopelvic bleeding, fluid overload from resuscitation, and other postoperative complications.

Faced with Unexpected cases - what to do?

Sometimes placenta accreta spectrum is unexpectedly recognized at the time of cesarean delivery, either before the uterine incision (optimal) or after the uterus is opened, the fetus is delivered, and attempts to remove the placenta have failed. It is also possible to make the diagnosis of placenta accreta spectrum after vaginal delivery. The level and capabilities of the response will vary depending on local resources, timing, and other factors. It is important, however, that all centers performing deliveries have considered the possibility of a case of placenta accreta spectrum and have plans in

place to manage or rapidly stabilize patients in anticipation of transfer to a higher-level facility.

If placenta accreta spectrum is suspected based on uterine appearance and there are no emergent circumstances mandating immediate delivery, the case should be temporarily paused until optimal surgical expertise arrives. In addition, the anesthesia team should be alerted and consideration given to general anesthesia, additional intravenous access should be obtained, blood products should be ordered, and critical care personnel should be alerted. Patience on the part of the primary operative team is a key point, and they should not proceed until circumstances are optimized. If mobilization of such a team is not possible, consideration of stabilization and transfer is appropriate, assuming maternal and fetal stability. Anecdotal examples for such accidental diagnosis and hysterectomy requiring multiple transfusions are there from the authors (C P Vijayan) center before the major vascular clamp era.

Many of the same principles apply when placenta accreta spectrum is inadvertently discovered with the uterus already opened immediately after delivery. Once the diagnosis of placenta accreta spectrum is established and it is clear that placental removal will not occur with usual maneuvers, then rapid uterine closure and proceeding to hysterectomy as judiciously as possible should be considered. Application of the common iliac artery clamps should be considered. Mobilization of appropriate resources should occur concurrently with ongoing hysterectomy in conjunction with the operating room nursing staff and anesthetic team.

If the patient is stable after delivery of the fetus and the center is unable to perform the hysterectomy under optimal conditions, transfer should be considered. Temporizing maneuvers, packing the abdomen, tranexamic acid infusion, and transfusion with locally available products should be considered.

Learning from examples

Example 1

This 27yr old G3 P2, with EDD on 9th of May, was admitted on 16/3 at 9 am, with history of fall in the bath room at 5 am followed by altered sensorium. Her previous two deliveries were by cesarean section. Last child birth was 3 years earlier. She was known to have gestational diabetes mellitus controlled on insulin. She was known to have central placenta previa.

On admission, she was gasping and in shock and soon had cardiac arrest. She could be resuscitated. US scan showed hemoperitoneum & intra uterine death of fetus. With a diagnosis of rupture uterus, laparotomy was done. Placenta was protruding through the scar and bladder was found opened up as it was densely adherent to lower segment. Classical CS and total hysterectomy was done. Massive transfusion was given. She was maintained on high dose vasopressors and ionotropic support. She continued to be in shock and following frequent cardiac arrests expired at 1.15 pm.

Learning points

The condition of the patient was so bad at admission that failure to salvage her was understandable. But looking back to the antenatal period, we are not sure whether the family was impressed enough about the seriousness of the potential problems. She was brought to the hospital four hours after the event. If the placenta previa accreta was diagnosed beforehand, the family should have been told about the potential for internal bleed and the need for reaching hospital at the earliest.

It was quite creditable for the team at the hospital to resuscitate her from cardiac arrest. But what happened during surgery could have been modified. We are not sure whether a vertical abdominal incision and an aorta clamp was used. It is written that a total hysterectomy was done. We feel that even few extra minutes spent to do a total rather than subtotal hysterectomy could have been saved. Looking at the overall picture it is not

sure whether all these modifications would have made a difference. However, every minute and every milliliter of blood saved in such a patient could turn out to be valuable.

Example 2

A 36 yr old G3 P1, 1st LSCS, 2nd MTP with EDD on 17/3 had her antenatal care at the local hospital. She was referred at 32 weeks to a tertiary care centre. She was known to have gestational diabetes mellitus and hypertension.

She was admitted at the higher centre on 22.2. On 24/2 CTG showed persistent tachycardia and decelerations. She was taken for cesarean section at 6 pm. On opening the abdomen multiple fibroids were found, uterus was adherent to anterior abdominal wall and bladder was pulled up. Baby was delivered (2.4 kg). Bladder was injured during the procedure. Placenta which was adherent was removed piecemeal. Uterus was atonic. Compression sutures were applied and stepwise devascularisation was done. As atonicity was not corrected subtotal hysterectomy was done. Massive transfusion was given. After stabilizing vitals, she was referred to a higher centre on ventilator and ionotropic support for better care. In spite of good care, condition worsened and she expired on 6/3/18.

Learning points:

Again, another difficult case in whom the team did their best to save her. The failure to save her is understandable. But purely from the angle of learning lessons we would like to point out some alternative approaches.

a. Was the team looking after her till 32 weeks aware of the possibility of a placenta previa percreta? Had she been subjected to the mandatory scans?

b. The centre that received her at 32 weeks- did they attempt to rule out accreta placenta. If they had done it, the fibroids and placenta previa percreta would not have come as a surprise.

c. She was taken up for surgery at 6 pm. Was the team prepared for managing at least a placenta previa, leave alone the adhesions to anterior abdominal wall.

d. It is reported that placenta was removed piecemeal. This is something we would try to avoid.

e. It is not clear whether a vertical abdominal incision and aorta clamp were used. From the case notes it does not seem to have happened.

f. Was there an attempt to save the uterus? If so, it would not have been the right move here.

g. It is appreciated that they did a subtotal hysterectomy and could stabilise her with massive transfusions. It can be argued whether the transfer to a still higher centre was warranted, but the team would have been helpless. The fact that the patient survived for another 12 days shows that the team at the second centre did a good job.

Example 3

31yr old G2P1, Previous CS, EDC Oct.25th

Admitted on 26/9 as IUD with placenta accreta.Hb 7.9gms%.Two units PRBC given. On 30/9 patient had dizziness and syncope. Emergency laparotomy was done. There was 2.5 litres of hemoperitoneum and scar dehiscence on right side with placenta protruding. IUD baby delivered. Obstetric hysterectomy with internal iliac ligation and bladder repair done. She was given 44 units of blood products. Patient was on ventilator after surgery. Weaned after 48 hrs. On 7th postop day, she went into septic shock and again was on ventilator. Managed by multidisciplinary team. Condition deteriorated and expired on 8/10.

Learning points:

This case also brings in some questions about the management strategies followed.

a. Being a previous cesarean, was she investigated for the placenta previa accreta.

b. Having diagnosed intra uterine death in a previous cesarean, what was the strategy?

c. It is written as obstetric hysterectomy; was it subtotal?

d. It is appreciated that she was brought out of the first hurdle with massive blood transfusion etc. But one begins to wonder if an aorta clamp was used, which would have made less demand on blood transfusion and saved on surgical time.

e. It is unfortunate that she had to succumb to sepsis.

Conclusions

Placenta previa accreta cases are bound to increase in our state because of the rising numbers of cesarean deliveries. Fortunately, we have the techniques developed to manage it without mortality even though morbidity will continue to be a concern. A concerted effort is required to upgrade the obstetrician's skill in diagnosing and appropriately managing this serious problem.

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CHAPTER

07

Hypertensive Disorders of Pregnancy.

PK Sekharan, VK Chellamma, CH Mini.

Editor's Note

Unfortunately hypertensive disorders still enjoy the second place as causative factor for maternal deaths in Kerala. This is inspite of the fact that "quality standards"identified and recommended simple and practical steps to address the problem of hypertension complicating pregnancy. The advice to check BP at every visit and checking for proteinuria once in each trimester and every visit after 34 weeks are simple recommendations that can be easily put to practice. The failure to pick up many of the cases is a testimony to noncompliance of this recommendations. Still we could observe some reduction in the number of cases over the years; which is a relief.

Great hopes were raised a few years ago that we can predict and prevent hypertensive disorders and resort to appropriate treatment early enough to prevent the condition leading to maternal and fetal compromise. Unfortunately, these apply to early onset preeclampsia only. Still that is significant. Analysis of hypertension related maternal deaths showed that 42 out of 106 maternal deaths happened before 34 weeks. Unfortunately, at the present state of affairs the screening biochemical test and Doppler studies may not be a practical solution to be recommended across the state. But we obstetricians have to keep a watch on these developments.

The recommendation made by KFOG regarding anticonvulsant treatment with MgSo4 is still proving right in our practice and we didn't

find any reason to alter it. What is required is adherence to the dosage schedule and prompt administration of the drug even in impending eclampsia at the first opportunity.

We had taken a proactive stand in starting antihypertensive treatment at BP of 140/90. Now the international community has started to recommend the same. What is needed now is aggressive control of high blood pressure using parenteral antihypertensives (IV Labetalol). As is pointed out by the authors, about 50% of hypertension related deaths were due to cerebral hemorrhage highlighting the importance of keeping the high BP under control.

We request the obstetricians of the state to be vigilant on preventing hypertension related maternal deaths.

Introduction.

Hypertensive disorders of pregnancy continue to be one of the leading causes of maternal and perinatal morbidity and mortality in Kerala, second only to obstetric hemorrhage. Pre-eclampsia (PE) is a multisystem disorder and is responsible for 76,000 maternal deaths and 500,000 fetal and neonatal deaths globally every year[1,2,3]. Pregnant women of third world countries are at higher risk of developing pre-eclampsia and its consequences. Early onset pre-eclampsia is associated with higher morbidity and mortality. Women who had pre-eclampsia are at higher risk of developing cardiovascular disease, metabolic syndrome, and chronic renal disease in later life. The life expectancy of women who had pre-eclampsia is reduced on an average by ten years [2].

Key Summary points.

- Hypertensive disorders of pregnancy (HDP) continue to be one of the leading causes of maternal mortality in Kerala.
- Out of the 1076 maternal deaths in Kerala over the 10-year period from 2010 to 2020, hypertensive disorders of pregnancy have accounted for 106 deaths. Out of the 106 deaths, 75 developed eclampsia.
- HELLP syndrome was seen in 40
- Of the 75 cases of eclampsia, 19 cases were postpartum eclampsia.
- The leading cause of death in HDP is cerebral hemorrhage - 41.
- About five percent of the HDP developed abruptio placentae and 12% developed DIC with other complications and expired.
- Twenty percent of the HDP patients progressed to MODS and expired.
- Out of 106 HDP cases, 42 had the disease before 34 weeks.
- Three cases had liver hematoma/rupture and nine had renal failure.
- Seventy six patients were referred with major complications to tertiary care facility from peripheral centers.
- In fifteen cases the dose of $MgSO_4$ was inadequate/or there was delay in starting.
- In twelve patients there was delay in controlling severe blood pressure.
- Seven patients who were referred to higher centre expired on the way.

Key Recommendations –

Practice Guidelines [1, 2, 5, 7, 8].

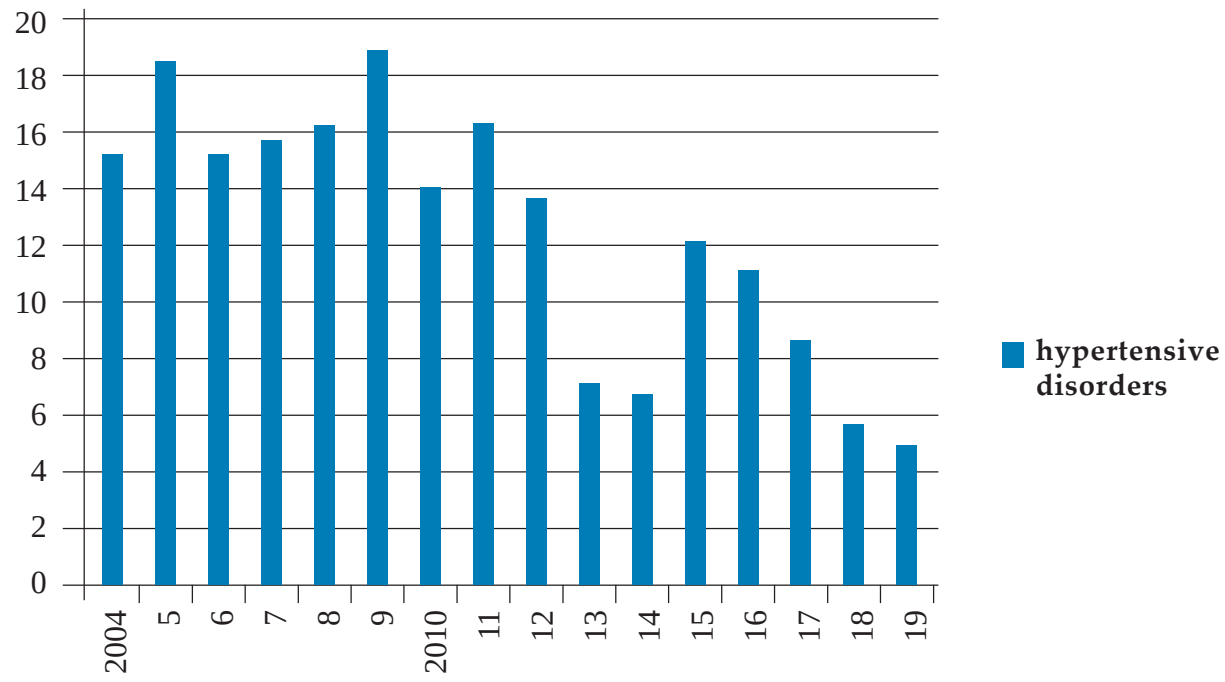
- Care must be taken for the early diagnosis of hypertension in pregnancy and its management.

- Blood pressure should be properly recorded in each antenatal visit.
- Preeclampsia should not be grouped as mild and severe, as the mild form can progress suddenly and lead to maternal morbidity and mortality.
- Persistent BP equal to or more than 140/90 should be treated with antihypertensive drugs.
- Severe hypertension of 160/110 and above should be controlled with parenteral antihypertensives as it may lead to cerebral hemorrhage.
- More frequent maternal and fetal monitoring is required once pre-eclampsia is diagnosed.
- Early onset pre-eclampsia is a more severe form of the disease and aim of management is to achieve reasonable fetal maturity and termination by 34 weeks after giving steroids.
- If termination of pregnancy is warranted before 32 weeks, give MgSO4 for neuroprotection.
- Even in the absence of major fetal and maternal compromise, pregnancy should be terminated by 37 completed weeks in pre-eclampsia.
- Pregnancy should be terminated in patients diagnosed with HELLP syndrome without delay after giving steroids and magnesium sulfate as indicated.
- Mode of delivery is decided by obstetric indications.
- Eclampsia is a preventable condition by proper control of hypertension and timely termination of pregnancy in pre-eclampsia.
- Patients with pre-eclampsia/eclampsia and severe hypertension (160/110 mmHg or more) should be given IV labetalol 20mg immediately as cerebral hemorrhage is the leading cause of death in such cases.
- In patients with impending eclampsia and eclampsia, give magnesium sulphate as per the KFOG regimen. (Annexure-III.)
- Management of eclampsia is as per the protocol given as - **Eclampsia drill**.
- Patients with pre-eclampsia should be carefully monitored for at least 72 hours after delivery as eclampsia can develop in postpartum period.
- In cases with fetal and maternal compromise, refer them to a higher centre early.
- When referring patients with severe symptoms, give the loading dose of magnesium sulphate and antihypertensives, noting the time and dose given. Better to contact the higher centre when referring such patients.
- With the availability of screening methods for the prediction of pre-eclampsia, first trimester screening should be offered to all pregnant women as per the protocol given in Annexure -I.
- Those who are having risk (1:100 and above), as predicted by the Fetal Medicine Foundation algorithm, should be started on low dose aspirin 150 mg (minimum 100mg) daily at bed time in the first trimester itself, at least before 16 weeks and continued till 36 weeks.
- Maternal risk factors and MAP should be the minimum requirement for risk prediction if uterine artery pulsatility index and serum placental growth factor measurement is not possible. Use the Fetal Medicine Foundation software for calculation of risk, which is available free of cost at the website — (*https://fetalmedicine.org/research/assess/preeclampsia*).
- Do *not* start low dose aspirin for every pregnant woman.
- For everyone with severe hypertension check platelet count and liver enzymes to exclude HELLP Syndrome.

3. Summary of findings, Trends and Observations.

The confidential review of maternal deaths in Kerala by the Kerala Federation of Obstetrics and Gynaecology (KFOG) shows that obstetric hemorrhage continues to be the leading cause of death followed by hypertensive disorders of pregnancy. If we can prevent and treat PPH and HDP, at least 25% of maternal deaths in our state can be prevented.

Fig-1 **Percentage of maternal death due to hypertensive disorders 2004/2020**

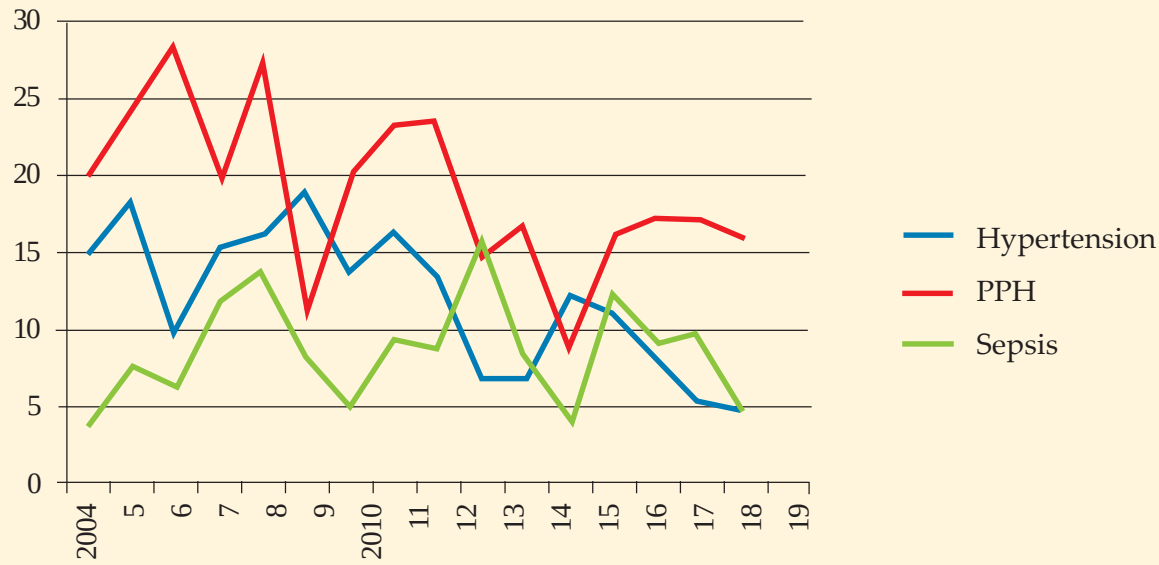


As per the KFOG study, hypertensive disorders of pregnancy continue to be the second leading cause of maternal mortality contributing to 10% of total deaths.

Trends in Maternal mortality.

Over the last 12 years the MMR of Kerala is in the range of 28-40/100,000 and for the year 2018-19, MMR is 33/100,000 and has come down to 28 in 2019/20.

Fig-2 Incidence of PPH, Hypertension and Sepsis (%) during the period 2004-2020



During the period 2004-2020 CRMD has analysed 1577 deaths. Out of these 184 were due to hypertensive disease of pregnancy. Over the years there is a decline in the number of cases (See Chart).

Table 2. Maternal mortality due to Hypertensive Disorders of Pregnancy (2010-2020).

Total number of maternal deaths, 2010-2020	-	1076
Deaths due to hypertensive disorders of pregnancy	-	106 (9.86%)
Chronic hypertension	-	9
Pre-eclampsia	-	22
Eclampsia (AP)	-	56
Postpartum eclampsia	-	19

AP- Antepartum Eclampsia.

Early diagnosis and management and timely termination of pregnancy could have saved some of these 106 who died due to HDP. There is a definite place for first trimester screening for pre-eclampsia and prevention of pre-eclampsia with low-dose aspirin starting before 16 weeks.

It is more worrying to see that there were 75 deaths due to eclampsia. Eclampsia is a preventable complication. Early diagnosis of pre-eclampsia, control of hypertension with parenteral antihypertensives like Labetalol in severe hypertension, prevention of seizures by prophylactic use of magnesium sulfate and timely termination of pregnancy would have helped to prevent these deaths. Patients with pre-eclampsia should be carefully monitored after delivery to prevent postpartum eclampsia.

Table 3 Complications in Pre-eclampsia/ Eclampsia associated with maternal Death.

Cerebral haemorrhage	41
HELLP Syndrome	40
MODS (Multiple Organ Disfunction Syndrome)	16
DIC (Disseminated Intravascular Coagulation)	12
Abruptio Placentae	6
Renal failure	17
Hepatic haematoma/rupture	3
Co-morbidities- Diabetes	11

The most important cause of maternal death in preeclampsia/eclampsia is cerebral hemorrhage. This underlines the need for immediate control of high BP (>160/110mm of Hg) by IV labetalol or oral rapidly acting nifedipine even before starting magnesium sulphate as fits may not kill the patient, but cerebral hemorrhage will.

Many cases had developed DIC and MODS as delay in arresting the progress of the disease process will lead to such complications. But in most situations, the cases were in an advanced stage with complications when they reached such facilities and could not be saved.

HELLP syndrome, the severe form of the disease, was noted in 40 of the 106 cases.

Once HELLP is diagnosed, early termination of the pregnancy after giving steroid and or magnesium sulphate, is the rule.

Hepatic hematoma and rupture are very serious complications and must be anticipated in severe cases especially with severe HELLP syndrome.

There is more risk of developing abruptio placentae and renal failure in preeclampsia and eclampsia. Hence, termination of pregnancy should be undertaken at the appropriate time.

Table - 4 Other observations on maternal deaths in Hypertensive Disorders of Pregnancy.

Referred to Tertiary care facility from other centers	76
Died on the way	7
Inadequate dose of MgSO4 or delay in starting MgSO4 (rough estimate)	15
Delay in controlling severe hypertension (rough estimate)	12

More than half the cases of pre-eclampsia/ eclampsia were initially treated in primary or secondary care centers and were referred to higher centers at a late stage of the disease. We may have to have a protocol for referring the patients of HDP to a center with facilities. It is evident from the fact that 7 of the referred cases died on the way, pointing to the delay in referral of such cases.

In several cases, there was deviation from the KFOG regimen of $MgSO_4$ in treating eclampsia which has resulted in recurrent fits and mortality.

Obstetric hemorrhage and HDP together contribute to about (25%) of the maternal deaths in our state. If we can prevent and treat PPH and preeclampsia/eclampsia, it is possible to further

reduce our maternal mortality and can achieve our goal -MMR of 20/100,000 by 2030.

With the availability of first trimester screening for prediction of early onset preeclampsia and the possibility of >60% reduction using low dose aspirin starting before 16 weeks, we can hope to reduce it further.

Learning from examples.

Example-1

A 34-year-old primigravida was admitted at 34 weeks of gestation with headache and vomiting, (BP was 160/100mm of Hg) to a secondary level hospital. She was referred to a teaching hospital where her BP was 160/110 on admission. She was started on $MgSO_4$ and an emergency cesarean section was done. She remained in coma and CT scan showed massive intracranial hemorrhage with midline shift. In spite of all efforts by the multidisciplinary team, she could not be saved.

Observations.

Blood pressure should be carefully measured during antenatal visits with test for urine proteins for diagnosis and control of pre-eclampsia. In this case severe hypertension was detected with signs of impending eclampsia. The patient should have been given rapidly acting nifedipine 10mg orally and the loading dose of magnesium sulphate. When referring such patients, give a letter mentioning the dose and time of administration. It is better to inform higher centre by phone before sending such patients.

At the tertiary care centre patient was having severe hypertension, vomiting and headache and was started on $MgSO_4$ regimen. Subsequently, she was given inj. labetalol. It may be prudent to give labetalol 20mg IV first in such a situation while the magnesium sulphate is being prepared as the seizure may not kill the patient, but cerebral hemorrhage will. Patient had fits and became comatose due to massive intracerebral bleed confirmed by CT scan. The leading cause of death in eclampsia is intracranial hemorrhage and hence the importance of bringing down the blood pressure quickly to a safer level with intravenous labetalol/ hydralazine or oral nifedipine as given in annexure-I.

Example-2

A 32-year-old G3, P2, L2, second delivery by cesarean section, was diagnosed to have hypertension at 36 weeks of pregnancy and was started on nifedipine retard twice a day from a secondary level hospital. It is not clear whether she had any investigation nor the level of blood pressure. She is also Rh-negative. She was admitted at 38 weeks with complaints of abdominal pain and her BP on admission was 220/140. She was given Inj. labetalol 20mg IV and inj. magnesium sulphate 2gm IM on each buttock. After one and half hours she started having breathlessness and followed soon by frothing through mouth and nose. She was given inj. deriphyllin and steroids and 40mg of inj.lasix. Started having BP fall, drop in oxygen saturation and then referred to tertiary care centre.

Observations.

Here again the importance of proper BP recording and diagnosis of hypertension in pregnancy is further stressed during the antenatal visits. (Annexure-IV). After having diagnosed hypertension, patient should have been admitted and investigated. Mild cases can be sent home with oral antihypertensives with more frequent checkup, and a plan to terminate the pregnancy by 37 weeks if the fetal condition permits. When the patient was admitted with severe hypertension at 38 weeks, aggressive efforts to control hypertension and plan to terminate the pregnancy should be considered or if facilities are not sufficient, should be referred to higher centre after giving antihypertensives and magnesium sulphate.

With severe hypertension, parenteral antihypertensives should be started as outlined in Annexure-I. Pulmonary edema should be treated

more aggressively with repeated doses Inj. Frusemide.

Example-3

A 24-year-old primigravida was diagnosed as a case of Gestational hypertension at 27-28 weeks of pregnancy at a private hospital and was treated with Tab. Labetalol for one month. She had 3-4 episodes of generalized seizures at 32 weeks and was referred to a tertiary care hospital. At the higher centre her BP was 160/100, SpO2 95%, and uterus was 32 weeks size, fetal heart sounds were percent. She was started on IV Labetalol and Magnesium sulphate regimen. Induction of labour was tried with vaginal prostaglandin gel with no response. Cesarean section was done and delivered a live preterm baby. CT scan showed features of PRES. Phosphenytoin was added and magnesium sulphate was continued. Patient developed cardiac arrest, revived, but succumbed to second episode of cardiac arrest.

Observations

Hypertension was noticed at an early stage of pregnancy and diagnosed as gestational hypertension and treated with oral drugs for one month. Early onset Gestational hypertension can progress to severe pre-eclampsia in up to 25% of cases. They must be monitored carefully with test for urine proteins, other system involvement by checking LFT, RFT, platelet count, coagulation profile and evidence of uteroplacental insufficiency.

When referring eclampsia patients, they should be started on magnesium sulphate, at least the loading dose and parenteral labetalol or rapidly acting nifedipine. The reference letter should contain the time and the dose given.

Pre-eclampsia- Recent Advances.

Pre-eclampsia is a multisystem disorder that affects 5-10% of the pregnant women[3]. The current theory suggests a two-stage process in the pathogenesis. In the first stage, there is shallow invasion of the trophoblast leading to inadequate remodeling of spiral arteries and failure to convert it into low-resistant high-low system resulting in hypoperfusion and ischemia of the placenta. This will lead to the second stage, the maternal response to endothelial dysfunction and imbalance between angiogenic and antiangiogenic factors, resulting in the clinical features of pre-eclampsia[4].

Pre-eclampsia is defined by the International Society for Study of Hypertension in Pregnancy, (ISSHP) in 2018[1], as follows which is endorsed by FIGO[2] and ACOG[5] and other international bodies

- Preeclampsia is new-onset hypertension at or after 20 weeks of gestation accompanied by one or more of the following new-onset conditions at or after 20 weeks.
  1. Proteinuria
  2. Another maternal organ dysfunction, including:
     - Acute kidney injury (AKI) (creatinine > 90 µmol/L; 1mg/dL)
     - Hepatic dysfunction- elevated transaminases e.g. ALT or AST > twice normal, with or without right upper quadrant or epigastric pain.
     - Neurological complications (examples include eclampsia, altered mental status, blindness, stroke, clonus, severe headaches, persistent visual scotomata)
     - Hematological complications – thrombocytopenia, platelet count below 150,000/µL, DIC, hemolysis
  3. Uteroplacental dysfunction such as
     - fetal growth restriction,
     - abnormal umbilical artery Doppler wave form or stillbirth
- FIGO and ACOG agrees with the criteria developed by ISSHP, that it is not essential to have proteinuria to diagnose Pre-eclampsia and

the internationally accepted definition for pre-eclampsia is the one proposed by the ISSHP.

- Proteinuria is present in 75% of pre-eclampsia.
- HELLP syndrome is a serious manifestation of pre-eclampsia and is not a separate entity.
- ACOG and ISSHP do not recommend classification of pre-eclampsia into mild and severe forms as mild disease could progress rapidly leading to maternal and perinatal morbidity and mortality. Instead ACOG recommends pre-eclampsia with or without severe features.
- Pre-eclampsia may develop intra-partum or post-partum.

Hypertension in Pregnancy

- Defined as systolic BP > 140 and/or diastolic BP > 90 mmHg.
- Blood pressure should be repeated after 4 hours to confirm hypertension.
- If blood pressure is severe, (SBP > 160 and/or DBP > 110 mmHg) then BP should be confirmed within 15 minutes and treatment should be started.

Sub classification of Pre-eclampsia

- Early-onset pre-eclampsia (delivery at <34 weeks)
- Late-onset pre-eclampsia (delivery at >34 weeks)
- Pre-term pre-eclampsia (delivery at <37 weeks)
- Term Pre-eclampsia (delivery at > 37 weeks)

Early-onset pre-eclampsia is associated with higher risk of developing short and long term maternal and perinatal complications.

Eclampsia

- Development of new onset of grand mal seizures in a woman with pre-eclampsia.

HELLP Syndrome

- Severe form of pre-eclampsia with laboratory findings of Hemolysis, Elevated liver enzymes, and Low Platelet count.

Gestational Hypertension

- New-onset hypertension after 20 weeks of pregnancy, often near term without proteinuria or other system involvement.
- In patients where BP is not normalized in the postpartum, think of chronic hypertension.
- Generally, the outcome in patients with gestational hypertension is good, but about a quarter of them will develop pre-eclampsia especially when it develops early.
- Any case of Gestational hypertension may be pre-eclampsia before the development of proteinuria or other system involvement and can progress rapidly to severe form of pre-eclampsia and requires careful monitoring.

Chronic hypertension.

- Hypertension predates pregnancy or diagnosed before 20 weeks of gestation.

Chronic hypertension with superimposed pre-eclampsia.

- Women with chronic hypertension experiences sudden exacerbation of hypertension requiring increase in dosage or addition of antihypertensive drugs, manifest impairment of liver function, and kidney functions and evidence of thrombocytopenia or DIC or substantial increase in proteinuria.

White coat hypertension/ Masked hypertension/ Delta hypertension.

- White coat hypertension is hypertension seen only when checked in the office (Hospital). 8% of these patients may develop pre-eclampsia [6].
- Masked hypertension is having normal BP when checked in the office but having hypertension with home BP monitoring.

- Delta hypertension is defined as when a patient who has normal BP of less than 140/90 shows a sudden increase in mean arterial pressure in the second half of pregnancy.

First Trimester Prediction of Pre-eclampsia.

NICE[7,9] WHO[8]and ACOG[10] recommends maternal risk factors for prediction of pre-eclampsia. According to NICE, one high risk factor or two moderate risk factors if present is taken as risk for developing preeclampsia. As per ACOG, previous history of pre-eclampsia is the risk factor.

NICE- Risk factors for Prediction	
High Risk	**Moderate risk**
H/o of Pre-eclampsia	First pregnancy
Chronic renal disease	Age >40 years
Chronic hypertension	Body mass index >35kg/m^2.
Diabetes mellitus	Interpregnancy interval > 10 years
SLE or APS	Family history of pre-eclampsia

- One high risk factor or two moderate risk factors is predictive of preeclampsia.
- ACOG recommends low dose aspirin for prevention of pre-eclampsia with-
  - History of pre-eclampsia necessitating delivery before 34 weeks.
  - More than one pregnancy complicated by pre-eclampsia

Although identification of maternal risk factors might help in selecting at-risk women for low dose aspirin, it is not an efficient tool for prediction of pre-eclampsia.

The detection rate has been improved by using the Fetal Medicine Foundation algorithm where maternal risk factors combined with biophysical and biochemical markers are used and the risk is calculated using the FMF software available free of cost at their web site. A risk of 1in 100 and above is high risk or screen positive. - *https://fetalmedicine.org/research/assess/preeclampsia.*

Details to be entered on to the software

- Maternal risk factors to be recorded are, age, weight, racial origin, (South Asian), parity, h/o pre-eclampsia, family history of pre-eclampsia, conception by IVF, hypertension, diabetes mellitus, SLE, APS.
- Biophysical measurements - Mean Arterial Pressure (MAP) and uterine artery pulsatility index (UTPI)
- Biochemical markers – Placental Growth Factor (PLGF)
- Uterine artery pulsatility index can be measured at the time of NT scan.
- Blood for PLGF is sent along with that for PAPP-A and the estimation done in the same platform.
- Universal screening is recommended.
- The screening is done along with aneuploidy screening at 11-13^{+6} weeks.
- When it is not possible to measure biochemical markers or uterine artery pulsatility index, baseline screening should be a combination of maternal risk factors with MAP using the risk calculator

Nicolaides et al (2016) [11] reported that, at the false positive rate of 10%, the detection rate of early onset pre-eclampsia - before 34 weeks - was 90%, preterm pre-eclampsia - before 37 weeks was 75%, and term preeclampsia was about 45% after using the FMF algorithm for first trimester screening for pre-eclampsia .

The ASPRE trial[12] and the SPREE trial[13] have shown that the combination of maternal risk

factors, MAP, UTPI and PLGF using the Fetal Medicine Foundation algorithm for first trimester screening for pre-eclampsia is by far superior to the methods recommended by NICE and ACOG and is applicable to Asian population also [14,15].

Prevention of Preeclampsia

- Women identified as at risk of developing pre-eclampsia with the first trimester screening should receive aspirin at a dose of 100 to150mg/ day from 12 weeks, at least before 16 weeks of gestation, till 36 weeks.
- Aspirin given at bedtime is more effective [16].
- Aspirin started after 16 weeks of pregnancy and dose less than 100mg per day is not associated with any significant reduction of pre-eclampsia[17].
- Using the Fetal Medicine Foundation (FMF) algorithm, 80-90% of the preterm pre-eclampsia could be predicted in the first trimester, who can be started on low dose aspirin to reduce the incidence of pre-eclampsia[18].
- The ASPRE trial has shown that the rate of preterm preeclampsia can be reduced by 62% by aspirin starting at 11-14 weeks of pregnancy for high risk women[17].
- Low dose aspirin should not be given to all pregnant women; it is to be given only to those who are having risk identified by first trimester screening, (about 10% of the screened population).
- Calcium supplementation of 1gm/day for women with low calcium intake is beneficial.
- Periconceptional and continued use of folic acid throughout pregnancy.
- Aspirin started at 12 weeks at a dose of 100-150 mg given at night till 36 weeks of gestation prevents more than 60% of the severe form of the early onset pre-eclampsia , reduces the delivery of the preterm babies, and reduces the maternal morbidity and mortality.
- It is cost effective and saves lives.

Role of Angiogenic and Antiangiogenic factors in prediction of Pre-eclampsia.

- Evidence has suggested that an imbalance between angiogenic factors like Placental Growth Factor, and antiangiogenic factors, such as soluble fms-like tyrosine kinase 1 (sFlt-1) and soluble endoglin (sEng), plays a key role in pathogenesis of pre-eclampsia. With increase in ratio of sFlt-1 to PlGF will predict and diagnose pre-eclampsia before clinical evidence of PE.

Pre-eclampsia detection kit-Congo Red Dot paper test (CRD).

- Women with pre-eclampsia excrete urinary *misfolded* proteins pointing to pre-eclampsia being a protein conformational disease [19]. This protein will bind to Congo red dye- urine Congophilia. This phenomenon has been developed into a rapid bed side test which will differentiate pre-eclampsia from other conditions with hypertension or proteinuria.

Management - Practice essentials

- Irrespective of the hypertensive disorders of pregnancy, blood pressure above 140/90 mm of Hg. should be treated to avoid progression of the disease. The target blood pressure is 120-130 systolic 85 diastolic. Oral drugs like methyl dopa, nifedipine or Labetalol could be used.
- BP of 160/110 and above requires urgent care in a monitored condition to bring down the BP to a safer level of 130-140 systolic and 85-95 diastolic. This is important to prevent cerebral hemorrhage which is an important cause of maternal death. Rapidly acting oral tablets of nifedipine, intravenous labetalol or hydralazine could be used.
- Patients with signs of impending eclampsia should be given magnesium sulphate for seizure prophylaxis.

- Patients should be monitored with frequent BP checkup, clinical parameters, laboratory evaluation of liver and renal function tests, CBC and if platelet count is low, check coagulation profile. In worsening situation repeat the tests twice a week or earlier.
- Pre-eclampsia should not be classified as mild and severe, as all cases can progress rapidly and may lead to life threatening situation.
- Patients with pre-eclampsia should be delivered by 37 weeks or earlier if there is severe hypertension not responding to treatment, thrombocytopenia, progressive worsening of liver and renal function tests, severe persistent headache, visual disturbances, or non-reassuring fetal status.
- Early onset pre-eclampsia should be delivered by 34 weeks.

Fetal Monitoring and management.

- In pre-eclampsia where maternal condition allows the continuation of pregnancy, serial evaluation of fetal biometry, amniotic fluid volume and umbilical artery Doppler at diagnosis and then at every two weeks or earlier as indicated.
- With absent end diastolic flow before 34 weeks, daily NST and thrice weekly Doppler study, give steroid for pulmonary maturity and decide on termination on the result of NST and Doppler evaluation. Delivery should be considered around 34 weeks.
- With reversal of end diastolic flow, delivered not later than 30 weeks.

  Prenatal corticosteroids should be administered between 24-34 weeks if termination is planned.
- MgSO4 for neuroprotection is to be given if delivery is anticipated before 32 weeks.
- Mode of delivery in absent/reversal of end-diastolic flow and in extreme prematurity is by cesarean section.

Timing and mode of delivery.

Planned delivery on the best day in the best way- the most crucial decision that will decide the outcome. Expectant management will be of great benefit for the baby especially if remote from term. For the mother, delivery is the only intervention that initiates resolution of preeclampsia.

Pregnancy is terminated in

- Pre-eclampsia without severe features at the completion of 37weeks.
- Uncontrolled blood pressure despite using more than three drugs.
- Eclampsia, Abruptio placentae or fetal demise.
- HELLP syndrome
- Progressive Thrombocytopenia.
- Progressively worsening renal and liver function.
- Pulmonary edema.
- Progressive neurological features like severe intractable headache, repeated visual scotoma, and convulsions.
- Non reassuring fetal status

Hypertensive disorders of pregnancy as such is not an indication for cesarean section. Careful selection of the cases for induction with ripening of the cervix to achieve vaginal delivery is possible in pre-eclampsia and in eclampsia. Prolonged induction should be avoided. Patients with extreme prematurity and non-reassuring fetal status will be benefitted by cesarean section.

- Antihypertensives and $MgSO_4$should be continued during labour.
- Active management of 3rd stage of labour is an essential component in management (avoid ergometrine)
- Patient should be monitored carefully for 48-72 hours with blood pressure measurements

as eclampsia can develop in the postpartum.

- Avoid NSAIDs for pain relief as it may precipitate renal failure.
- Pre-eclampsia patients will require thromboprophylaxis especially following caesarean section

Management - HELLP Syndrome

The clinical course of HELLP syndrome often is characterized by progressive and sometimes sudden deterioration in maternal and fetal condition. Considering the serious nature of this entity, women with HELLP syndrome should be delivered regardless of their gestational age. As the management of patients with HELLP syndrome requires the availability of neonatal and obstetric intensive care units and personnel with special expertise, they should be managed at tertiary care centre. Women with HELLP syndrome are also at increased risk of pulmonary edema, acute respiratory distress syndrome and renal failure.

- Termination of pregnancy is advised irrespective of gestational age
- Labour should be induced depending on bishop score
- Corticosteroids for lung maturity and $MgSO_4$ for neuroprotection if gestational age <34 weeks
- Blood and blood components should be made available.
- Postpartum evaluation of LFT, RFT and other blood investigations for remission

Platelet count and Indication for Platelet transfusion

- Less than < 20,000/ml- regardless of mode of delivery.
- Between 20,000-49,000/ml- transfusion prior to cesarean section.
- More than >50,000/ml with active bleeding.

Management of impending eclampsia/ eclampsia – Eclampsia Drill.

Eclampsia is an obstetric emergency and the unit should be prepared to tackle this life-threatening complication by periodic practice of the protocol-based management as a drill. The essential drugs and equipment should be kept ready, (Eclampsia Box-See Annexure-III) and a team should be trained to deal with the emergency.

1. During a seizure, give general supportive care and resist the impulse of giving intravenous medications. Establish airway patency, administer oxygen by mask, 8-10 L/min, oxygen saturation by pulse oximeter to maintain at >95%.
2. Prevent maternal injury and aspiration - Cot with side rails padded with pillows, oropharyngeal airway, lateral position,
3. When the convulsions stop, secure intravenous line, take blood for investigations and cross matching - CBC, LFT, RFT, LDH, Coagulation profile and peripheral smear.
4. If BP >160/110, give inj. labetalol 20mg IV as the first intervention to prevent intracranial hemorrhage. It is the major cause of death in eclampsia.
5. Start eclampsia regimen. (see Annexure-II)
6. Treat severe hypertension to keep BP 130-140mm of Hg systolic and 85-95 diastolic with IV labetalol, hydralazine or oral nifedipine. (see Annexure-I)
7. Look for complications -pulmonary edema, give IV Frusemide 40mg. Fluid restriction to 70-80 ml/hr.
8. Cerebral hemorrhage - suspect in patients having recurrent convulsions, remaining in coma, neurological lesions- neuroimaging.
9. When the patient is stabilized - ie fits are controlled, blood pressure brought to safer level

and initiate labour induction. Faster delivery if abruptio placentae is present or suspected.

10. Look for toxicity of MgSo4.
11. Give calcium gluconate if there are signs of magnesium toxicity as per annexure II
12. ***Intravenous phenytoin, diazepam or midazolam are not advised as these are less effective than magnesium sulphate[22].***

Post-partum care-

- Hourly BP check for 6 hours especially in CS, and thereafter 6th hourly when she is awake for 72 hours.
- Blood pressure may increase in postpartum, especially 3 to 6 days after delivery. Observe the patient for at least five days.
- Blood pressure should be checked, and anti-hypertensives should be continued to maintain the BP at 130/85 or less.
- Long acting nifedipine, labetalol, or methyl dopa can be given during breast feeding. If BP is not controlled in the postpartum period, change to ACE inhibitors or beta blockers.
- NSAIDs for pain relief are contraindicated due to nephrotoxicity.
- Postpartum thromboprophylaxis should be considered in preeclampsia especially with other risk factors and/or in cesarean section.
- Patients with persistent hypertension should be investigated to detect chronic renal disease, SLE and diabetes.
- Patients are counseled to lead a healthy lifestyle, ideal interpregnancy interval, less weight gain, as they are at higher risk of developing recurrent pre-eclampsia, chronic hypertension, and cardiovascular disease.

Annexure – I

Prediction of Pre-eclampsia using Fetal Medicine Foundation Algorithm.

Can be done along with the Aneuploidy screening at 11-13+ weeks.

I. Maternal characteristics, medical and obstetric history is recorded as given below-

1. Maternal age – yr
2. Maternal Weight-kg
3. Maternal height-cm
4. Maternal ethnicity -Afro-Caribbean, Southeast Asian ,White, Mixed
5. Past obstetric history: nulliparous, parous without prior PE (Pre-eclampsia), parous with prior PE
6. Interpregnancy interval in years between the birth of the last child
7. Gestational age at delivery and birthweight of previous pregnancy beyond 24 wk
8. Family history of pre-eclampsia
9. Method of conception: spontaneous, ovulation induction, invitro fertilization
10. Smoking habit
11. History of diabetes mellitus: type 1, type 2,
12. History of systemic lupus erythematosus or antiphospholipid syndrome

II. Check BP carefully and take the average of two values to calculate the MAP

III. Take the uterine artery pulsatility index at the time of NT scan.

IV. Take blood for serum Placental growth factor along with PAPP-A.

Enter all the details- Maternal history, MAP, UTPI, PlGF (and PAPP-A) to the FMF Software available free of cost https://fetalmedicine.org/research/assess/preeclampsia to get the risk score. A score of 1/100 and above is considered positive and is started on low dose aspirin before 16 weeks. If UTPI and PLGF is not possible, calculate the risk with maternal history and MAP.

Annexure – II

Management of severe hypertension - (Systolic BP > 160 Diastolic BP > 110 mmHg)

1 Administer 10 mg of rapidly acting nifedipine orally. Check BP every 15 minutes, if BP is not controlled, repeat 10 mg of nifedipine after 45 minutes. May be given one more dose or start the IV medication.

2 IV labetalol – 20 mg labetalol IV bolus injection, check BP every 15 minutes. If BP is still high, give one more dose of 20 mg before doubling dose to 40 mg and 80 mg every 15 minutes IV till the BP is controlled to safer level. Can be given as IV infusion- labetalol 200 mg is added to 80 ml of normal saline to make it 100 ml. give it at 1ml /min (2mg/min).

3 IV hydralazine – Dilute 20 mg of hydralazine in 20 ml of water for injection, administer 5 ml (5 mg) IV bolus, check BP every10 minutes. If BP is not controlled, give next dose of 5 mg, and if after 20 minutes the BP remains high, give the third dose of IV hydralazine. If the BP is still high after the third dose, add 80 mg of hydralazine in 500 ml of normal saline and give as infusion of 5 mg per hour.

Antihypertensive agents in Pre-eclampsia/Eclampsia

Medication	Onset of action	Dose
Labetalol (IV bolus)	10-15 Min	20 mg, 40 mg, 80 mg /15 Min Max. 220 mg
Labetalol IVinfusion	10-15 Min	200 mg added to 80 ml of N.S to make it 100 ml. Give it at 1ml /min (2 mg/min)
Nifedipine- oral rapidly acting	5-10 min	10 mg every 45 min 3-4 doses
Hydralazine	5-10 min	5 mg IV bolus 2 to 3 doses at 20 min
Hydralazine IV infusion		80 mg of Hydralazine in 500 ml of normal saline given at 5 mg/ hr.

- The goal of antihypertensive therapy in severe hypertension is to prevent cerebral hemorrhage, which is the leading cause of death in eclampsia, and will be the first step in the management. Maintain the BP between 130-140 systolic and 85- 95 diastolic.

Annexure – III - Eclampsia Regimen- KFOG.

- Loading dose of $MgSO_4$– 4 gm IV and 4 gm IM, Total 8 gm.
- Maintenance dose – 1 gm per hour IV for 24 hours. give one gm/hr as infusion using infusion Pump or syringe pump
- Restrict IV fluids to 80 ml/hr to avoid pulmonary edema, including the fluid infusion of MgSO4
- $MgSO_4$ should be continued during delivery and cesarean section.

2 Monitor for toxicity- Clinical monitoring is sufficient.

- Monitor pulse, BP, respiratory rate, patellar reflex and urine output hourly.
- Stop $MgSO_4$ if there are signs of toxicity like:
  - Respiratory rate < 14 / min.
  - Patellar reflex sluggish or absent.
  - Urine output less than 30 ml per hour.
  - Oxygen saturation < 95%
- Give IV 10 ml of 10% calcium gluconate in 10 minutes. In case of respiratory paralysis, intubate and ventilate as cardiac depression will not happen.
- Loading dose of $MgSO_4$ should be given on admission irrespective of the urine output. Subsequent doses only if urine output is at least 30 ml per hour

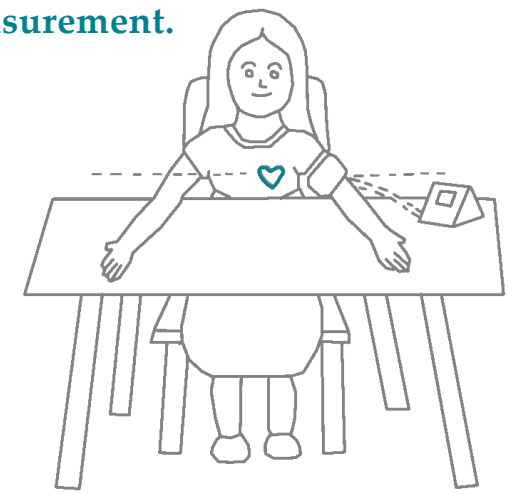
* The loading dose of 4 gm IV and 4 gm IM of magnesium sulphate is to achieve the therapeutic level to prevent recurrent fits.

Annexure-IV.
Content of Eclampsia Box.

Oropharyngeal airway, IV canulae, syringe, drip set, blood collecting test tubes for lab. investigations, 100 ml normal saline bottles, Magnesium sulfate 1 gm ampoules, Inj. labetalol, Inj. hydralazine, Tab. nifedipine. Calcium gluconate 10% 10 ml amp., Foley's catheter, Uro-bag, knee hammer.

Annexure-V.
Blood pressure measurement.

Women should be comfortably seated on a chair, back supported, with their arms well supported at the level of their heart on a table and legs not crossing. After resting for 5 minutes, blood pressure is measured ideally using calibrated and automated apparatus. Two readings are taken at one-minute interval and the average is taken.



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CHAPTER

08

Bacterial Sepsis and Maternal Mortality

V Rajasekharan Nair, P K Syamala Devi, S Sreelatha, Aravind Reghukumar

Editors' Note :

The authors have given a very useful and summarized overview of bacterial sepsis and maternal mortality with the practicing obstetrician in mind. Please note that sepsis and infection are not synonymous. When infection progresses to organ dysfunction it becomes sepsis. Our aim should be to avoid infection itself and if at all infection occurs, to pick up and manage before it leads to the level of sepsis. Since most of the deliveries take place in small centres without the luxury of an infection control team or in house microbiologist, the onus is on the obstetrician to plan and execute the preventive and therapeutic recommendations made by the authors in this chapter. The importance of cleanliness, proper sterilization of all instruments and good surgical practices during conduct of labour and cesarean section etc. cannot be overemphasized. A rational antibiotic policy should be developed in every delivery centre. Inspection and palpation of the wound (Episiotomy and Cesarean) should become a routine. The colour coded observation chart (MEOWS) should become an essential part of the case records. Observing q SOFA should become a habit for clinician.

Aseptic practices like regular cleaning of the labour room, proper maintenance of air conditioners, use of appropriate sterilization methods for instruments and drapes, proper segregation and disposal of waste etc. should be established in the labour room and theatre. Faculty should ensure that everyone follows good surgical practices like proper scrubbing for surgery, skin preparation, hair clipping rather than shaving and proper tissue handling.

Practices which are known to reduce infections like chlorhexidine shower/ bath before labour and surgery, painting upper vagina and cervix with antiseptics before cesarean section especially in those with PROM should be insisted on. Catheter and intravenous lines should be kept for the minimum required duration. The culture of using sterile bundles for conduct of labour, cesarean section, obstetric vaginal examination etc should be established. Written down protocols for antibiotic use and management of premature rupture of membranes etc. should be displayed in the labour ward.

V P Paily

General lay out of the article

1. Key Summary points.
2. Key recommendations
3. Summary of findings, trends etc.
4. Learning from examples.
5. Brief write up of topic
6. Conclusions.
7. Annexure.

Key Summary points

- Sepsis remains a significant cause for morbidity and mortality in pregnancy and puerperium.
- Sepsis is recognized as a time sensitive clinical condition of diverse origin.
- The physiological changes in pregnancy result in unique response to disease processes and could mask the early signs and symptoms of sepsis.
- The commonest cause is E-Coli infection, but group A Streptococcal infection is notorious to cause maternal death.
- Do not forget that non-bacterial or non-infective conditions may mimic sepsis.
- Refractory hypotension and elevated lactate levels are clues towards diagnosis of septic shock.
- Consider pregnancy induced normal ranges for investigations and observations.
- Pregnancy or lactation should not be a deterrent to the use of appropriate imaging modality if indicated.
- Blood culture and appropriate microbiological specimens should be obtained ideally before initiation of antibiotics. However drawing specimens for culture should not preclude the timely administration of antibiotics in sepsis.
- Decision on antibiotic: All major hospitals treating sepsis should have their own antibiogram. **Hit hard and then focus should be the strategy.** Use right antibiotic, at the right time, in right dose and duration for the right patient. Principles of antibiotic stewardship should be borne in mind while treating sepsis.

Key Recommendations

- In any case of Obstetric collapse, think of sepsis also (cause/ co existing/ end result)
- Subtle signs of sepsis should be picked up at the earliest for timely diagnosis and intervention.
- Any postoperative patient – note
    1. Talk (mentation)
    2. Touch (temperature, pulse, wound)
    3. Count (pulse rate, respiratory rate)
- Screen for sepsis using the qSOFA score. Sepsis may manifest with or without fever or an obvious source.
- Assess for evidence of organ failure by SOFA score and use MEOWS for monitoring.
- Lactate estimation is not a one-time investigation.
- Management should be guided by the updated sepsis bundle recommendations.
- Start broad spectrum antibiotics at the earliest after drawing blood for culture. Fluid resuscitation, correction of metabolic acidosis and thromboprophylaxis are also important measures.
- Sepsis – ***A black cat in the dark*** – catch it with "MEOWS"
- Prevent sepsis by appropriate infection prevention and control measures in all obstetric situations. Create awareness among junior staff during rounds on prevention, early recognition, and management of sepsis.

Summary of findings - Trends

In the first edition covering 2004-05 period, sepsis was the twelfth contributory cause for maternal mortality. However very few cases were made available for the confidential review and hence we skipped the chapter on this topic in the first edition.

In the second report for the period 2006-09, we saw the emergence of sepsis as the third major cause of maternal mortality in Kerala. This was a disturbing trend, more so to take note that many of the cases had developed sepsis following cesarean section. The importance of aseptic technique to reduce the incidence along with early diagnosis and focused treatment with fluid therapy and timely administration of antibiotics were highlighted in the chapter. Specific steps to increase awareness on key issues related to sepsis was highlighted during CMEs, classes etc. The key messages on surviving sepsis campaign reached most of the practitioners in subsequent years.

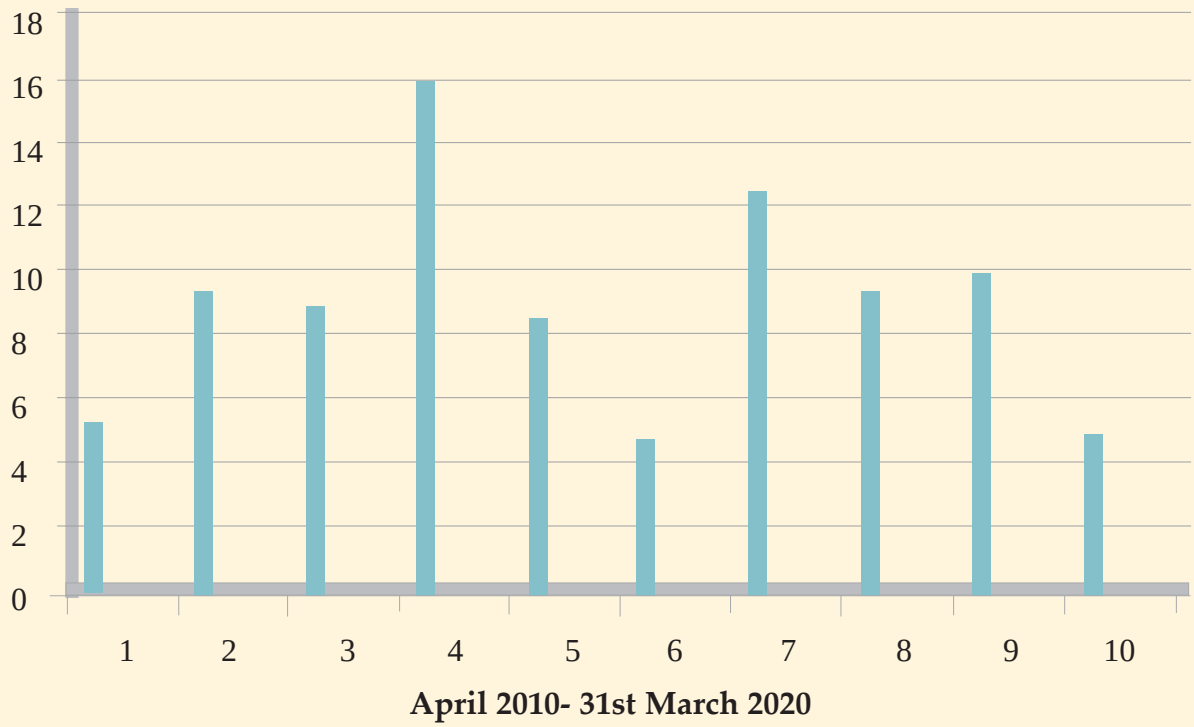
Table 1. Ten most common causes of maternal deaths (10 year period, 1076 cases)

No	Cause	Percentage
1	Postpartum hemorrhage	17.56
2	Hypertensive disorders	9.85
3	Sepsis	8.92
4	Respiratory disease (including H1N1)	8.82
5	Neurological disorders	7.43
6	Suicide	7.34
7	Heart Disease	6.97
8	Amniotic fluid embolism	5.4
9	Pulmonary Embolism	5.2
10	Acute Fatty Liver of Pregnancy	2.41

Table 2. Year wise incidence of sepsis 2010-11 to - 2019- 20

Year	Total deaths analysed	**Total sepsis deaths**	Septic abortions	Criminal abortions	Bowel Perforation	No of cases following cesarean
2010-11	113	6 (5.3%)	1	1		2
2011-12	85	8 (9.4%)	1	1		2
2012-13	101	9 (8.9 %)	2			3
2013-14	112	18 (16.07%)		2	1	10
2014-15	117	10 (8.5%)	2	1		5
2015-16	106	5 (4.7 %)	2			2
2016-17	80	10 (12.5 %)	nil		1	7
2017-18	138	13 (9.4 %)	3			7
2018-19	122	12 (9.83%)	5	1	1	4
2019-2020	102	5 (4.9%)	nil		1	2
Total	1076	96	16	6	5	44

Fig-1
Year wise incidence of deaths due to sepsis (2010-2020)
(percentage of maternal deaths , n=1076)



The present ten year review shows that there is wide variation in the incidence of sepsis as a cause of death, with an average of seven percent. The wide variation from 4.7% to 16.07% probably reflects problems with reporting.

Post-abortal sepsis is dealt with in another chapter; however, a few lines on that may be added here. Septic abortion, often following criminal attempts to terminate an unwanted pregnancy is a major cause of maternal mortality in several states in India. Fortunately, it had never been an issue in Kerala in recent years, thanks to the wider uptake of contraceptive measures and an educated public who do not go to quacks for this purpose. Still a few cases have come to our notice. These were due to attempts at termination of pregnancy by unauthorized and unqualified practitioners in remote parts of our state. Creation of awareness among the public about safe contraceptive practices is the solution for this problem.

We had more than 20 cases in the ten years falling under septic abortion. Most of these were in spontaneous abortions or legally terminated pregnancies –highlighting the importance of aseptic practice while dealing with abortion in general.

There were five cases of bowel perforation ending in peritonitis leading to maternal deaths. In almost all of these the reason for bowel perforation was not obvious.

Perusal of the relevant patient data reveals that substandard care was a major factor leading to mortality. Observed lacunae were

1. Failure in recognizing the early symptoms and signs of sepsis.
2. Delay in understanding the seriousness of the condition.
3. Failure to institute aggressive management measures

Association with Cesarean delivery

Around 45% of deliveries in the State are by cesarean section. Of the reported sepsis deaths excluding abortions 60% are associated with cesarean section (44/74). 50 % of these cases had other risk factors such as PROM, PPROM, failed induction etc. where there is an added risk of sepsis. This figure is after excluding the deaths due to PPH, internal bleeding etc. associated with cesarean section. It is to be expected that when the cesarean section rates increase there can be a parallel increase in mortality due to cesarean related causes.

It is to be noted that all these cases are done by specialists, in institutions where facilities are adequate. These point to the fact that increased vigil need to be maintained by all concerned to reduce sepsis related to cesarean section.

It is also high time to change the attitude of the public as well as the health care providers that cesarean section is without complications. It is immensely clear from this chapter and from the chapter on hemorrhage that cesarean section is associated with a higher morbidity and mortality than vaginal delivery.

Learning from example

Example 1:
Look at the woman, look at the surgical site

A 2ndgravida with multiple pregnancy underwent cesarean section in a well-equipped hospital for PROM of 5 days duration. She developed postoperative pyrexia, tachycardia, abdominal distension and oliguria from the third day. Antibiotics were escalated and blood transfusion was administered. She was referred on the 4th day, when she developed hypotension.

At the referral centre it was observed that the woman was already in septic shock. There was extensive necrotizing fasciitis which on exploration

revealed dehiscence also. The patient was put on ventilator and had other supportive measures, but died on the 6th postoperative day.

Lessons:

- The woman had three high risk factors, viz multiple pregnancy, PROM and cesarean section. There was a high chance of wound infection. The wound was not carefully examined. In many hospitals, it is a common practice to remove the dressing on the 3rd or 4th day. In such situations, the wound related sepsis will not be diagnosed early. We recommend to remove wound dressing within 24 hours, usually the next morning during ward rounds. On the least suspicion of wound infection, the wound should be explored for possible collection or fasciitis.

- The general signs were also not given adequate consideration. The presence of tachycardia and tachypnea were not viewed seriously and was treated with blood transfusion. Very often these symptoms are perceived as normal phenomena in a post operative patient.

Example 2.

Puerperal sepsis – not uncommon even now

Twenty year old woman who had an instrumental delivery nine days earlier, was admitted with cough and breathlessness. Pulse rate 150/min, BP 102/70mm of Hg, respiratory rate 34/ min. Her episiotomy was gaping with foul smelling discharge, and bulging fornix. Pus culture yielded E. coli and Staphylococcus aureus. There was no record of any action taken for the bulging fornix. In spite of aggressive antibiotic treatment, she progressed to ARDS and died.

Lessons:

- This case clearly indicates the need for sterile techniques during conduct of labour. Use of autoclaved sets for vaginal examination and other procedures must become a routine in all obstetric units.
- Overuse of antibiotics and the resultant emergence of antibiotic resistant microbes has also become a major problem. For normal deliveries use of routine antibiotic coverage is discouraged.
- More than 48 hours of hospital stay is a risk factor for resistant nosocomial pathogens, hence consider early discharge whenever possible.
- There is no mention of draining the pus in the pouch of Douglas. Whenever there is pus collection, it needs drainage. In this case colpotomy would have been enough.

Some Common omissions noted during the review process.

- *A good temperature chart* is often not maintained. Temperature variations fever/hypothermia not picked up
- *Tachycardia* – careful recording of pulse rate and the change from the basal rate
- *Tachypnea* – Most over-looked but very significant
- *Hypotension* – In the absence of any obvious cause for hypotension, suspect sepsis.
- *Productive cough* – now nonproductive cough is also significant – (corona virus)
- *Abdominal pain* – often labeled as postoperative pain and ignored
- *Vaginal discharge* – often overlooked during routine rounds , never bother to check
- *Oliguria* – output often ignored unless a continuous drainage catheter is there
- *Sensorium* – any alteration is to be viewed seriously and not labelled as postpartum psychosis
- *Ileus*- in post cesarean patients, labeled as normal,

but could be a sign of sepsis

- *Wound* – may miss an important finding if not inspected and palpated.
- *Third delay* (delay in providing appropriate care after reaching the institution) is a significant observation in some cases, even in major hospitals. In some cases of referred patients undue delay is noticed in resorting to appropriate treatment even after reaching the higher centre.

Update on Sepsis in obstetrics

Maternal Sepsis is a life threatening condition defined as organ dysfunction resulting from infection during pregnancy, childbirth, post - abortion, or postpartum period.

Septic shock can be defined as sepsis associated with vasopressor requirements to maintain a mean arterial pressure (MAP) of 65mmHg or more in the absence of hypovolemia and a serum lactate >2 mmol/l (Surviving sepsis campaign 3)[1]

Etiology

Maternal sepsis can be due to a direct genital tract infection or due to indirect causes like pneumonia, influenza or following major obstetric hemorrhage secondary to uterine atony or DIC.

Causative micro-organisms

- Although most commonly bacterial in etiology, sepsis can also result from viral and other causes. A number of non-infective conditions can also mimic sepsis. Escherichia coli is the most common pathogen accounting for 37% of maternal sepsis cases. E-coli infection is more common in the antenatal period especially in the second and third trimester. It gives rise to more fetal deaths resulting from chorioamnionitis following PPROM.
- Less common but more severe infection is caused by Group A Streptococcus especially Streptococcus pyogenes. It can rapidly progress to necrotizing fasciitis and toxic shock syndrome.
- Less common bacterial pathogens implicated in obstetric sepsis are Hemophilus influenza, Listeria monocytogenes, Clostridium species and Mycobacterium Tuberculosis.

  In order to formulate an effective empiric antibiotic policy, the likely organisms implicated in sepsis and their susceptibility pattern should be known.

Causes of Severe Sepsis and Septic Shock in Pregnancy and the Puerperium

(modified from Barton & Sibai)[2]

- Retained products of conception
- Septic abortion
- Conservative management of placenta accreta/ percreta
- Neglected chorioamnionitis or endomyo-metritis.
- Uterine microabscess or necrotizing myometritis
- Pelvic abscess
- Abdominal incision, Episiotomy, Perineal laceration
- Unrecognised or inadequately treated necrotising fasciitis
- Acute pyelonephritis
- Gas gangrene
- Pneumonia

Intraperitoneal etiology (non - obstetric)

- Ruptured appendix or acute appendicitis
- Bowel infarction

- Acute Cholecystitis, necrotising pancreatitis

Common organisms

E Coli, Group A Streptococcus, Staphylococcus, Pneumococcus-

Mycoplasma, Legionella, Hemophilus influenza

Non infective conditions that can mimic sepsis are acute pulmonary embolism, diabetic ketoacidosis, AFE, AFLP, acute adrenal or pituitary insufficiency, autoimmune conditions, catastrophic APLA etc.

Risk Factors for Sepsis and Septic Shock

Risk factors can be obstetric or patient related

Obstetric risk factors:

- Cesarean section and operative vaginal deliveries are important risk factors for postpartum maternal sepsis. There is 5% - 20% increase in infectious morbidity compared with vaginal birth. Emergency cesarean section poses the greatest risk compared to elective cesarean and operative vaginal delivery.
- Other obstetric risk factors include cervical cerclage, prolonged rupture of membrane, history of group B Streptococcal infection, or group A Streptococcal infection in close contacts or family members.
- Abnormal vaginal discharge, multiple pregnancy, PPROM, retained products of conception,
- Amniocentesis or other invasive procedures.

Patient related risk factors:

- These include primigravida, low socio-economic status, pre-existing medical disorders, febrile illness and antibiotic usage within 2 weeks prior to presentation.
- Co-morbidities include chronic liver and renal diseases, CCF, HIV infection, SLE, diabetes.

Diagnosis of Sepsis

In pregnancy and puerperium, women are more susceptible to rapid deterioration following an infection. Immunological and cardiovascular adaptation of normal pregnancy may have an adverse impact on the maternal response to infection. Physiological changes of pregnancy which mimic symptoms of sepsis often delay early recognition and optimal management.

The hyperdynamic circulation associated with pregnancy along with peripheral vasodilatation, drop in systolic and diastolic blood pressure and compensatory tachycardia, all mask the cardiovascular symptoms and signs of sepsis. Endothelium derived nitric oxide, a potent smooth muscle relaxant and vasodilator is up-regulated in sepsis and further enhances the already existing hypotension. The interleukins liberated as a result of tissue destruction along with excess nitric oxide causes hypoperfusion and organ damage.

Tachypnea and hyperventilation caused by sepsis may be confused with the tachypnea of pregnancy. More over tachypnea of pregnancy creates a respiratory alkalosis that is countered by an increase in renal bicarbonate excretion. Accordingly pregnant women may slightly be less able to buffer the metabolic acidosis caused by sepsis.

Prior to 2016, the diagnosis of sepsis was mainly based on SIRS criteria. Apart from temperature all other features of SIRS criteria overlap with the physiological parameters observed in healthy pregnancy, giving rise to high false positive rate. So SIRS criteria is no more used as a diagnostic tool.

In 2016 in the 3rd International sepsis consensus conference, sepsis was redefined as life threatening organ dysfunction caused by a dysregulated host response to infection, thereby necessitating the presence of organ dysfunction to diagnose sepsis. Organ dysfunction can be identified as an acute change in total SOFA [Sequential Organ Failure Assessment, Annexure-1] score > 2 points consequent to the infection. The baseline SOFA score can be assumed to be zero in patients not known to have preexisting organ dysfunction. A SOFA score > 2 reflects an overall mortality risk of approximately 10% in a general hospital population with suspected infection. Even patients presenting with modest dysfunction can deteriorate further, hence the need for prompt intervention.

But this scoring system had incorporated many lab criteria, hence for bedside evaluation of suspected sepsis cases "a quick SOFA score" (qSOFA, Refer Annexure II) was devised.

qSOFA score is a bedside screening tool for identifying sepsis in 'out of ICU settings' like in wards. It is meant to identify adult patients with suspected infection who are more likely to have poor outcomes typical of sepsis if they have at least two of the following clinical criteria.

- Respiratory rate of 22/min or greater
- Altered mentation, (Glasgow Coma score < 13)
- Systolic blood pressure of < 100 mm Hg.

qSOFA is used as a mortality predictor rather than as an early predictor of a probable sepsis. Moreover this was not validated in pregnant woman and hence requires validation as pregnant population has altered physiological parameters when compared to nonpregnant population.

Sepsis and septic shock are obstetric emergencies. Sepsis is a time-sensitive disease process and as obstetricians we prefer to diagnose sepsis in the early period where **it is "an infection most probably going in for sepsis syndrome",** hence for this our track and trigger system is a good tool. RCOG recommends the use of the Modified Early Obstetric Warning Signs (MEOWS – see annexure III)

Prevention of sepsis

Prevention is better than cure. Improve health of pregnant women, prevent or correct anemia and look for and treat asymptomatic bacteriuria. Ensure that standard and transmission based precautions are adhered to; to prevent health-care associated infections.

- CRMD, Kerala showed that many cases of sepsis occurred following cesarean section. So the first step is to reduce cesarean section rate. Adhere to strict asepsis in labor ward and Operation theatre.
- Avoid elective surgeries in the presence of infection.
- Ensure proper skin preparation and prefer hair clipping as opposed to shaving prior to surgery. Prefer chlorhexidine containing skin preparation {chlorhexidine IP 10% v/v (Equivalent 2% w/v chlorhexidine gluconate) Isopropyl Alcohol IP 70% V/v} rather than povidone iodine to clean surgical site. Ensure contact time of 5 minutes.
- Take care to avoid too much tissue damage and to attain complete hemostasis during surgery.
- Single dose of prophylactic antibiotic should be administered half an hour prior to skin incision.

Consider second dose in case prolonged surgery, more than 3 hours or blood loss more than 1000ml.

- Postoperative wound care and consistent infection control surveillance are very pertinent in sepsis prevention.

Management of Maternal Sepsis:

Since 2004, the SSC (Surviving Sepsis Campaign) has published various protocols for the initial management of patient with sepsis. The latest is in 2018 - "Hour-1 bundle" ("golden hour"). It consists of five elements of care, which should be initiated with in the first hour of recognition of sepsis[3]. The elements are

Hour -1 bundle

- Measure lactate level. Remeasure, if initial lactate is >2 mmol/L
- Obtain blood cultures prior to administration of antibiotics
- Administer broad spectrum antibiotics
- Rapidly administer 30ml/kg crystalloid for hypotension or lactate > 4mmol/L
- Consider vasopressors if patient is hypotensive during or after fluid resuscitation to maintain MAP > 65 mm.Hg

The UK sepsis Trust has adopted a "Sepsis Six" bundle which also include administration of high flow oxygen and monitoring of urine output.

Key points about antimicrobial therapy

Infections in obstetric patients tend to be polymicrobial and many culprit organisms are part of the normal vaginal flora. The most frequent microbes include groups A, B and G Streptococci, E coli, Streptococci oralis, Staphylococcus aureus, Citrobacter and Fusobacterium species. Peripartum sepsis is usually due to beta-hemolytic Streptococcus and E coli. Chosen empiric antimicrobial therapy should provide adequate gram positive, negative and anaerobic coverage.

Kumar et al has noted that for every additional hour to effective antimicrobial initiation in the first six hours after onset of hypotension, survival dropped an average of 7.6%. This means that we have to get our empirical regimen right at the onset itself. There is no mortality benefit in escalating the antibiotics based on culture results. So to get the combo right, we have to hit hard (start smart...use broad spectrum drugs) within first hour and later we have to deescalate (focus) to narrow spectrum drugs based on culture and sensitivity. Automated ID/AST cultures will yield the result by 48 to 78 hours. Based on the result we have to step down to narrow spectrum antibiotics.

Conclusions

In spite of the advances in medicine we are unable to prevent all maternal deaths due to sepsis. Very often it is due to failure of a systematic evaluation of the patient coupled with a tardy response. Fortunately for us, the pathophysiology of this time sensitive disease is increasingly understood and the best way will be to stick to the recommendations of the surviving sepsis campaign. Other things which should not be forgotten are the cardinal principles of preventing sepsis. Never fail to bring in your colleagues from other specialties for better patient salvage.

Table No 3 Suggested antibiotic policy

SUSPECTED SOURCE	RECOMMENDED THERAPY	IF MDR ORGANISMS ARE SUSPECTED
Unknown etiology	Cloxacillin 2g every 6 hours + Ceftriaxone 1g daily + Clindamycin 600mg every 8 hours	MDR organisms should be suspected if 1. patient has recent contact with health care system (referred) 2. Exposure to antibiotics in last 90 days. 3. Hospitalization > 5 days 4. Immuno compromised 5. Recent surgery 6. Infections following invasive procedures. In such patients, the empirical antibiotic therapy for septic shock should cover for pseudomonas, ESBL enterobacteriacea and MRSA.
Perineal wound	Ampicillin 2 g every 6 hours+ Metronidazole 500mg every 12 hours	
Wound: abdominal, breast, other line related infection	Cloxacillin 2g every 6 hours + Ceftriaxone 1g daily	
Chorioamnionitis Endometritis	Ampicillin 2g every 6 hours + Gentamicin 5-7mg/kg** + Metronidazole 500mg every 12 hours	
Group A, C & G Streptococcal sepsis (toxic shock)	Benzyl Penicillin 1.8g every 4 hours + clindamycin 600mg every 8 hours	
Intrapartum fever	Ampicillin 2g every 6 hours + Metronidazole 500mg every 12 hours + Gentamicin 5-7mg/kg**	
Mastitis	Cloxacillin 2g every 6 hours	So instead of betalactams we should use betalactam plus betalactamase inhibitor combinations or carbapenems upfront. Eg.piperacillin-tazobactam, cefoperazone-sulbactam, cefepime-tazobactam, ceftazidime-tazobactam, ticarcillin-clavulanate or mero/ imipenem plus vancomycin if indicated.
Pyelonephritis / Urinary Sepsis	Ceftriaxone 1g daily + Gentamicin 5-7mg/kg**	
Pneumonia (see Pneumonia Score) if pregnant, consider Oseltamivir		
Community acquired and moderate	Ceftriaxone 1g daily + Clarithromycin 500mg every 12 hours (orally)	
Community acquired and Severe	Ceftriaxone 2g daily Azithromycin 500mg daily	

**** Dose to be adjusted as per renal function**

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ANNEXURES

ANNEXURE I SOFA SCORE

Organ System	1	2	3	4
Respiratory PaO_2/FiO^2, (mmHg)	<400	<300	<200	<100
Hematologic Platelets/µl	<150	<100	<50	<20
Hepatic Bilirubin, mg/dl (µmol/1)	1.2-1.9 (20-32)	2.0-5.9 (33-101)	6.0-11.9 (102-204)	> 12.0 (>204)
Cardiovascular Hypertension	MAP <70 mm Hg	Dopamine < 5 or dobutamine (any dose)	Dopamine > 5 or epinephrine < 0.1) or Norepinephrine < 0.1)	Dopamine > 15 or epinephrine > 0 or Norepinephrine 0.1
Neurologic Glasgow Coma Score	13-14	10-12	6-9	<6
Renal Creatinine, mg/dl (µmol/1)	1.2-1.9 (110-170)	2.0-3.4 (171-299)	3.5-4.9 (300-440)	> 5.0 (>440)
Urine output			<500 ml/day	<200 ml/day

ANNEXURE II Quick SOFA Test

Table 2 Quick Sequential Organ Failure Assessment (SOFA) Score

qSOFA (Quick SOFA) Criteria	Points
Respiratory rate >22/min	1
Change in mental status	1
Systolic blood pressure <100 mmHg	1

CHAPTER

09

Amniotic Fluid Embolism

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Editor's Note

Amniotic Fluid Embolism (AFE) continues to be an enigmatic disease. However, we hope that soon some diagnostic tips will emerge. In the meantime, we have to continue to diagnose it on the basis of symptomatology. The Society for Maternal Fetal Medicine (SMFM) has suggested the diagnostic criteria as "the classic triad of hemodynamic and respiratory compromise accompanied by strictly defined disseminated intravascular coagulation". CRMD had been following the above with an addition of one more symptom "brief spell of seizures" which is an indication of cerebral anoxia. Regarding the time frame, our recommendation was to follow a time limit of 30 minutes from termination of pregnancy.

There is no international consensus on the above recommendations but I think we should continue to hold on to the above criteria even though all four criteria may not be present in all the cases. Of course, AFE should be diagnosed only after excluding all possible causes of sudden collapse.

V P Paily

Key Summary Points

- Amniotic Fluid Embolism (AFE) is the eighth leading cause of maternal deaths in Kerala. It was in the fifth position in the last edition; respiratory causes, neurological causes and suicide having overtaken AFE.
- The symptom triad, that was searched for to make a diagnosis was hypotension, chest discomfort with hypoxia and coagulation problems. Convulsions and acute fetal distress are very common accompaniments.
- The diagnosis was made on clinical grounds alone after excluding other causes.

There were 59 deaths assigned to AFE out of a total of 1076 deaths (5.48%) reported to CRMD (Confidential Review of Maternal Deaths) in the 10 years.

- Hyperstimulation of uterus is a common association of AFE. The use of prostaglandin (E1 or E_2) and or oxytocin with artificial rupture of membranes (ARM) was seen associated with AFE.
- Although the use of vasodilators in active labour has come down, it is evident that some of our obstetricians are still using it in active labour.
- Even when revived from cardiorespiratory collapse, many maternal deaths occurred due to disseminated intravascular coagulation (DIC) or postpartum hemorrhage (PPH) and its sequelae.
- Maternal and perinatal mortalities appear to have decreased during the last decade most likely because of improvements in the critical care training (EmOCALS, ORRT) and early recognition of atypical or milder cases.

Key Recommendations

- Due to the association between hyperstimulation and AFE, avoid all steps that lead to hyperstimulation.
- Induction of labour should be only for a valid reason, especially in a multigravida and ripening the cervix with Foley catheter+/- extra amniotic saline infusion(EASI) should be done before using prostaglandins. This will reduce the need /dose of prostaglandins and the risk of hyperstimulation.
- Adhere to the dose and time schedule of prostaglandins use (E1 and E2)-minimum 4 hours between E1 and 6 hours between E2 doses.
- Once cervix is effaced, prostaglandins should not be used for acceleration of labour, instead titrated dose of oxytocin alone should be used.
- Give minimum 4-6 hours interval between prostaglandins and oxytocin
- Once ARM is done, oxytocin should not be started within one hour. Once started, monitor the dose of oxytocin carefully.
- Once cervix is effaced, use of smooth muscle relaxants like valethamate, drotaverin and hyoscine will lead to vasodilatation and may increase the risk of PPH and AFE.
- Early warning signs like chest discomfort, symptoms of respiratory distress, altered mental status and features of hypoxia and hypoxemia in active labour and postpartum period should not be ignored.
- All labour rooms should have emergency trolley with necessary drugs, laryngoscope, endotracheal tube etc.
- If AFE is suspected in first stage **anticipate** DIC and PPH.
- Good 'Post Event' care is important. All staff taking care of obstetric women should be

trained in Emergency obstetric care and Life Support (EmOCALS). Ideally an Obstetric Rapid Response Team (ORRT) should be in place in every Obstetric unit.

- If maternal cardiac arrest has occurred resuscitative hysterotomy (Perimortem cesarean section) will improve the chance of survival for fetus and mother.

Summary of Findings

Though AFE has been pushed down the list as a cause of maternal death, it is still a major killer contributing to 5.66 %. Many of the maternal deaths attributed to AFE were reclassified after quarterly CRMD meetings. It was an 'Escape diagnosis' many a time. Table 1 compares the data of last few years.

Fig:1.Incidence of AFE over the period 2004 to 2020

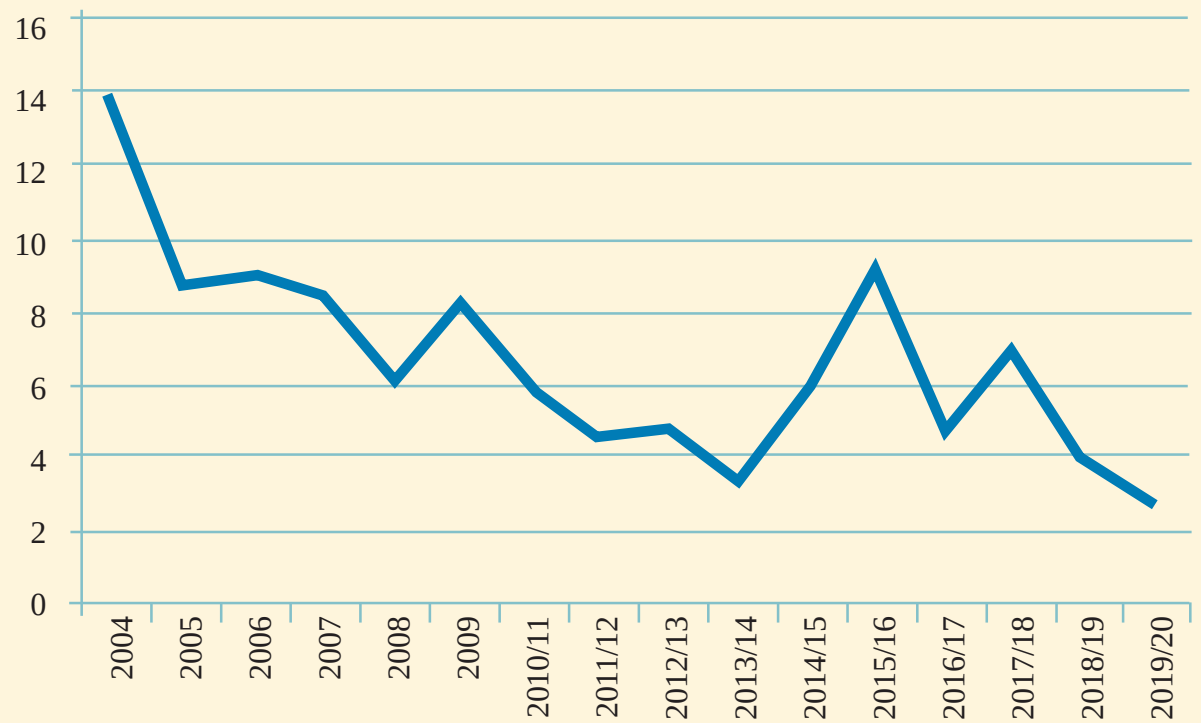

Table 1. Deaths due to AFE over the 10yr period (2010 - 2020)

	2010/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	**Total**
Total deaths analysed	113	85	101	112	117	106	80	138	122	102	**1076**
Deaths due to AFE	7	4	5	4	7	10	4	10	5	3	**59**
% of deaths	6.19	4.7	4.9	3.5	5.98	9.4	5	7.2	4.09	2.9	**5.48**

Table 2. Age distribution

Year	Total no. AFE	Age 20-29	30-35	>36
2010/11	7	4	3	
11/12	4	2	2	
12/13	5	4	1	
13/14	4	2	1	1
14/15	7	3	4	
15/16	10	7	2	1
16/17	4	1	3	
17/18	10	3	6	1
18/19	5	4	1	
19/20	3	1	1	1
Total	**59**	**31**	**24**	**4**

Table 3. Gravida

Year	Total AFE	G1	G2	G3& above
2010/11	7		3	4
11/12	4	1	2	1
12/13	5	1	2	2
13/14	4	1	1	2
14/15	7	4	1	2
15/16	10	2	4	4
16/17	4	0	1	3
17/18	10	1	2	7
18/19	5	1	1	3
19/20	3	0	2	1
Total	**59**	**11**	**19**	**29**

Table 3 shows that there is a significant increase in the incidence of AFE as parity increases, unlike PPH. Many of them had received oxytocin for induction of labour.

Table 4. Mode of delivery

	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	Total
Total AFE cases	7	4	5	4	7	10	4	10	5	3	59
Vaginal delivery	1	2	2	1	4	2	2	1	1	1	17
Instrumental	1	nil	1	nil	1	3	1	2			9
Cesarean Emergency	1	1	1	nil	2			3	2	1	11
Cesarean Elective						2		1			3
Perimortum CS									1		1
Undelivered	4	1	1	3		3	1	3	1	1	18
Obstetric hysterectomy	2	0	1	0	2	2	2	1	0	0	10

Table 4 shows the mode of delivery in cases of deaths due to AFE. Most of the emergency cesarean sections and instrumental vaginal deliveries are for fetal distress which is a very common association. Should we not promote perimortem cesarean sections? (only one out of 59 deaths!). Ten patients underwent obstetric hysterectomy for uncontrolled PPH after AFE.

Table 5. Outcome of baby

	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Total cases	**7**	**4**	**5**	**4**	**7**	**10**	**4**	**10**	**5**	**3**
Normal					4	5	1	2	1	1
Asphyxiated	3	2	2	1	1	2	1	1	2	
Fresh Still born			2		2		1	4	1	1
Undelivered	4	1	1	3		3	1	3	1	1

Table 6. Symptoms observed and their incidence

	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	total
Total no of AFE	**7**	**4**	**5**	**4**	**7**	**10**	**4**	**10**	**5**	**3**	**59**
Seizures	3	3	4	2	4	6	1	5	1	2	31
Cyanosis		2	2	1	2	2		5	1		15
Hypotension, collapse	5	3	4	2	5	2	2	7	4	2	36
Chest discomfort &Breathlessness	2	2	1	3	3	3	2	4	1	3	24
Blurring of vision								1	1		2
Cardiac arrest	1	1	1	3	3	6	2	4	3	3	27
PPH, DIC	2	2	4	1	4	3	3	2			20
Giddiness	2		1		1	1					5

Table 7. Induction & Augmentation

	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
PgE1	1	1	1		2	3		3	2	
Foley +PgE1							1	1		
PGE2		1	1							
Oxytocin for induction	1			2		1	1	2		
Oxytocin for acceleration	2	2	3	1	5	1	1	4	1	2
Epidosin/ Buscopan				1	1	1		2		

Table 7 shows the mode of induction and augmentation. PGE1 induction is more widely used, so the numbers are definitely high; but incidence of AFE is high when PGE1 is used against a closed cervix. Thirty out of 59 patients had received oxytocin. As per the data retrieved from case records five patients had received epidosin & / or Buscopan (definitely under documented).

Learning from Examples

Example 1

30 year old Primi with expected date of confinement (EDC) on April 26th, was admitted on April 12th at 7am with leaking since 5am. Oxytocin drip started along with antibiotics. At 12.20 pm cervix (Cx) 3cm, At 2pm Cx 7-8 cm, Vertex at -1. At 2.10 pm patient had convulsions. She was delivered by vacuum at 2.22pm. Immediately after separation of placenta she developed atonic PPH & DIC. As medical management (packed with 5 roller gauze, Inj Mg So4, 15 units pitocin on flow, cytotec 600 microgram per rectum) failed, proceeded with emergency laparotomy, total hysterectomy & internal iliac artery ligation. She arrested on the table. Revived but after repeated cardiac arrests, she died at 7pm.

Learning Points

1. Most of the patients with PROM get into spontaneous labour, no need to induce or augment immediately. Nurse's records show use of 3 doses of epidosin and buscopan which might have accelerated the progress of labour , but might have led to AFE.
2. Active management of third stage of labour (AMTSL) was not practiced.
3. No role for Inj. MgSO4 in this patient.
4. The management of PPH is not according to existing protocols (Refer chapter on PPH).
5. Internal iliac artery ligation is not for patients in DIC.

Example 2

35 year old primi, EDC on May 2nd, admitted in a private hospital on April 30th at 3.20am with labour pains. 8.15am - vaginal examination was done - Cx 5cm, 80% effaced, vertex -1, membranes+, ARM done and pitocin 2.5 units was started. Delivered normally at 12 noon and collapsed immediately. She was resuscitated by critical care team. After 20 mts of CPCR (Cardiopulmonary and cerebral resuscitation), she could be revived but developed another cardiac arrest and expired at 1.30pm.

Learning points

- For any patient who is progressing well in labour, unnecessary augmentation is not warranted.
- Also, oxytocin should not be started within one hour of ARM as it causes hyperstimulation which can lead to AFE. The dose of 2.5 units oxytocin is not the standard practice.
- The presence of Critical Care Team has to be appreciated. In smaller centres at least an Obstetric Rapid Response Team (ORRT) should be available to provide the correct first aid.

Example 3

A 38 year old woman ($G_3P_2L_2$, 2 FTND, LCB 8yrs, EDC on August 14th) with history of PPH in first pregnancy and hypertension detected near term was admitted in a private hospital with spontaneous onset of labour. On August 17th, oxytocin 2.5 units was started when cervix was 3-4 cms dilated. Epidosin 3 doses was given. She collapsed at full dilatation and was referred to another private hospital where she was resuscitated and referred to medical college hospital with endotracheal tube (ET) and Ambu bag ventilation. On arrival at the medical college, pulse and BP were not recordable, pink frothy secretions were present in the E.T. tube, fetal heart sounds were absent and cervix was fully dilated with vertex at +2. She

was delivered with forceps at 10.30am, baby 3.58 kg. In spite of aggressive resuscitative measures mother could not be revived. Death declared at 11am.

Learning Points

- Hypertensive patients are not allowed to continue beyond 37-38 weeks. Pregnancy should have been terminated earlier.
- At 3- 4 cm of cervical dilatation, ARM would have been a better option than oxytocin.
- It is very disheartening to see that STILL there are centers using smooth muscle relaxants in active labour.
- A patient in second stage with cardiovascular collapse, being referred by 2 hospitals undelivered is unacceptable. Uterine evacuation improves the survival of the mother.

Our responsibility does not end by referring

Amniotic fluid embolism
(Anaphylactoid syndrome of pregnancy)

Amniotic fluid embolism should be considered in the differential diagnosis in any pregnant or immediately postpartum woman who suffers sudden cardiovascular collapse or cardiac arrest, seizures, severe respiratory difficulty, or hypoxia, particularly if such events are followed by a coagulopathy that cannot be otherwise explained. Amniotic fluid embolism is thought to be caused by abnormal activation of immunologic mechanisms following entry of fetal antigens into maternal circulation. Mast cell degranulation and complement activation may play a role in this anaphylactoid or systemic inflammatory response syndrome[2]. The striking similarities between clinical and hemodynamic findings in amniotic fluid embolism and both anaphylaxis and septic shock suggest a common pathophysiologic mechanism for all these conditions [3].

Incidence: 1-12 cases/ 100000 deliveries.

The proposed clinical course

- **Phase 1:** Prodromal.
- **Phase 2 :** Acute hypoxia, pulmonary hypertension –lasts for 15-30mins, ventilation perfusion mismatch, Right Ventricular Failure (RVF), O2 saturation decreases.
- **Phase 3 :** Acute left ventricular failure (LVF), sets in after 3-4 hours.
- **Phase 4 :** A few hours after early pulmonary edema, leakage of fluid into the alveoli due to damage of alveolar capillary membrane - ARDS (Acute Respiratory Distress Syndrome).
- **Phase 5 :** Disseminated intravascular coagulation **(**DIC).

In practice, the sequence of events need not follow this order. A prodrome may not be present and DIC can develop soon after acute collapse.

It can occur during the first, second or third stage of labour or within 30 mts of delivery.

Presenting symptoms

Dyspnea

Chest pain

Persistent dry cough

Symptoms of poor tissue oxygenation

Altered mental status (anxiety, confusion, panic; 80%-100% of cases)

Chills and shivering

Lightheadedness

Tingling in extremities

Nausea and vomiting

Once symptoms manifest, death usually occurs within 1 to 7 hours

Clinical Signs

Consider AFE:

- Whenever a woman becomes suddenly unwell around the time of delivery,
- Or baby shows sudden unexplained deterioration or is born in poor condition,
- Observe these patients for another 24 hours and check coagulation profile.

To diagnose AFE, 3 criteria recommended by US and UK AFE registry

1. Acute Hypotension or cardiac arrest
2. Acute hypoxia
3. Coagulopathy or severe hemorrhage in the absence of other explanations

All of these occurring during labour, cesarean section, D&E (Dilatation and Evacuation), or within 30 minutes postpartum with no other explanation or findings

The recommendation by the Society for Maternal Fetal Medicine study group is that all three of these criteria must be met in order to diagnose AFE. But some of the other national bodies do not agree that all the three criteria should be met. Our observations are shared in table 6 above. We have assigned this diagnosis on the basis of the overall clinical picture. All cases do not have all the classical symptoms. It is admitted that there is imperfection in documentation in our records.

Diagnosis depends on history and physical examination findings and exclusion of other likely causes, and a high index of suspicion.

Investigations

Laboratory values are useful in providing only effective supportive measures for the patient.

Arterial blood gas: ABG levels help to assess hypoxia/hypoxemia

Complete Blood Count with platelets

Coagulation studies: PT, APTT, Fibrinogen

Rotational thromboelastometry (ROTEM) helps to guide the management of the coagulopathy.

Chest X-Ray, Electrocardiogram and Echocardiogram are useful.

Pulmonary artery catheter- demonstrate amniotic fluid debris, squamous cells, trophoblastic cells, mucin, lanugo- not confirmatory.

Histology- Not confirmatory.

Serology- TKH -2 antibody to detect fetal antigen.

Treatment Goals are

- Resuscitate the woman
- Achieve survival of the fetus (if viable)
- Maintain oxygenation
- Reverse cardiovascular and pulmonary failure
- Correct coagulopathy

Treatment Options

1. Management should be by a multidisciplinary team / ORRT. If a patient develops cardio pulmonary arrest, begin immediate high-quality cardio pulmonary resuscitation with standard basic cardiac life support and advanced cardiac life support displacing uterus laterally during resuscitation.

2. Prepare for urgent delivery either vaginal/ operative vaginal delivery or cesarean delivery
3. Preparations for urgent **Resuscitative cesarean delivery** be initiated simultaneously with cardiopulmonary resuscitation. Uterine evacuation improves the survival of the mother as it decompresses the inferior vena cava and improves venous return.
4. Administer oxygen to prevent hypoxia.
    - Maintain PaO, of 60 mm Hg or higher and SpO2 94% or more.
5. Fluid resuscitation to treat hypotension.
    - Place 1 to 2 large bore IV lines.
    - Provide crystalloid-based volume replacement.
    - Avoid excessive fluid administration.
    - Monitor fluid therapy with pulmonary artery catheter or central line.
6. Provide hemodynamic support.

    Initial phase of amniotic fluid embolism is mainly right ventricular failure. So inotropes such as dobutamine and milrinone are recommended to improve right ventricular output.
    - Sildenafil, inhaled or IV epoprostenol, or inhaled nitric oxide may decrease pulmonary vascular resistance and improve oxygenation.
    - Norepinephrine (or vasopressin) is recommended to treat hypotension.
    - Maintain systolic blood pressure of 90 mm Hg or higher.
    - Maintain urinary output of 0.5 mL/kg/hour or higher.
7. Early evaluation of clotting status and early initiation of massive transfusion protocols are recommended. (Refer chapter on Obstetric hemorrhage).
8. Management of uterine atony and hemorrhage.
9. Use of steroids has been suggested because the process may be immune mediated.
10. Hemodialysis with plasmapheresis and extra corporeal membrane oxygenation (ECMO) with intra-aortic balloon are other options . Use of ECMO is not routinely recommended.

Timely resuscitation has reduced mortality rate from 90 % to 20 % and Perinatal mortality rate to less than 50%. (Ref : Near miss data).

Conclusions

This chapter shows the fact that AFE has come down in the state and that it is unprecedented and unpreventable in many a case. It can be diagnosed early if the Obstetric team is vigilant. Even when diagnosed, mortality can be reduced if EMOCALS training of Doctors and Nurses and ORRT are in place.

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CHAPTER

10

Cardiovascular Diseases in Pregnancy

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Editors' Note

Cardiovascular disease continues to be the leading non-obstetric cause of maternal deaths from the inception of CRMD. But the type of cardiovascular problems changed. In the beginning of CRMD it was valvular heart disease of rheumatic etiology. At present it is more of peripartum cardiomyopathy and problems related to treated congenital heart disease. In this respect we are following the same pattern that has happened in the western world. The authors have rightly advised the need for team approach in managing heart disease in pregnancy. Also, Dr.Vijayaraghavan has repeatedly warned us that a dilated heart seen after the patient has suffered maternal collapse and myocardial ischemia should not be diagnosed as dilated cardiomyopathy. The dilated heart may be a manifestation of ischemic damage to the myocardium.

V P Paily

Key Summary points

- Heart disease continues to be a major non obstetric cause for maternal mortality.
- Rheumatic heart disease, particularly mitral stenosis alone or with other valvular lesions is the most common cardiac problem reported in the present series.
- Operated congenital heart diseases and prosthetic valve patients are increasingly presenting to the obstetrician with pregnancy and require specialized care.
- Peripartum cardiomyopathy is being recognized more frequently.
- Aortic dissection, rupture of aortic aneurysm, also found to be contributing factors

Summary

Out of 331 cases of maternal deaths reported to CRMD in Kerala during the years 2006-2009, 17 were diagnosed as cardiac problems causing maternal mortality of 5.13% (46 out of 676 (6.8%) total maternal deaths). This is in sharp contrast to the number reported during 2004-2006, 15 out of 170 (8.8%) of CRMD cases and 29/307 (9%) total cases which made cardiac problems the most common nonobstetric cause for maternal death. During the ten year period April 2010 to end of March 2020 there were 1076 cases of maternal death analysed in CRMD and 75 cases were due to cardiac disease. This is 6.97% of the maternal deaths. This drop in numbers could be attributed to increased awareness, early detection and better management of cardiac problems during pregnancy or due to under reporting or designation of maternal cardiac deaths to other causes.

Etiological distribution of cardiac diseases causing maternal death

- An analysis of 75 cases of cardiac disease provided showed that the most common cause was Rheumatic heart disease (28/75) (37.3 %). Mitral valve disease was the most frequent valvular lesion.
- Congenital heart disease 11/75.
- Eisenmenger syndrome is the predominant congenital lesion (6/75)
- Peripartum cardiomyopathy contributed significantly 9/75 (12 %)
- Primary Pulmonary hypertension 11/75.
- Aortic dissection, rupture of aorta, coarctation of aorta 8 cases.
- Less common causes are myocarditis, infective endocarditis, acute coronary artery syndrome etc.

Analyzing the background of maternal death, we could find many preventable causes of maternal mortality.

1. **Referral to Tertiary care Centre:**

   There were many instances where pregnant women preferred to be treated in a nearby hospital, refusing to go to a tertiary care centre for specialized investigation and treatment. Better patient education and making them aware of the modern medical facilities available in a tertiary care centre is an important part of health care of mothers with heart disease. It was found that many patients with mitral and aortic valve disease chose to a specialized centre only at the middle of 2nd trimester when they developed heart failure. The opportunity for any corrective treatment like Balloon valvotomy was delayed and hence attended with high risk at this time.

2. **Irregular medical management:**

   Many patients who sought treatment from tertiary care centre did not adhere to the treatment prescribed or even discontinued treatment altogether. This also resulted in tragic maternal death.

3. Overtreatment:

Analyzing the case records of the patients who died with the heart disease, it became evident that many maternal deaths were due to over use of diuretic therapy. Pregnant women even though presented with heart failure are not markedly overloaded with fluids nor had been exposed to chronic diuretic therapy. ***We have to remember that loop diuretics can acutely dehydrate pregnant patient and lead on to cardiogenic shock and death.***

The usual dose of furosemide should be 20 to 40 mg once or twice a day for pregnant women with heart disease. The obstetric team which looks after such women especially towards term and during delivery should be aware that frequent, sometimes even large dose of diuretic are harmful to such patients. When the patient is already in hypotension and shock, loop diuretics can only worsen this scenario. If the initial diuretic did not produce enough urine in the 1st few hours, intravenous infusion of 5 mg of furosemide per hour is preferable to repeated large dose. Even this infusion should be discontinued and once or twice a day dosage should be started as early as possible. Patients receiving loop diuretics should also get adequate potassium supplementation.

4. Sedatives:

Analgesics & sedatives should be used very cautiously. Small dose of (2 to 4mg) intravenous morphine is an important part of treatment for pulmonary edema. However, ***repeating this dose should be done only by the chief of the obstetric team looking after the patients.***

We could find many incidences of repeated morphine administration resulting in irreversible shock. Morphine is peripheral vasodilator, more so in the dehydrated patients in labour and could be counterproductive in treating such patients.

5. Patients with Metallic prosthetic Valve require anti coagulant therapy throughout pregnancy :

All members of the obstetric team should move in unison in maintaining anticoagulants. It is advisable to change from oral anticoagulants (warfarin sodium, or acenocoumarol) to intravenous heparin, the moment pregnancy is diagnosed. Some authors advocate low molecular weight heparin as subcutaneous injection, mainly enoxaparin twice daily. Unfractionated intravenous heparin should be titrated to maintain APTT of about 70 seconds (twice the control value). Ideally factor X a estimation is required to titrate the low molecular weight heparin. This is available only in very specialized labs & we use a fixed dose combination with minimum problems. By the 14th week of pregnancy oral anticoagulant is restarted till term and a week before term it is preferable to move over to parenteral heparin. We found confusion among doctors and patients on the use of anticoagulants in pregnancy.

It is heartening to note that there is a steady decline in maternal mortality due to cardiovascular disease in the last 10 years and we hope the guidelines to be suggested will result in further improvement of the management of heart disease in pregnancy.

Key Recommendations

1. Cardiac status should be assessed before planning a pregnancy in known cases of heart disease.
2. Patients with Primary pulmonary hypertension, Eisenmenger Syndrome, Cyanotic congenital heart disease and patients with other cardiac diseases with severe functional disability should be advised not to conceive and undergo termination of pregnancy if already pregnant.

3. Heart disease should be managed either medically or surgically before attempting pregnancy.
4. High index of suspicion should be kept to rule out cardiac disease in any pregnant patient who experiences breathlessness, chest pain, palpitation or syncope in the antenatal period and they should be referred for further assessment.
5. Echocardiographic evaluation which is a relatively inexpensive test along with a detailed clinical examination will help to rule out significant cardiac problems in most patients.
6. Once cardiac disease is diagnosed she should be referred to a higher center for proper assessment and management.
7. Cardiac problems in pregnancy should be managed by a team comprising cardiologists, obstetricians, anesthetists, intensivist and neonatologist especially in complex cases in a tertiary care center.
8. Medications should be strictly followed. Overtreatment and irregular treatment should be avoided.

Introduction

Approximately 2% of pregnancies involve maternal cardiovascular disease, associated with increased risk to both mother and fetus. Though hypertensive disorders are the most frequent cardio vascular events during pregnancy [6–8% of all pregnancies], among heart diseases rheumatic heart disease still dominates in our country (56-89%); especially mitral stenosis. Most women with cardiovascular disease can have a pregnancy with proper care, but a careful pre-pregnancy evaluation is mandatory.

Basics to Remember

- The plasma volume begins to increase in the sixth week of pregnancy and, by the second trimester approaches 50% above baseline.
- Heart rate increases 10-20% and remains high till 2-5 days after delivery.
- Cardiac output increases to 30-50% above baseline by end of 2nd trimester and decreases to baseline 2 weeks postpartum.
- Blood Pressure (BP) falls in early gestation and Diastolic BP (DBP) decrease 10 mm below baseline in the 2nd trimester. In 3rd trimester DBP increase and reaches to non-pregnant values by term.
- Cardiac output increase in twins or triplets is only slightly greater than in single pregnancy.
- Peripheral resistance and pulmonary vascular resistance decreases, whereas venous pressure in lower extremities increases (pedal edema).
- With each uterine contraction, up to 500 mL of blood is released into the circulation, prompting a rapid increase in cardiac output and blood pressure.
- During a normal vaginal delivery, approximately 400 mL of blood is lost. By contrast, with a cesarean section, approximately 800 mL of blood is lost.
- After delivery of the baby, an abrupt increase in venous return occurs, because of auto transfusion from the uterus and as the baby no longer compresses the inferior vena cava. This continues in the 24 to 72 hours after delivery, and may cause pulmonary edema in patients with heart disease.
- Any systolic murmur more than grade 3/6 and any diastolic murmur should be taken as abnormal during pregnancy.

Clinical findings in Normal pregnancy

1. Elevated JVP.
2. Reduced breath sounds at lung bases as diaphragm moves up.
3. Apex slightly down and out, prominent impulse, active precordium (volume loaded ventricles).

4. Tachycardia, low DBP, pulse pressure increased (bounding pulses) pulsatile finger tips, warm hands, occasionally quincke.
5. S1 loud (Tachycardia, increased LV mass), S2 wide split accentuated (P2 delayed), occassional S3, Flow murmur at aortic, pulmonary; ESM grade 3 at Left Lower Sternal Border (LLSB); cervical venous hum; mammary souffle at LLSB.
6. Pedal edema in more than 60% women (increased plasma volume, increased venous pressure)

Cardiovascular abnormalities placing a mother and infant at extremely high risk

Advice avoidance or interruption of pregnancy

- Pulmonary hypertension (>60-70% of systemic pressure)
- Dilated cardiomyopathy with congestive failure.
- Marfan syndrome with dilated aortic root (>4 cm).
- Cyanotic congenital heart disease

Pregnancy counseling and close follow up required

- Prosthetic valve
- Coarctation of aorta
- Marfan syndrome
- Dilated cardiomyopathy in asymptomatic women
- Obstructive lesions (MS, AS)

Predictors of adverse maternal cardiovascular events during pregnancy

- NYHA (New York Heart Foundation) functional class III or IV, or cyanosis.
- Previous cardiovascular events (e.g., heart failure, transient ischemic attack, or stroke before pregnancy) or arrhythmia.
- Left heart obstruction (mitral valve area smaller than 2 cm^2, aortic valve area less than 1.5 cm^2, or peak left ventricular outflow tract gradient greater than 30 mm Hg) as assessed by echocardiography.
- Ejection fraction < 40%.
- Cyanotic heart disease
- Severe pulmonary vascular disease.

How to assess?

- Pre-pregnancy counseling is important to give prospective mothers appropriate information about the advisability of pregnancy and to discuss the risks to her and the fetus.
- Such patients should be seen in a high-risk pregnancy unit for evaluation including a clinical examination, electrocardiogram, and chest radiography.
- Cardiac symptoms of importance are chest pain, exertional dyspnea, palpitation and syncope.
- Many disorders can be identified by taking a careful personal and family history, particularly cardiomyopathies, the Marfan syndrome, congenital heart disease, long QT syndrome.
- History of prior cardiac disease, details of interventional treatment should be obtained. A detailed drug history and smoking history should be taken.
- It is important to ask specifically about possible sudden deaths in the family.
- A thorough physical examination considering the physiological changes that occur during pregnancy is mandatory, including auscultation for new murmurs, changes in murmurs, and looking for signs of heart failure.
- When dyspnea occurs during pregnancy or when a new pathological murmur is heard,

echocardiography is indicated. It is the preferred screening method to assess cardiac function.

- It is crucial to measure the BP in left lateral decumbency, and to look for proteinuria, especially with a history or family history of hypertension or preeclampsia.
- Oximetry should be performed in patients with congenital heart disease.
- Exercise testing should be performed in patients with known heart disease, preferably prior to pregnancy to assist in risk assessment. It can also be done prior to conception in patients with prior peripartum cardiomyopathy and recovered LV function, to assess the myocardial reserve.
- Sub maximal exercise test, preferably semi recumbent cycle ergometry can be performed in asymptomatic pregnant patient with suspected CVD.
- In general, patients who cannot achieve more than 70% of their predicted functional aerobic capacity are unlikely to tolerate a pregnancy safely.
- Dobutamine stress should be avoided.

Prenatal care

- Antenatal women with diagnosed cardiac lesions should be seen in high risk obstetric clinic and should be evaluated by the cardiologist, maternal and fetal medicine specialist and anesthesiologist when needed.
- During each visit apart from the assessment of weight, BP, and fetal growth, cardiac status should be assessed clinically as well as by relevant investigations. The frequency of antenatal care should be decided based on the specific condition.
- Fetal ECHO is mandatory in women with congenital heart disease as there is a chance of inheritance of the same lesion or a different lesion. Growth of the fetus should be assessed as there is a chance of IUGR especially in women with severe cyanotic heart disease.
- Antenatal fetal surveillance should be started from 32 weeks if the fetus is otherwise normal.
- Anemia should be prevented.

Timing and mode of delivery

High risk delivery requires expertise and collaborative management by skilled cardiologists, obstetricians, and anesthesiologists, in experienced maternal–fetal medicine units.

Timing of delivery:

- Should be individualized, according to the gravida's cardiac status, Bishop score, fetal well-being, and lung maturity.
- In women with mild unrepaired congenital heart disease and in those who have undergone successful cardiac surgical repair with minimal residual lesion, the management of labor and delivery is the same as for normal pregnant women.

Labor induction

- Spontaneous onset of labor is appropriate for women with normal cardiac function and is preferable to induced labor for the majority of women with heart disease.
- Plan the time of induction of labor so that delivery occurs during day time when all the senior consultants will be available.
- Oxytocin and artificial rupture of the membranes are indicated when the Bishop score is favorable.
- A long induction time should be avoided if the cervix is unfavorable.
- Mechanical methods such as a Foley catheter would be preferable to pharmacological agents,

particularly in a patient with cyanosis where a drop in systemic vascular resistance and/or BP would be detrimental.

Mode of delivery

- The preferred mode of delivery is vaginal.
- In high risk lesions, delivery should take place in a tertiary center with specialist multi disciplinary team care.
- Vaginal delivery is associated with less blood loss and infection risk compared with cesarean delivery, which also increases the risk of venous thrombosis and thromboembolism.
- In general, cesarean delivery is reserved for obstetric indications.
- Cesarean delivery should be considered for the patient :
  - Patients with Marfan syndrome and an aortic diameter >4 cm.
  - Patients with acute or chronic aortic dissection.
  - Those in acute intractable heart failure.
  - Also be considered in severe aortic stenosis, severe pulmonary hypertension (including Eisenmenger syndrome), acute heart failure or in patients with mechanical heart valve prosthesis.

Anesthesia/ analgesia

- Continuous lumbar epidural analgesia with local anesthetics or opiates, or continuous opioid spinal anesthesia can be safely administered.
- Regional anesthesia can, however, cause systemic hypotension and must be used with caution in patients with obstructive valve lesions.

Labour

- Once in labor, the woman should be placed in a lateral decubitus position to attenuate the hemodynamic impact of uterine contractions.
- Close monitoring of the maternal and fetal condition and progress of labor.
- Continuous electronic fetal heart rate monitoring is recommended.
- Avoid prolonged and difficult vaginal delivery Early decision for cesarean section should be taken if a poor progress of labor is diagnosed.
- The uterine contractions should descend the fetal head to the perineum, without maternal pushing, to avoid the unwanted effects of the Valsalva maneuver.
- Delivery may be assisted by low forceps or vacuum extraction.
- Routine antibiotic prophylaxis is not recommended.

Postpartum

- A slow intra venous (iv) infusion of oxytocin (<2 U/min), which avoids systemic hypotension, is administered after placental delivery to prevent maternal hemorrhage.
- Prostaglandin F analogues are useful to treat post-partum hemorrhage, unless an increase in pulmonary artery pressure (PAP) is undesirable.
- Methyl ergonovine is contraindicated because of the risk (>10%) of vasoconstriction and hypertension.
- Meticulous leg care, elastic support stockings, and early ambulation are important to reduce the risk of thromboembolism. Hemodynamic monitoring should be continued for at least 24 hours after delivery (High chance for pulmonary edema in the first 24 hrs.).

- Patients may need prolonged hospital stay. Should be discharged when the cardiac status is stable.
- Contraception should be discussed at the time of discharge.

Lactation

- Unless patient is highly symptomatic/unwell, breast feeding is advised.

Specific cardiac conditions

Rheumatic Heart Disease

- All patients with significant valvular heart disease should receive pre pregnancy counseling by a cardiologist about the risks and benefits of all options for operative interventions, including mechanical prosthesis, bio prosthesis, and valve repair.
- Pregnant patients with severe valvular heart disease should be monitored in a tertiary care centre with a dedicated Heart valve Team of cardiologists, surgeons, anesthesiologists, and obstetricians with expertise in the management of high-risk cardiac patients during pregnancy.
- During pregnancy, best time for any procedure is between 20-28 weeks.

Mitral Stenosis (MS)

Patients with severe MS are at increased risk for complications during pregnancy. The increased blood volume, heart rate, and cardiac output will more than double the Transmitral gradient, significantly increasing Left Atrial (LA) pressure. Upto 74% of patients with severe MS will have clinical deterioration during pregnancy, manifested primarily by Heart failure (HF) symptoms and atrial arrhythmias. The predictors of poor outcome are severity of the stenosis and symptoms before pregnancy. The rate of premature delivery is 14% in patients with mild MS and up to 33% in patients with severe MS.

- Valve intervention (replacement or percutaneous balloon mitral commissurotomy (PBMC)) is recommended before pregnancy for symptomatic patients with severe MS.
- Even in asymptomatic patient with severe MS, PBMC should be done, prior to pregnancy.
- For pregnant patients with severe MS with valve morphology favorable, who remain symptomatic with NYHA class III to IV, HF symptoms despite medical therapy, PBMC is recommended. Valve replacement during pregnancy should be done only if the patient is in refractory NYHA class IV failure.
- Anticoagulation should be given to pregnant patients with MS and AF unless contra-indicated.
- Beta blockers and diuretics can be used in symptomatic patients.
- Timing for PBMC is at around 20 weeks and procedure has 95-97% success.

Aortic Stenosis (AS)

Patients with severe AS have an increased risk of sudden clinical deterioration and even death during pregnancy, particularly in patients who are symptomatic.

- Exercise testing is reasonable in asymptomatic patients with severe AS before pregnancy to obtain an objective assessment of exercise tolerance. Patients with symptoms provoked by exercise testing should be considered symptomatic.

- Patients with severe AS should be advised not to conceive prior to surgical correction of the lesion.
- Valve intervention is reasonable before pregnancy for asymptomatic patients with severe AS. But during pregnancy, Valve intervention for severe AS is done only if there is hemodynamic deterioration or NYHA class III to IV HF symptoms.

Regurgitation lesions (MR, AR etc)

Patients with valve regurgitation tolerate pregnancy better than patients with valve stenosis do, because the decrease in afterload that occurs throughout pregnancy allows an appropriate increase in cardiac output without a rise in ventricular filling pressures. However, patients with severe regurgitation who are already symptom limited or have a reduced LVEF or pulmonary hypertension may develop HF symptoms because of the volume load of pregnancy

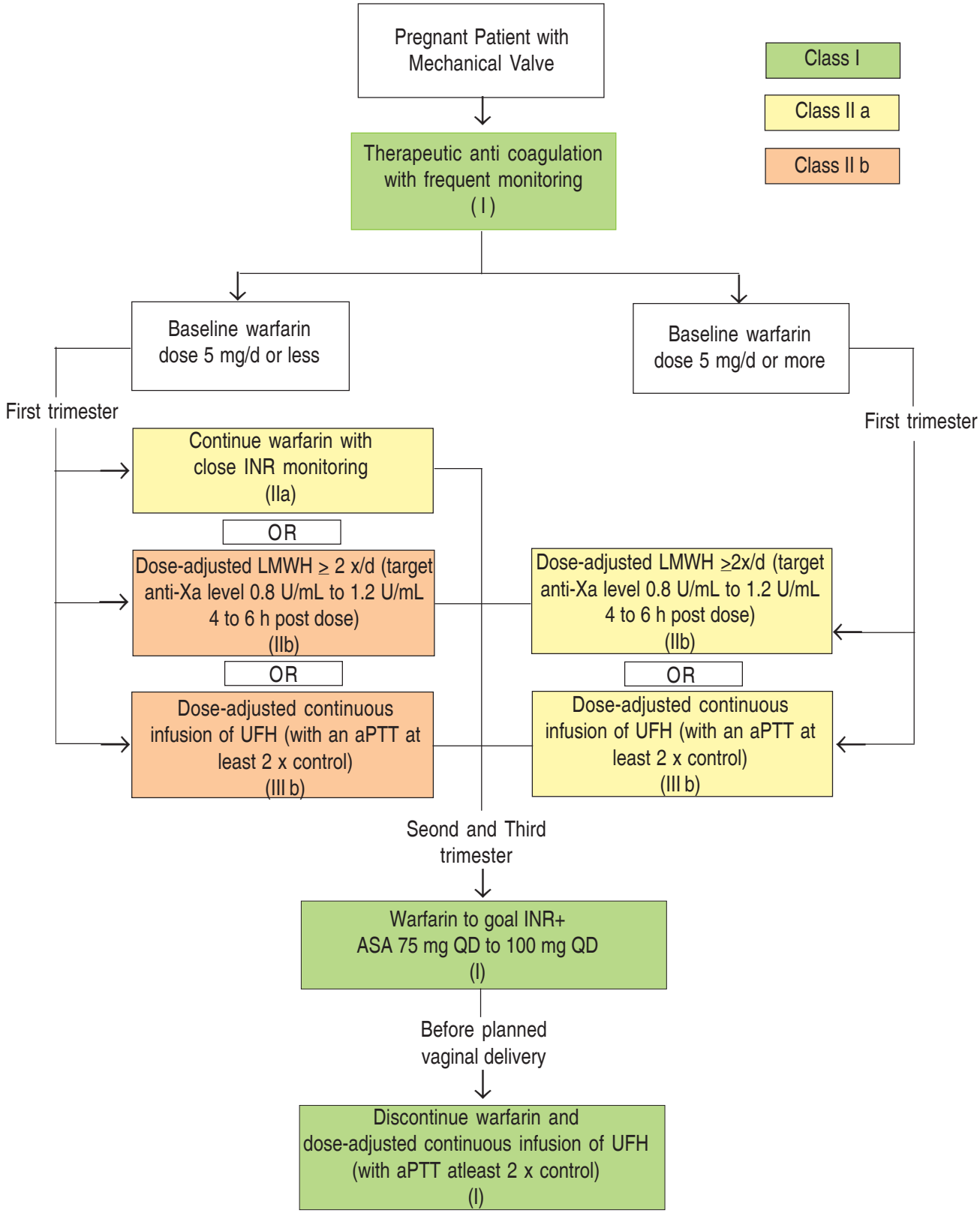
- Valve repair or replacement is recommended before pregnancy for symptomatic women with severe valve regurgitation.
- Repair should always be preferred over replacement.
- Valve operation for pregnant patients with severe valve regurgitation is reasonable only if there are refractory NYHA class IV HF symptoms.

Prosthetic Valves in Pregnancy

Major complications can occur during pregnancy in patients with prosthetic valves. The increased hemodynamic burden of pregnancy can lead to heart failure (HF) if there is prosthetic valve thrombosis, stenosis, regurgitation, or patient prosthesis mismatch. In addition, there is an increased risk of valve thrombosis in patients with a mechanical prosthesis due to the hypercoagulable state of pregnancy. Due to an increase in cardiac output during pregnancy, the mean pressure gradient across all prosthesis will increase throughout the first and second trimesters and remain elevated in the third trimester. Bio prosthetic valves are at risk of tissue degeneration.

- Pre pregnancy counseling should be given.
- Pregnant patients with a mechanical prosthesis should be monitored in a tertiary care center.
- Dose-adjusted continuous intravenous UFH (with an APTT at least 2 times control) during the first trimester is reasonable for pregnant patients with a mechanical prosthesis.
- Dose-adjusted LMWH at least 2 times per day (with a target anti-Xa level of 0.8 U/mL to 1.2 U/mL, 4 to 6 hours post dose) can also be used.
- Continuation of warfarin during the first trimester is reasonable for pregnant patients with a mechanical prosthesis if the dose of warfarin to achieve a therapeutic INR is 5 mg per day or less after full discussion with the patient about risks and benefits. (as warfarin induced fetal toxicity is minimal at this dosage; inadequate anti coagulation with UFH or LMWH may be fatal).
- Warfarin is recommended to achieve a therapeutic INR in the second and third trimesters.
- Low-dose aspirin (75 mg to 100 mg) once per day is also recommended for pregnant patients in the second and third trimesters with either a mechanical prosthesis or bio prosthesis.
- LMWH should not be administered to pregnant patients with mechanical prostheses unless anti-Xa levels are monitored 4 to 6 hours after administration.
- Newer anticoagulants should not be used.

Fig.1. Anticoabulation for pregnant women with mechanical heart valve



Infective Endocarditis

Infective endocarditis during pregnancy is rare. Patients with the highest risk for infective endocarditis are those with a prosthetic valve or prosthetic material used for cardiac valve repair, a history of previous infective endocarditis, and some special patients with congenital heart disease.

- Endocarditis prophylaxis is recommended only for patients at highest risk of acquiring endocarditis during high risk procedures, e.g. dental procedures. Highest risk patients include those with cyanotic heart disease, prosthetic heart valves, or a previous history of endocarditis.
- There is no evidence that infective endocarditis is related to either vaginal or cesarean delivery, hence, antibiotic prophylaxis is not recommended during vaginal or cesarean delivery.
- The diagnosis of infective endocarditis during pregnancy involves the same criteria as in the nonpregnant patient, and it should be treated the same way as in the nonpregnant patient, taking into consideration the fetotoxic effects of antibiotics.
- Antibiotics that can be given during all trimesters of pregnancy are penicillin, ampicillin, amoxicillin, erythromycin and cephalosporin.
- Vancomycin, imipenem, rifampicin, and teicoplanin are all group C, which means risk cannot be excluded and their risk–benefit ratio must be carefully considered.
- There is a definite risk to the fetus in all trimesters of pregnancy with group D drugs (aminoglycosides, quinolones, and tetracycline).

Congenital Heart Diseases

Some patients will present for the first time in pregnancy with symptoms and learn that they have congenital heart disease. Others with repaired defects may encounter cardiac problems during pregnancy, the most common being heart failure and arrhythmias. An exercise test before pregnancy achieving <70% of expected workload, showing a drop in arterial pressure or a drop in oxygen saturation may identify women at risk of developing symptoms or complications during pregnancy.

Atrial septal defect

Patients with even a large secundum atrial septal defect usually tolerate pregnancy without complications unless concomitant pulmonary hypertension or atrial fibrillation is present.

- Closure of a hemodynamically significant atrial septal defect (ASD) should be performed before pregnancy.
- For a secundum defect, catheter device closure can be performed during pregnancy, but is only indicated when the condition of the mother is deteriorating.
- Because of the increased risk of paradoxical embolism, in women with a residual shunt, prevention of venous stasis (use of compression stockings and avoiding the supine position) is important, as is early ambulation after delivery.
- Small VSD or PDA has a lower risk of complications during pregnancy. Corrected lesions have good prognosis with preserved LV function. Large lesions most likely have resulted in Eisenmenger physiology, is highly dangerous.

Right to left shunts (cyanotic heart disease)

Presence of cyanosis is associated with high fetal loss, prematurity and reduced infant birth weights. When pulmonary hypertension is present, maternal

mortality is high. Even when pulmonary hypertension is not there, women are at risk of heart failure, thromboembolism, arrhythmias and endocarditis.

Tetralogy of Fallot is the most common form of right to left shunting. If it is uncorrected, maternal mortality is high and fetal loss can exceed 50%. But after surgical correction, maternal mortality does not exceed that of a woman without heart disease.

- Providers should consider aspirin therapy and early delivery if fetal maturity can be established.
- Eisenmenger physiology is contraindication for pregnancy. If early, interruption of pregnancy should be done.
- If woman opt to continue pregnancy, they should be put on bed rest, heparin, and oxygen for at least the third trimester and should be monitored closely in post-partum period without premature hospital discharge.
- Pulmonary vasodilators may be considered.

Coarctation of the Aorta

Women with Coarctation of the aorta may present with symptoms for the first time during pregnancy, typically systemic hypertension. Significant Coarctation impairs flow to both the uterus and fetus.

- Therapeutic options include antihypertensive therapies (beta blockers), percutaneous stenting of the Coarctation, and surgical intervention
- Aggressive antihypertensive therapy should be avoided because of the chance of placental hypo perfusion.
- Most women, however, will have a successful pregnancy with proper care.

Marfan syndrome

The risk of death from rupture or dissection during pregnancy is high, especially when aortic root is greater than 4 cm. The expected life span of women with Marfan syndrome is reduced to half of normal, implying that her years of motherhood will be limited. Half of the offsprings will be affected with the syndrome.

- If one wishes to continue pregnancy, regular monitoring of aortic root diameter is required.
- Activities should be restricted and systemic hypertension should be treated promptly.
- Prophylactic beta blockers may be useful.
- Cesarean delivery is recommended to avoid the hemodynamic stress of the labor.

Pulmonary hypertension

A high mortality rate (30-50%) is noted, whatever be the etiology. Maternal death occurs in the last trimester of pregnancy and in the first months after delivery because of pulmonary hypertensive crises, pulmonary thrombosis, or refractory right heart failure. This occurs even in patients with little or no disability before or during pregnancy. Even moderate forms of pulmonary vascular disease can worsen during pregnancy as a result of the decrease in systemic vascular resistance and overload of the right ventricle, and no safe cut-off value is known.

- If pregnancy occurs, termination should be offered.
- If patients choose to continue pregnancy despite the risk, they should be managed in a center with expertise in PAH with all therapeutic options available.
- Every effort should be made to maintain circulating volume, and to avoid systemic hypotension, hypoxia, and acidosis which may precipitate refractory heart failure.
- Supplemental oxygen therapy should be given if there is hypoxemia.
- Intravenous prostacyclin or aerosolized iloprost have been occasionally used antenatal and

peripartum to improve hemodynamics during delivery.

- In patients who are already taking drug therapy for PAH before becoming pregnant, continuation of this therapy should be considered, but patients should be informed about the teratogenic effects of some therapies, such as bosentan.
- In patients where the indication for anticoagulation is established, anticoagulation should also be maintained during pregnancy.
- Because of the increased risk of bleeding in these patients, subcutaneous application of LMWH or UFH is favored over oral anticoagulation during pregnancy.

Cardiomyopathies

Peripartum cardiomyopathy (PPCM)

The incidence varies from 1:300 to 1:4000 pregnancies. Predisposing factors seem to be multiparity and multiple childbirths, family history, ethnicity, smoking, diabetes, hypertension, pre-eclampsia, malnutrition, advanced age of mothers or teenage pregnancy, and prolonged use of beta-agonists. It is a diagnosis of exclusion. The LV may not be dilated, but the Ejection Fraction is nearly always reduced below 45%. Other than heart failure Complex ventricular arrhythmias and sudden cardiac arrest are also described. Prognosis of PPCM is different from others, with a significant proportion improving or normalizing their LV function over the first 6 months after diagnosis

- Guidelines for the management of acute/ chronic heart failure apply.
- Urgent delivery, irrespective of gestation, may need to be considered in women presenting or remaining in advanced heart failure with hemodynamic instability.
- When ACE inhibitors are needed during breastfeeding (not during pregnancy), benazepril, captopril, or enalapril should be preferred.
- Dopamine and levosimendan can be used if inotropic drugs are needed.
- Beta blocker treatment is indicated for all patients with heart failure (metaprolol, not atenolol).
- Diuretics should only be used if pulmonary congestion is present. (Furosemide or thiazides, not spironolactone).
- Role of bromocriptine (post partum) is favored by some studies.

Dilated cardiomyopathy

- If not known before conception, the condition is most often unmasked during the first or second trimester when the hemodynamic load is increasing.

  LVEF<40% is a predictor of high risk, and, If LVEF is < 20%, maternal mortality is very high and termination of the pregnancy should be considered.

- Treatment is same as in any heart failure.

HOCM (Hypertrophic Obstructive Cardiomyopathy).

The decrease in peripheral vascular resistance and peripheral pooling of blood during pregnancy can cause hypotension, and the intermittent high catecholamine state of pregnancy may increase the LV outflow tract obstruction. An increase in symptoms of dyspnea, chest discomfort, and palpitations has been noted. Deaths with pregnancy can exceed 1%.

- Just like other obstructive lesions, hypovolemia should be avoided.
- Beta blocker is recommended at the time of labor and delivery

Coronary artery diseases

Though rare in women of child bearing age, may occur, particularly in the setting of diabetes, advanced maternal age and tobacco abuse. The most common cause is coronary artery dissection. Maternal mortality after ACS is estimated at 5–10% and is highest during the peripartum period.

- Coronary angioplasty is the preferred reperfusion therapy in pregnancy.
- Tissue plasminogen activator does not cross the placenta but may cause placental bleeding and should be avoided.
- Drug-eluting stents should be avoided.
- Clopidogrel should be used only when absolutely necessary (e.g., after stenting) and for the shortest duration possible.

Arrhythmias

Because of the physiologic changes of pregnancy, the heart may be more vulnerable to arrhythmias.The presenting symptom complex may be difficult to separate from the normal symptoms of pregnancy, including a sensation of fast heartbeat and skipped beats, which most commonly are supraventricular ectopics.

- Look for any precipitating causes, and rule out any concomitant medical problems (e.g., thyroid disease).
- In general, supraventricular and ventricular ectopic beats require no therapy.
- Atrial arrhythmias are the most common, and treatment generally is the same as for nonpregnant women, but with added concern about medication effects on the fetus.
- Intravenous adenosine usually is the drug of choice if vagal maneuvers fail.
- If the arrhythmia is unresponsive to medical therapy or with hemodynamic instability, electrical cardio version may be performed and usually is not harmful to the fetus.
- Atenolol should not be used for any arrhythmia.
- Treatment of ventricular tachycardia is like that of non-pregnant. ICD can be implanted at any time during pregnancy if needed.
- Reflex bradycardia during delivery can be managed by positioning to left lateral decubitus.
- Temporary or permanent (preferably one chamber) pacing is safe during pregnancy

Learning from Examples

Example 1,

A patient with mitral and aortic valve disease, with severe pulmonary hypertension and pregnancy.

30 years old lady G3 P2 L2 , 30weeks pregnancy was admitted to the cardiology ward on 22nd June for acute pulmonary edema. She had undergone balloon mitral valvotomy three years earlier. She developed mitral restenosis and pulmonary hypertension. Her blood group is AB positive. Clinically she was in frank pulmonary edema and improved on anti-failure treatment. She required non-invasive ventilation due to hypoxia. Echo showed severe mitral stenosis with moderate mitral regurgitation and moderate aortic regurgitation. There was severe pulmonary hypertension. She improved on medical treatment and was discharged on 28th June to continue medical treatment and to be under medical and obstetric supervision. She was again admitted in cardiology for a day for abdominal discomfort and was discharged next day as she remained stable.

She was readmitted to the Obstetric ward on 24th July 2012 for Grade 2 dyspnea and pitting edema feet. She was anemic and had bilateral basal crepitation. ECG showed left atrial enlargement, right axis deviation and right ventricular hypertrophy, all features of severe pulmonary hypertension due to mitral and aortic valve disease. On admission dyspnea worsened with hypoxia and she had to be on non-invasive ventilation. As she developed labor pains she was transferred to labor

room and delivery was helped with forceps. A male baby weighing 1.53 Kg was delivered. Baby was normal and cried spontaneously. Maternal tachycardia was noticed after the delivery. She was transferred to the ward and continued to have dyspnea, and cough. Pulmonary consultation was done and sputum checked for AFB. Patient improved and remained comfortable on nasal oxygen.

From 5th August she was running a low grade fever. On 7th at 4.30 P.M. she complained of increasing dyspnea. BP was 150/72 mm Hg, HR was 85/min and Oxygen saturation 82%. Infusions of Lasix 3mg/hr and NTG was started. By 6.40 PM patient became hypoxic and had to be intubated and ventilated. She was given Methyl prednisolone 1 gm. She developed bradycardia of 20/min. Atropine 2 ampoules were given. Patient went into asystole and atropine 2 ampoules were given with adrenaline. CPR was started with DC shocks given. She remained stable on inotropic support with dopamine and adrenaline. By 11.10 PM she developed bradycardia and atropine 2 ampoule and adrenaline 4 ampules were given. Blood sugar was only 68 mgs and I/V glucose given, By 12.20 AM she developed bradycardia and hypotension which was treated with adrenaline 2 ampules and atropine 2 ampules. Both the drugs repeated again at 1.30 AM and 2.05 AM. At 2.15 AM atropine 4 ampules and adrenaline 4 ampules given. Patient went into asystole with no spontaneous respiration. Patient expired by 2.35 AM.

Final Diagnosis:-

1. Heart disease complicating pregnancy. Mitral restenosis, had balloon mitral valvotomy, moderate mitral regurgitation, moderate aortic regurgitation, severe pulmonary hypertension, recurrent pulmonary edema.
2. Probable chest infection.

Discussion:-

Whether she had a preconceptional cardiac status assessment is not known.

Preventive:- This patient and family should have been counseled for avoiding pregnancies till the heart valve problem is corrected with mitral and aortic valve replacement. If the family is keen to have another child tissue valve has to be given. Normally at this age we will give only metal prosthetic valve as it lasts longer on anticoagulants.

As the patient attended the cardiology department at 30 weeks of pregnancy, the only option is strict failure treatment under medical supervision. This treatment was given and she improved temporarily. Even at the time of first medical consultation she was in heart failure and family have to be warned of premature labor with dire consequences. Her obstetric management was good with labor being helped by forceps and a live baby being admitted to the neonatal nursery.

Postpartum management has to be carefully tailored to the cardiac patient. Immediate post partum week patient should be given nutritious diet and rehabilitated. During the postnatal period she would have been managed in ICU and not in the ward because of the risk of worsening pulmonary edema. Anemia, hypoproteinemia, and infection would have contributed to worsening of cardiac status.

It is written that she was dyspnoeic. We have to be sure the dyspnea is not contributed by low hemoglobin, low albumin and such correctible factors. This patient was given multiple injections of lasix on the 7th July with infusions of Lasix 5mg/hour. This patient is dehydrated and her intravascular volume should be assessed by IVC imaging by echo or abdominal ultrasound. What is required is to assess the Hb, PCV values and if possible try to correct the same. The serum albumin values seen in some results appear low in the range of 2.2 gms. Correction of albumin is also important to keep the lungs dry. I agree these are difficult at a time you think the patient is in pulmonary edema. Dyspnea could be aggravated by anemia and hypoalbuminemia.

Ventilator management cannot be assessed as there are scanty details of it in the file.

CPR management ;-

Always use IV adrenaline diluted. Each ampule should be counted by another person and later accounted. The timing of chest compression and adrenaline should be as per ACLS protocol.

Atropine:- Repeated injections of atropine should be avoided and more than 2 mgs is unnecessary at one event. Again please follow ACLS protocol.

Example. 2

A patient with Marfan's syndrome, Type A aortic dissection and pregnancy

Admitted on 4th November, LSCS on 7th November 33 Years old lady, gravida 3 and para 2 at 34 weeks of gestation was admitted to cardiology ward for backache. She had features of Marfan's syndrome. Cardiac examination showed aortic regurgitation and mitral regurgitation. Right radial and brachial pulses were weak. The left femoral and dorsalis pedis pulses were also weak. A transthoracic echo revealed aortic regurgitation and mitral regurgitation. Ascending aorta was dilated and a dissection flap could be seen extending from the ascending aorta. An MDCT revealed aortic dissection involving thoracic and abdominal aorta. The dissection flap could be seen extending from the level of aortic valve to the proximal right common iliac artery. A short undissected aorta could be seen at the level of L1 vertebra. Dissection did not involve the aortic valve. Partial communication of the false and true lumen could be identified at the level of D6. Coronary arteries appeared normal.

She was scheduled for repair of the dissection and cesarean section at the same sitting. There was delay in getting the aortic vascular graft. On 7th November at 4.00 PM she developed cardiac arrest. She was resuscitated and put on ventilator and inotropes to maintain blood pressure. A bed side echo revealed cardiac tamponad. Immediate pericardial tapping was not done as it was thought to be lethal in presence of aortic dissection. Patient's relatives were counseled and a decision to do immediate cesarean section was done to salvage the baby. The procedure was done under aseptic conditions in the CCU and a female baby was delivered at 5.40 PM. The baby was asphyxiated with no spontaneous respiration. Baby was resuscitated and shifted to the neonatal ICU. Mother expired at 7.30 PM due to hypotension due to pericardial tamponade. The baby also expired at 10.00 AM on 9th November due to perinatal asphyxia and hypoxic encephalopathy.

Diagnosis :-

1. Marfan's syndrome,
2. Type A aortic Dissection with aortic and mitral regurgitation, Aortic rupture
3. Acute pericardial tamponad due to pericardial effusion/ bleeding into pericardial cavity.

Cause of Death ;- Dissecting aortic aneurysm rupture with acute pericardial tamponade.

Discussion:-

The doctors involved did their best to give adequate medical care available at the institution. The decision to do the LSCS should be done without delay as soon as the patient develops cardiogenic shock due to pericardial tamponade in dissecting aneurysm. Ideally the patient should have been referred to an advanced center with experience in managing dissecting aneurysm of aorta on the same day as the diagnosis as time matters most. The center could have posted her for surgery on the same day with preterm cesarean section done to save the baby followed by aortic surgery at the same time. Even if the patient develops pericardial tamponade one can put in a pigtail catheter and do a controlled release of pericardial effusion to keep the blood pressure reasonable. Often removal of 10 to 20 ml of pericardial fluid will bring up the systolic blood pressure. Unless the LSCS followed by aortic surgery could be done at the same setting one could not save the baby and the mother. One could also infuse fluids to maintain blood pressure in these circumstances.

SUMMARY

- Counseling and management of women of childbearing age with suspected cardiac disease should start before pregnancy occurs.
- Early identification of women at increased risk for development of cardiovascular disease later in life, and such women should be referred to their primary care physician or a cardiologist.
- If the woman is going to pursue a pregnancy, a strategy should be outlined regarding he frequency of follow-up evaluation by the cardiologist and a plan should be put in place for obstetric and cardiovascular management during the pregnancy as well as during labor and delivery.

CHAPTER

11

Venous Thromboembolism in pregnancy with emphasis on Pulmonary Embolism

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Editor's Note

Pulmonary embolism was a significant contributor to maternal deaths. During the period under review, there were about 50 cases of pulmonary embolism. It is admitted that most of these are presumptive clinical diagnosis.

Thromboprophylaxis is not routinely followed by most of the obstetricians. KFOG had been endorsing more liberal use of thromboprophylaxis especially after cesarean delivery. The RCOG recommendations allots a score of three for any surgical procedure in pregnancy or puerperium like appendicectomy or postpartum sterilization and yet allots only one point for elective cesarean section and two points for cesarean in labour. Any score more than two is advised thromboprophylaxis for at least ten days.

It is against this background that KFOG recommends thrombo-prophylaxis for every woman after any type of cesarean delivery with appropriate increase in dose and duration if there are other risk factors. In most of the cases we may have to give the low molecular weight heparin for a day or two only until the patient becomes fully ambulant.

There is an urgent need to change the habit of prescribing complete bed rest for situations like threatened abortion, cerclage or bad obstetric history. This bed rest paves the way to venous thrombosis and embolism.

V P Paily

Introduction

Pregnancy and puerperium are well established risk factors for venous thromboembolism (VTE), a disease that includes pulmonary embolism (PE) and deep vein thrombosis (DVT). The risk of VTE is 4 to 5 fold in pregnant women and absolute risk is 1/1000 pregnancies and can occur at any stage of pregnancy but highest risk is during puerperium, around 20 -30 fold. Most cases of postpartum DVT occur within the first 4 weeks, with highest number occurring in the second week.

Thromboembolism is an important and unexpected direct cause of maternal morbidity and mortality. In the recent years there has been a significant decline in maternal deaths globally because of DVT and PE. This is because of widespread use of thromboprophylaxis since 1995. In UK, maternal deaths due to VTE was 41 during

Table 1. Type of pregnancy/delivery in patients of PE

Year	Total cases	Cesareans	Others	Co-morbidities
2010	4	3	Ectopic - Laparatomy	obesity, twins, Hypertensive 2, elderly primi infertility treated
2011	6	3	vaginal delvery -1, vacuum delivery -1 Heart disease, in labour, undelivered - 1	Diabetic on insulin -2, phlebitis -1 hypertension -3, heart disease -1
2012	2	1	Antenatal,bedridden and vomiting -1	gestational hypertension 1
2013	7	4	7 weeks gest, sudden dyspnoea -1 vaginal del -1	valve replacement -1 Diabetes on insulin -1
2014	9	6	9weeks gestation, vomiting, on bedrest -1 pl.previa -1 (AN) 30 wks vaginal del -1	Hypertensive disorder -3 Diabtes -3, Hyperemesis -1, known renal disease
2015	9	8	PROM, in laour -1	Hypertensive disorder -3, pl.previa-1 Immobilised because of trochanteric bursitis-1
2016	3	1	IUD-1 Abortion, D&C-1	Protein C deficiency Diabetes & hypothroid -1 Hypertension & hypothyroid-1
2017	3	1	Vaginal delivery, Postpartum sterilization (PPS) -1 Vaginal delivery -1	Chronic lung disease-1 Hypertensive disordsr -1
2018	6	5	IVF conception, 32 weeks, leaking - in labour, undelivered -1	hypertensive disorder – 1, obese -1 Hypothyroid 1, Relaparotomy 1
2019	4	2	34 weeks on bed rest for short cervix -1 Vag del, PPS- 1	Hypertensive disorder,& obese , GDM -1
Total	**53**	**34**		

the period 2003-05 which came down to 18 in 2006-08 . In the reports of previous CEMD in UK, of the 46 deaths from pulmonary embolism, 15 occurred antepartum, 25 occurred postpartum and 3 in early pregnancy.

In the Confidential Review of Maternal Deaths in Kerala for years 2004 and 2005, out of 170 cases analysed 7 were due to pulmonary embolism. From 2006 to 2009, out of 331 deaths reported to CRMD, 9 were presumed to be due to thromboembolism. All the 9 deaths reported occurred postpartum. Out of 9 deaths, 7 occured following cesarean section, 1 following abortion at 22 weeks of gestation and 1 following a preterm delivery. In the ten years covered in this report, there were 53 cases of pulmonary embolism leading to maternal deaths.

The case fatality rate of obstetric pulmonary embolism is reported to be 13%. Though recovery from nonfatal PE is complete, residual changes in lungs is detected by pulmonary function tests (PFT). Recurrence risk is as high as 26% in subsequent pregnancies, even if the case is detected and treated at the right time. Though recanalisation is possible, post phlebitic syndrome (swelling, pain and skin ulceration) is a long term sequel to DVT.

Key Recommendations

1. Risk assessment for VTE should be started from prepregnancy or atleast during first antenatal visit. Interrogation to find out family history of young stroke, previous bad obstetric history like recurrent pregnancy losses, early onset preeclampsia, IUGR and prior history of DVT should be done. The risk assessment should be continued through all antenatal visits and during early labour. Thromboprophylaxis is to be initiated appropriately.

2. Plan pregnancy in obese women after achieving ideal weight. Calculate BMI at initial visit and entry to be made in the antenatal record at the first visit.

3. Women who are at high risk for thrombosis as those having homozygous Factor V Leiden mutation, prothrombin gene mutation or antithrombin deficiency, need anticoagulation throughout pregnancy and puerperium.

4. Advise rest only when indicated. Advising bed rest during pregnancy does more harm than good. There is no scientific evidence to support this.

5. Early ambulation and proper hydration are mandatory in puerperal period. Encourage women to have adequate fluid intake during postpartum period. Otherwise because of diuresis during this phase it may be harmful.

6. Elastic compression stockings should be advised for women having large varicose veins. Pneumatic compression stockings should be advised in women at high risk for thrombosis during cesarean.

7. In suspected cases of DVT, Doppler studies and MRI should be employed.

8. D Dimer should not be used for diagnosing DVT. When there is a suspicion, Compression Doppler study or MRI should be employed for ruling out DVT.

9. In patients with symptoms suspicious of pulmonary embolism, Spiral CT scan should be done.

10. Any woman with a diagnosis of DVT or PE should be started on parenteral heparin and warfarin should be added later. Intravenous

heparin to be continued till PT/INR become more than two. When a woman is diagnosed to have massive PE in puerperium with hemodynamic instability the treatment of choice is thrombolysis.

11. Heparin for thromboprophylaxis especially low molecular weight heparin will not increase risk of hemorrhage in pregnancy. When indicated heparin must be given in pregnancy and puerperium.

12. Reducing episiotomy and opting for transverse incision for cesarean will be of help.

13. Thromboprophylaxis to be initiated depending on risk stratification. Woman with history of recurrent pregnancy loss who on evaluation turns out to be APLA positive and those positive for lupus syndrome need thromboprophylaxis. Low molecular weight heparin should be started during pregnancy and continued for 6 weeks postpartum.

14. If epidural catheter is in situ, do not remove it within 12 hrs of LMWH administration. Similarly, do not give LMWH within 6 hrs of removal of catheter.

Pathogenesis of DVT during pregnancy[1]

Pregnancy is a prothrombotic state; it has all components of Virchow's triad: venous stasis, endothelial damage and hypercoagulability.

Venous Stasis

Results from a hormonally induced decrease in venous tone and obstruction of venous flow by enlarging uterus. This starts from 25-29 weeks of gestation. This lasts until 6 weeks postpartum. Hormone mediated decreased vascular tone and valvular competence of the venous system play an important role in the process. These changes start from early part of second trimester with a nadir at 36wks, and returns to normal 6 weeks following delivery.

Endothelial damage

Injury to pelvic vessels is brought about by passage of fetal head through birth canal in normal vaginal delivery and instrumental delivery; use of forceps or vacuum induces vascular intimal trauma along with trauma to pelvic veins. This could be the reason for higher risk of VTE in puerperal period.

Hypercoagulability

During pregnancy a hypercoagulable state is initiated as a natural protective mechanism against bleeding during pregnancy and puerperium. It is brought about by increased hepatic production of fibrinogen, prothrombin and clotting factors VII, VIII, IX, X , increased levels of anti fibrinolytic substances – plasminogen activator inhibitor type 1 and type 2 (PAI-1 & 2) and decreased levels of natural anticoagulant protein S, protein C, resistance to activator protein C and factor V Leiden.

Pregnancy specific risk factors

- Age >30yrs
- Obesity (BMI>30)
- Hyperemesis gravidarum
- Multifetal pregnancies
- Intrauterine sepsis
- Cesarean section , instrumental deliveries, Cesarean Hysterectomy
- Prolonged second stage, genital tract injuries
- Puerperal sepsis

Other risk factors

- Immobility
- Enforced bedrest
- Extensive varicose veins
- Family history of VTE
- Previous h/o VTE
- Air travel
- Hypertension
- Severe anaemia, blood transfusion
- SLE
- Sickle cell anaemia
- Thrombophilias
- OHSS, ART and IVF

Thrombophilias

Thrombophilia is a disorder of hemostasis that predisposes an individual to a thrombotic event. Several regulatory proteins act as inhibitors in the coagulation cascade. Inherited or acquired deficiencies of these inhibitory proteins are collectively referred to as Thrombophilias. These are protein C, protein S, Antithrombin, Activated Protein C resistance and Factor V Leiden. They contribute to 50% of VTE in pregnancy. Two types of thrombophilias are described

- Inherited thrombophilias
- Acquired thrombophilia

Inherited Thrombophilias-

They often have family history of thrombosis and is responsible for more than 50 % of thrombotic events before the age of 45 in the absence of risk factors.The inheritance is in an autosomal dominant pattern for Antithrombin, Protein C and Protein S .

Antithrombin deficiency

It is the most important inhibitor of thrombin and a natural anticoagulant. It acts by binding and inactivating thrombin, activate coagulation factors IXa, Xa, XIa and XIIa.

Protein C deficiency

This is a natural anticoagulant deficiency that can lead to coagulation. Protein C operates by inactivation of factor V. When thrombin is bound to thrombomodulin on the endothelial cells, its procoagulant activity is neutralized and activates Protein C, in the presence of Protein S and controls thrombin generation by inactivating factor Va and VIIIa. Activated protein C also inhibits the synthesis of plasminogen activator inhibitor 1. The excess risk of VTE appears to be ten fold in those who are heterozygous.

Protein S deficiency

This circulating anticoagulant is activated by Protein C, which enhances its capacity to inactivate Factor Va, VIIIa. Protein S deficiency is associated with maternal cerebral venous thrombosis.

Activated protein S Resistance and factor V Leiden mutation

Resistance to activated Protein S is one of the prevalent causes of thrombophilia. Mutation of factor V Leiden which is a heterozygous inherited factor accounts for 40 percentage of VTE in pregnancy. Diagnosis is made by DNA analysis for mutation in Factor V gene.

Prothrombin G20210a mutation

Mutation in the prothrombin gene leads to excessive accumulation of Prothrombin, which is then converted to Thrombin. Homozygous patients or those who inherit G20210a mutation with factor V Leiden mutation have even greater thrombo-embolic risk.This increases risk of VTE by 2-4 fold.

Hyperhomocysteinemia

Most common cause of elevated homocysteine is the C66T mutation of the enzyme **5, 10 methylene tetrahydrofolate reductase (MTHFR) -** Raised level of plasma homocysteine can lead to increased risk of venous and arterial thrombosis.

Elevated levels may also result from deficiency of one of several enzymes involved in methionine metabolism. This condition is a correctable nutritional deficiency with folic acid, vitamin B6 and vitamin B12. Diagnosis is possible by measuring fasting threshold level of homocysteine more than 12 micromol per litre.

Other Potentially thrombophilic polymorphisms have been discovered recently

Protein Z is a vitamin K dependent protein that serves as a co-factor in Xa inactivation.

Low protein Z levels and polymorphism in plasminogen actitvator inhibitor type 1 are associated with slightly greater VTE risks.

Acquired Thrombophilias

Antiphospholipid Antibodies (APLA)

- Anticardiolipin antibodies
- Lupus anticoagulant

APLA is responsible for 2 percentage of thromboembolism in pregnancy. This disorder can affect both the venous and arterial circulation. The deeper veins of the lower limbs and the cerebral arterial circulation are the most frequent sites of venous and arterial thrombosis respectively. Other major clinical manifestations of APLAS are obstetrical. The clinical criteria include-

1. At least one unexplained fetal death at or beyond 10 weeks.
2. At least one preterm birth before 34 weeks gestation because of severe preeclampsia or eclampsia.
3. At least three unexplained consecutive spontaneous abortions before 10 weeks.

The risk of thrombosis rises significantly in women with APS (5 –12% risk during pregnancy or puerperium).

Thrombophilia screening - Whom to screen ?

Universal screening for thrombophilia is not recommended and is not cost effective. Only a selectitve screening is advised. Screening is advisable in following situations:

1 A personal history of VTE associated with a nonrecurrent risk factor such as fractures, surgery and/or prolonged immobilisation.

2 A first degree relative with a history of high risk thrombophilia or VTE before 50 years of age in the absence of other risk factors.

3 Women with recurrent (three or more early or late) pregnancy losses or a previous history of DVT in pregnancy.

Screening for thrombophilia include full blood count, coagulation screen, antithrombin and protein C activities, total free protein S Ag, lupus anticoagulant test, anticardiolipin antibodies, prothrombin gene status and determination of factor V.

Table 2 RISK FACTORS FOR VTE [3]

Risk factors for Venous Thrombo Embolism	
Pre-existing risk factors	
History of previous VTE (except a single event related to major surgery)	4
Known high risk thrombophilia	3
Medical comorbidities like Malignancy, Heart failure; Diabetes with nephropathy, Active SLE, Sickle cell disease	3
Family history of VTE in first degree relatives	1
Known low risk thrombophilia (no VTE)	1
Age (above 35 years)	1
Obesity- BMI -30 or more	1
40 or more	2
Parity - three or more	1
Gross varicose veins	1
Obstetric risk factors	
Preeclampsia in current pregnancy	1
ART/ IVF (antenatal only)	1
Multiple pregnancy	1
Cesarean section in labour	2
Elective cesarean section	1
Midcavity or rotational operative delivery	1
Prolonged labour (more than 24 hours)	1
PPH (more than 1 litre or transfusion)	1
Preterm birth (less than 37 weeks in current pregnancy), still birth	1
Transient risk factors	
Any surgical procedures in pregnancy or puerperium except immediate repair of perineum. e.g. appendicectomy, postpartum sterilization	3
Hyperemesis	3
OHSS (Ovarian hyperstimulation syndrome)(First trimester only)	4
Current systemic infection	1
Immobility, dehydration	1

Adapted from Tahir A Mahamood and Anan Hassan Section 2 chapter 3 Deep Vein Thrombosis and Pulmonary Embolism,Obstetrics and Intrapartum Emergencies edEdwinChandraharan and SabaratnamArulkumaran Cambridge University Press 2012.

Thromboprophylaxis

Based on the score, one has to consider thromboprophylaxis. Most of the cases of pulmonary embolism (34 out of 53) have been associated with cesarean delivery. So for postpartum thromboprophylaxis we take a liberal view – anybody with a cesarean delivery and one more factor (see table 2) is recommended to have prophylactic low molecular weight heparin. In practice, almost any one who had a cesarean delivery becomes eligible for thromboprophylaxis. Even after vaginal delivery if the score is two or more, thromboprophylaxis is to be considered.

Regarding thromboprophylaxis in the antenatal period, we are not restrictive except in those with previous history of venous thromboembolism or who get score of 4 or more. However, for anybody on enforced bed rest thromboprophylaxis has to be considered.

We do not recommend thromboprophylaxis for as many days as in the UK. In anybody without additional ongoing risk factors, we stop LMWH after the woman is fully ambulant.

Diagnosis of DVT

The symptoms and signs of DVT include leg pain and swelling usually unilateral and lower abdominal pain indicating extension into pelvic vessels. The subjective clinical assessment of DVT is unreliable in pregnancy as edema and leg pain can occur in normal pregnancy. When there is clinical suspicion Doppler screening should be undertaken which has got high sensitivity. The symptoms of PE include dyspnoea, chest pain, hemoptysis and collapse.

- If total score antenatally is above 4 - consider thromboprophylaxis from first trimester.
- if total score more than 3 - antenatally consider thromboprophylaxis from 28 weeks onwards.
- If total score more than two postnatally- thromboprophylaxis at least for 10 days.
- If admitted to hospital antenatally - consider thromboprophylaxis.
- if prolonged admission for more than three days or readmission to hospital during puerperium - consider thromboprophylaxis.

Learning from Case scenarios

Example 1.

This 30 year old G2P1L1 was referred to a medical college at 38 weeks gestation for breech presentation and fibroid complicating pregnancy. She was a known case of GDM on insulin. She had a 9x9 cm fibroid at the left cornual region. Cesarean section was done and a 3.7 kg baby was delivered. It is not clear from the notes whether a myomectomy was done. It is written that postoperative period was uneventful and that she was discharged on the 6th day.

On 13th postoperative day she collapsed at home and was brought back to the hospital, unfortunately in a dead state.

Autopsy was done which confirmed massive pulmonary embolism

Points for consideration

- It is not clear from the notes whether a myomectomy was done along with cesarean section, thereby making the surgery a prolonged one.

- It is also not clear whether she received thromboprophylaxis in the postpartum period. She should have received thromboprophylaxis considering the fact that she had a cesarean delivery and was a diabetic requiring insulin.
- It is not clear whether she was given advice regarding steps to avoid thromboembolism like adequate fluid intake, regular exercise etc.

Example 2

This 25 year old primigravida had regular antenatal checkup. She was detected to have gestational hypertension at 21 weeks and was on alphadopa. She was induced with PGE2 gel. LSCS was done in the evening, delivering a baby weighing 3.16Kg.

Immediate postoperative period was uneventful. On day 6, she complained of pain in the scapular region for which diclofenac was given. On day 7 she came back from the toilet complaining of severe pain in the chest and collapsed. All resuscitative measures failed.

Points to note

- She was induced on the day prior to EDC. This may not have any etiological implication in her developing a possible pulmonary embolism.
- It is not clear from the notes whether she received thromboprophylaxis postoperatively.

Learning points

- As per our protocol she should have received heparin postoperatively and told about early ambulation.
- It is to be admitted that the diagnosis of pulmonary embolism was not confirmed by investigation or autopsy.

Treatment of VTE in pregnancy

Initial management of suspected VTE depends on the degree of clinical suspicion, whether anticoagulation is contraindicated, and whether PE, DVT or both are suspected. Adjusted dose of subcutaneous LMWH is recommended for pregnant women rather than IV UFH. The dose of LMWH to be titrated against the woman's prepregnancy or booking visit weight. Anti-coagulant therapy to be continued for at least 6 weeks postpartum. The suggested 'total duration of anticoagulant therapy for women with transient risk factor is 3 – 6 months. Women with persistent risk factors for VTE may require longer therapy.

RCOG Guidelines 2017 [4]

Table 3. Suggested thromboprophylactic doses for antenatal and postnatal LMWH

Weight	Enoxaparin	Dalteparin	Tinzaparin (75u/kg/day)
<50kg	20 mg daily	2500 units daily	3500 units daily
50-90 kg	40 mg daily	5000 units daily	4500 units daily
91-130 kg	60 mg daily*	7500 units daily	7000 units daily*
131-170 kg	80 mg daily*	10,000 units daily	9000 units daily*
>170 kg	0.6 mg/ kg/day*	75u/kg/day	75u/kg/day*
High prophylactic dose for women weighing 50-90 kg	40 mg 12 hourly	5000 units 12 hourly	4500 units 12 hourly

** may be given in 2 divided doses*

Labour Management

- If on thromboprophylaxis, stop 24 hours before planned induction or surgery. Regional anesthesia is better avoided at least for 12 hours of last dose (fear of hematoma). No removal of epidural catheter for 12 hours of last injection. LMWH can be restarted 4 to 6 hours after surgical procedure.
- Abdomen should be closed with abdominal and rectus sheath drains, and skin is sutured with interrupted sutures to allow drainage of collection.
- After delivery heparin is continued for 7 to 10 days. If prophylaxis is needed for longer period, warfarin is added after 5 days along with heparin and monitored with PT and INR. When INR is maintained between 2- 3, heparin is discontinued and warfarin may be continued for 6 to 12 weeks or even upto 6 months if indicated.

Management of Pulmonary Embolism

Massive PE is a medical emergency. PE may present with shock, refractory hypoxemia and/ right ventricular dysfunction on ECG. A multi-disciplinary resuscitation team should decide on the line of management. The options are intravenous unfractionated heparin, thrombolytic therapy, or surgical embolectomy.

- Intravenous unfractionated heparin is the drug of choice
- Loading dose of 80 units/kg, followed by IV infusion of 18 units/kg/hour
- Measure APTT 4-6 hrs after the loading dose.
- The therapeutic target APTT ratio is 1.5 – 2.5 times the average control value.

Oral anticoagulants Vitamin K antagonists have been advocated in pulmonary embolism along with heparin or LMWH after initial administration of Heparin/LMWH

Newer oral anticoagulants like dabigatran, apixaban, rivaroxiban are not recommended in pregnancy and puerperium[5]

In massive life threatening PE with hemodynamic instability, thrombolytic therapy or thoracotomy and surgical embolectomy are the other options.

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CHAPTER

12

Neurological causes of Maternal Death: Lessons from CRMD

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Editor's Note

Neurological causes continue to be responsible for about 7% of maternal deaths; this is almost equally distributed between antenatal and postnatal periods. Cerebral venous thrombosis(CVT) remains the most common reason for maternal deaths (about 35%) followed by intracerebral hemorrhage. General measures like ambulation and hydration are relevant in preventing cerebral thrombosis, like elsewhere in the body. Control of hypertension is paramount in preventing intracranial hemorrhage, as 50% of hypertension associated deaths are due to intracranial hemorrhage. Thankfully infective etiology is relatively less. Epilepsy associated deaths is an area where vigilance on the part of the obstetrician can make a difference. But, since epilepsy is associated with stigma in our society, public awareness also becomes crucial. With improvement and availability of sophisticated imaging facilities we should make a difference in neurological causes of maternal deaths. We should also consider that many neurological events related to pregnancy and puerperium may not kill but leave lifelong sequelae like paralysis. It is important to prevent such morbidities as well.

V P Paily

Key summary points

1. Confidential Review of Maternal deaths (CRMD), Kerala, 2010 to 2020 revealed that neurological causes (other than eclampsia) were responsible in 80 (7.43%) out of 1076 maternal deaths.
2. Maternal deaths due to neurological causes were almost equally distributed between antenatal and postnatal period (36/44).
3. Headache with or without vomiting was the most common initial presentation followed by seizures.
4. Fever with altered sensorium, fever with head ache and vomiting were the symptoms in cases of infective etiology.
5. The common causes of maternal mortality were
   - Cerebral venous thrombosis (CVT) 31.25% (25/80),
   - Intracerebral hemorrhage (ICH) 23.75% (19/80),
   - Meningitis / Encephalitis 16.25% (13/80),
   - Epilepsy 12.5 % (10/80),
   - Ischemic arterial stroke, subarachnoid hemorrhage (SAH) and others.

   During the period from 2015 to 2020, there was an increase in diseases not more commonly associated with pregnancy and puerperium like Herpes Simplex virus encephalitis, autoimmune encephalitis (1), demyelinating encephalopathy (1), and cerebral aneurysm rupture (2) and AV malformation (1).
6. Compared to the previous CRMD analysis of 2005 to 2009, there has been a doubling of neurology cases and a steep rise in CVT (cerebrovascular thrombosis) cases (2 vs 25) during the present ten year study period.

Key recommendations

- Headache of recent onset or short duration should be viewed with suspicion and should be evaluated promptly. It signifies raised intracranial tension until proved otherwise.
- Any pregnant or postpartum woman with neurological symptoms should be carefully evaluated by taking a detailed history and physical examination. A neurologist must be involved early in patients with neurological symptoms. A syndromic approach may help to come to a diagnosis quickly. Appropriate investigations like neuroimaging (CT, MRI, MRV) or D-Dimer must be done without delay.
- Always have a pretest diagnosis before investigating a patient. The investigation results are to be interpreted keeping the pretest clinical possibility in mind by the physician who ordered the tests.
- Exert caution while interpreting the neuro imaging results. Venous thrombosis leading to cerebral venous infarct may show a pool of blood which may be misinterpreted as intracerebral bleed. Primary intracerebral bleeding occurs at a single site. If the report shows bilateral bleed, it is likely to be venous hemorrhagic infarct due to superior sagittal sinus thrombosis since it drains both sides of the hemisphere. This knowledge will help in avoiding an error of interpreting thrombotic infarct as hemorrhagic infarct and will help in correct management.

  Do not rely on an initial CT report in suspected CVT, since a CT scan can show non-specific changes in the initial stages of CVT. D Dimer has more negative predictive value in suspected cases of CVT.
- ICH due to hypertension can be prevented by meticulous monitoring of blood pressure. Intracerebral hemorrhage is the commonest cause of maternal mortality in hypertensive patients. Hence aggressive management of

hypertension to keep the BP below 150/100 can save lives. It is recommended to continue vigilant monitoring and treatment of hypertension in the postpartum period also.

- Fever with neurological symptoms points to an infective etiology. Prompt evaluation with neuroimaging and CSF study will help to clinch the diagnosis.
- Women with previous deep venous thrombosis, CVT, or family history of recurrent venous thrombosis should be identified during the antenatal period and started on low molecular weight heparin (LMWH). Should consider screening for antiphospholipid antibodies during the antenatal period even though not standard of care. The patient should be educated to encourage ambulation and adequate hydration during pregnancy and the postpartum period.
- Women should be screened with echocardiography to look for mitral stenosis. An electrocardiogram should be done to look for atrial fibrillation. This will help to prevent cardio-embolic stroke.
- Family history of SAH or sudden unexplained death in the family may be a clue to a cerebral aneurysm. Can do MR angiogram time of flight (TOF)without contrast study to screen for the aneurysm.
- Any pregnancy with a history of epilepsy and on antiepileptic drugs (AED) must be evaluated by a neurologist. Most pregnancies are not planned. Often there is a tendency to stop or reduce the antiepileptic drugs un-supervised which must be discouraged. There is a need to control seizures with optimum use of antiepileptic drugs. This can be done with a multidisciplinary approach monitoring the foetus. Uncontrolled seizures are associated with increased maternal mortality. Women should be counseled that the continuation of AED is essential during pregnancy. Efforts should be taken to mitigate the social stigma associated with epilepsy.

Summary of findings during the period, outlining trends and observations

Table 1. Timing of maternal death

Year	Antenatal	POST NATAL			Grand Total
		Post LSCS	Post normal delivery	Total	
2010	1	4	3	7	8
2011	3	3	2	5	8
2012	5	2	2	4	9
2013	3	1	3	4	7
2014	3	3	1	4	7
2015	7	3	3	6	13
2016	3	2	1	3	6
2017	3	0	4	4	7
2018	7	0	3	3	10
2019/20	1	4	0	4	5
Total	**36**	**22**	**22**	**44**	**80**

Table 2. The table shows the neurological conditions leading to maternal death

Years	CVT	ICH	Encephalitis Meningitis	Epilepsy	Ischemic stroke	SAH	Others
2010	3	2	1	1	0	0	1
2011	2	3	1	1	0	1	0
2012	3	2	2	2	0	0	0
2013	2	1	0	1	0	1	2
2014	3	1	2	0	0	1	0
2015	3	1	3	1	3	1	1
2016	3	1	2	0	0	0	0
2017	4	1	1	1	0	0	0
2018	2	5	1	1	0	0	1
2019/20	0	2	0	2	0	0	1
Grand Total	**25**	**19**	**13**	**10**	**3**	**4**	**6**

Number of deaths due to CVT remains the same / trend to decrease

Deaths due to ICH has not changed.

Death due to meningoencephalitis has not decreased.

Learning from Examples

Cerebrovascular Thrombosis (CVT)

Example 1

Beware of headaches of short duration

A thirty year old woman (para 1) continued to have headache and vomiting for six days from the second postnatal day, managed as migraine. A day before admission, she became unconscious. Her Glasgow Coma Scale (GCS) was six: eye-opening (one), vocalization (one), motor response (four). Dolls eye movement was absent with dilated fixed pupils. She developed respiratory arrest and had to be intubated and ventilated. Emergency brain CT scan showed right cerebellar haemorrhagic infarct. The diagnosis was confirmed by MRI/MR Venogram(MRV) showing Straight sinus, Superior sagittal sinus, right Transverse sinus and right sigmoid sinus thrombosis. Later right pneumothorax was detected. Terminally she developed central diabetes insipidus.

Diagnosis: CVT.

Learning points:

- Primary headaches like migraine have a long duration of headache often lasting more than six months.
- On the contrary, the headache of recent onset with vomiting is secondary, headache particularly due to pathologies that raise the ICP. Secondary headache calls for an urgent investigation for the underlying cause.

Example 2.

Interpret the test results with a pretest possibility!

*Twenty nine year old pregnant woman (para 2) on third postpartum day developed recurrent seizures in hospital. D-dimer was (1264**µg/ml**). Emergency CT scan brain done was reported normal. Brain MRV failed to visualize the deep veins. On the seventh postpartum day, she developed right hemiplegia and dysphagia. Neuroimaging showed an area of infarct and bleeding in the left hemisphere with midline shift and blood tracking up to the brain stem.*

Diagnosis: Cerebral venous thrombosis

Learning points:

- The results of the D-dimer, CT scan, and MRV were not interpreted in the backdrop of the pretest possibility.
- ***On the 3rd day postpartum, if a patient has recurrent seizures for the first time, the diagnosis of CVT is high on the cards.***
- Elevated D-dimer values favoured CVT.
- This case reiterates the fact that the CT scan brain ***is not sensitive to detect early infarct e***ven though it is sensitive to detect intracerebral bleed and SAH. Knowing the limitations of investigations is also essential.
- With a provisional diagnosis of CVT, non-visualization of the deep veins on MRV is significant. Starting treatment on the 3rd postpartum day could have saved her life.

Example 3

Why is this, not ICH?

Thirty-one-year-old para two was admitted on the seventh post-partum day with three days of headache. Examination revealed that she was in delirium, with left Upper motor neuron (UMN) facial palsy, left hemiparesis and neck-stiffness. She was afebrile with BP 180/110 mm Hg. CT Scan brain reported as bilateral frontal hematoma with a subarachnoid component. She developed cardiac arrest while shifting for MRI. She died despite shifting to ICU and ventilating.

Diagnosis: CVT

Learning Points:

- Thrombosis of the superior sagittal sinus is classically bilateral since it drains both hemispheres. Venous infarct may have a pool of blood which may be misinterpreted as intracerebral haemorrhage by the novice.
- ***Intracerebral bleed most often occurs at a single site.*** Even though our patient had only unilateral signs, she had bilateral frontal hematoma. The reported bilateral hematoma is most likely hemorrhagic infarct due to superior sagittal sinus thrombosis.
- With a provisional clinical diagnosis of CVT, Heparin could have been started with the CT brain itself.
- This case reminds us to be cautious in transporting a patient with altered consciousness or raised ICP. We need to improve infrastructure facilities for the transportation of patients with altered consciousness, as well as facilities for immediate resuscitation at MRI units.

Intracerebral hemorrhage (ICH)

Example 4.

Lack of aggressive control of hypertension may cost life!

Our patient is a 24-year-old female, gravida two with one previous abortion. On the fifth postoperative day after LSCS, following a quarrel with her husband, she developed severe headache the whole night with repeated vomiting. She was detected to have a high BP of 160/110, which was attributed to stress. The next day she became unresponsive. Her history was significant for hyperemesis gravidarum with ketoacidosis. MRI confirmed intracerebral bleed with

intraventricular extension. Despite decompressive craniotomy, she had refractory non-cardiogenic pulmonary edema.

Diagnosis: Hypertensive intracerebral hemorrhage with intraventricular extension and Neurogenic pulmonary edema.

Learning Points :

- Sudden onset of headache in the post LSCS period with hypertension, warrants an urgent CT scan brain and control of BP.
- This situation could be due to different causes: hypertensive encephalopathy, PRES, hypertensive intracerebral bleed, SAH or CVT.
- A CT scan brain would have detected intracerebral bleed.

Example 5.

Fever suggests infective etiology!

Nineteen year old female on the second postpartum day presented with visual hallucinations. The next day she had a fever (102^0 F) and generalised tonic clonic seizures (GTCS). She continued to be deeply comatosed.

She was given IV MgSO4.

MRI/MRV done on the third day was normal. She died on the fourth postpartum day.

Diagnosis:-Encephalitis

Learning Points:

- Encephalitis can be diagnosed when a patient presents with fever with altered consciousness and/ or seizures. Early diagnosis of encephalitis, especially Herpes Simplex Encephalitis (HSE) is vital since the prognosis improves with early initiation of IV acyclovir.
- MRI brain shows a typical distribution of lesion in the medial temporal lobe, cingulate gyrus and insular cortex.
- HSV PCR in CSF study helps to confirm HSE. If fever is a red herring in this patient, the possibility of Reversible Cerebral Vasoconstriction Syndrome (RCVS) should be considered and investigated.

Meningitis

Example 6.

Pregnancy is an immune suppressed state! Beware of a flare-up of tuberculosis.

Four Days after delivery, a 30-year-old para two, developed fever, vomiting and altered consciousness. She was febrile (103^{0}F), unresponsive to painful stimuli, had pallor and neck stiffness. She had a history of TB adenitis. She was a tribal, ex-alcoholic, ex-smoker and pan chewer. CSF showed 180 cells (P30L70,) protein 370 mg/dl and sugar 20 mg/dl. Chest radiograph showed a right lower lobe consolidation. USG abdomen showed hepatosplenomegaly. MRI brain showed a ring-enhancing lesion in the left frontal lobe with mild hydrocephalus.

Diagnosis: Tuberculous Meningitis (TBM) with hydrocephalus and tuberculoma.

Learning points:

Altered consciousness or abnormal behaviours with fever indicate a central nervous system infection, the cause of which must be investigated with neuroimaging and Lumbar puncture(LP) CSF study. CSF in our patient showed lymphocyte dominant pleocytosis with raised protein and hypoglycorrhachia. This CSF picture is consistent with chronic meningitis, eg. TBM. A brain granuloma, as evidenced by ring-enhancing lesion, is consistent with a diagnosis of TBM. A flare-up of tuberculosis can occur during pregnancy and the postpartum period.

Epilepsy

Example 7.

Most Women with Epilepsy need to continue AEDs during pregnancy!

Twenty-three-year-old primigravida, who had epilepsy, underwent LSCS at 37 weeks gestation. The next day she had complex partial status epilepticus. She had stopped antiepileptic drug (AED) carbamazepine on her own once she became pregnant. She died following aspiration pneumonia. MRI revealed periventricular hyper-intensities.

Diagnosis: Aspiration pneumonia, status epilepticus following drug withdrawal.

Learning Points:

- We must see teratogenicity from the proper perspective. The chance for major congenital malformation (MCM) in the general population is 2 to 3 % while it increases to 4 to 9% in a woman with epilepsy on antiepileptic drugs.
- The risk of MCM depends on the antiepileptic medication, its dose and the number of AEDs.
- A neurologist should evaluate women with epilepsy. Ideally, we may be able to taper off antiepileptic drugs (AED) in a minority of patients with epilepsy. However, most patients require continued treatment with AEDs during pregnancy.
- AEDs have to be fine-tuned pre-conceptionally with the use of the appropriate AED at the lowest dose as monotherapy along with the folic acid supplement. High-quality fetal ultrasound monitoring at about 19 weeks of gestation should be done. There is a substantial risk of recurrent seizures following AED withdrawal which puts the mother at considerable risk.

Our patient should have been investigated with EEG and MRI even though she was seizure-free on withdrawal of AEDs. The risk of recurrence of seizures was 38% in patients with normal MRI, which increases with structural lesions like hippocampal sclerosis (72%) [1]. Hence, she should have been urged to continue AEDs despite the risk of teratogenicity.

Example 8

Twenty-five-year-old para 1 (one live child) with long-standing epilepsy of 12-year duration was on phenobarbitone 60 mg at night. Carbamazepine, 800 mg was added. Gestational diabetes mellitus was under control on insulin. Following LSCS at 38 weeks gestation, she collapsed and died on the 13th postoperative day.

Diagnosis: Sudden unexpected death in epilepsy (SUDEP)

Learning points:

- SUDEP is diagnosed when an epileptic patient dies for no apparent cause. It is a risk in patients with epilepsy, especially in patients with uncontrolled epilepsy.
- Most likely, she had uncontrolled epilepsy, and hence carbamazepine was added during pregnancy.
- An alternate cause of sudden death is cardiac dysrhythmia or massive pulmonary embolism in the postoperative period. We do not know how quickly carbamazepine (a sodium channel blocker) was added and if she had any preexisting cardiac conduction abnormalities.
- Carbamazepine is known to cause cardiac arrhythmias, especially in patients with preexisting cardiac conduction abnormalities. The dose of carbamazepine should be increased slowly.

Example 9.

The cause of loss of consciousness in pregnancy should be found out.

Twenty-four-year-old (G2L1) woman, 16 weeks pregnant, developed sudden onset headache with

vomiting, followed by loss of consciousness. She had papilledema. She had recurrent attacks of headache over the last six months and one episode of loss of consciousness four months back. In the hospital, she developed cardiac arrest, and she was intubated. CT brain revealed dilatation of lateral and third ventricles but normal fourth ventricle, probably due to aqueductal stenosis. Despite external ventricular drainage, the patient died.

Diagnosis: Obstructive hydrocephalus due to aqueductal stenosis.

Learning point

Headache, vomiting followed by altered consciousness indicates raised ICP, which warrants neuroimaging.

Approach to patients with neurological symptoms and signs in pregnancy

For the diagnosis of neurological emergencies in obstetrics, a syndromic approach is most desirable. This strategy should be supplemented by a prompt neuroimaging like CT brain plain / MRI ± MRV or lumbar puncture (LP). (Table 3). Diseases with increased frequency during pregnancy and puerperium are discussed later in this chapter.

Encephalitic Syndrome

In encephalitic syndrome there is prominent seizures and persistent altered consciousness.

If there is an abrupt onset of encephalitic syndrome with lateralizing deficits and hypertension, then ICH needs consideration.

Thunderclap headaches at onset suggest RCVS (**Reversible cerebral vasoconstriction syndrome**) or PRES.

CVT should be considered when there is a prominent headache or lateralizing deficits in a person with encephalitic syndrome.

The presence of fever suggests an infective cause of encephalitic syndrome like viral encephalitis.

The common types of seizure encountered during pregnancy are focal motor seizures with or without impaired awareness and generalised tonic clonic seizures. It is only a symptom, indicating cortical grey matter affection. The common causes of seizure during pregnancy are eclampsia, CVT, encephalitis, and PRES. Less frequently it may be seen in ICH, meningitis and SAH. If seizures cannot be explained by eclampsia patient needs further investigations to find the cause. Status epilepticus, a seizure that lasts more than 5 minutes is a medical emergency requiring intensive care treatment with intravenous anti-epileptic medications.

Meningitic Syndrome

Headache with meningeal signs suggests a Meningitic syndrome due to meningitis or subarachnoid hemorrhage. Fever suggests infective meningitis. Subarachnoid hemorrhage can be primary due to rupture of a cerebral aneurysm or may be due to extension from the intracerebral bleed.

Table3. : Syndrome approach to the central nervous system emergencies.

Syn drome	Diseases	Headache ±vomiting	Fever	Lateralizing deficit at onset	Convul sions	Altered conscious -ness	HT	Neck stiff ness	CT brain plain
Encephalitic	CVT	+	-	±	±	±	-	-	± Infarct / hemorrhagic infarct
	ICH	+	-	+	±	±	+	-	Hemorrhage
	RCVS / PRES	Thunder clap headache	-	±	++	++	±/	-	Can be abnormal
	Enceph- alitis	±	+	±	++	++	-	-	Can be abnormal
Meningitic	Mening- itis	+	+	-	-	±	-	+	Normal
	SAH	+	-	-	±	±	-	+	SAH

Lateralizing deficits –includes speech abnormality, hemiparesis, monoparesis, or homonymous hemianopia; HT - hypertension; SAH - subarachnoid hemorrhage; - Absent; ± - present or absent;+- present; ++ - repeated/severe.

Investigations are part of the clinical examination to confirm the diagnosis or to know the prognosis of the disease.

Fresh blood appears white (hyperdense) on a CT scan. CT scan brain has a high sensitivity for intracerebral hemorrhage. Blood in the subarachnoid space following rupture of cerebral aneurysm is often located in suprasellar or Sylvian fissures. Cerebrospinal fluid (CSF) examination is essential to confirm CT negative SAH.

Fresh blood clots in the venous sinuses can be seen as hyperdense lesions. CVT can result in Cerebral venous infarct which is often hemorrhagic. For the untrained, the hemorrhagic infarct due to venous thrombosis may be mistaken for an intracerebral bleed due to the presence of a pool of blood. It must be kept in mind that early CVT CT may be normal or only shows subtle signs like hyperdensity in the cerebral venous sinuses. C T Venogram and MR venogram may show a filling defect in the superior sagittal sinus, transverse sinus, sigmoid sinus, straight sinus and internal jugular vein. However, MRI with contrast enhanced MRV is more sensitive to detect CVT than CT scan with venogram.

Cerebrospinal fluid (CSF) Examination is needed to confirm meningitis.

Cerebral venous thrombosis

Clinical features: Pregnancy and puerperium are the most common risk factors for CVT[2]. The risk was maximum in the postpartum period (adjusted OR 10.6)[3]. Anaemia was also a relevant risk factor in this population[4]. Three frequent CVT presentations are as isolated intracranial hypertension syndrome, focal syndrome, and encephalopathy[(5)]. Less often they may present as

cavernous sinus syndrome or syndromes of multiple lower cranial nerves palsies. The onset of symptoms can vary from acute in 47%, subacute in 34%, to chronic in 19%[6]. Clinical symptoms and signs included headache (87%), isolated headache in 25%, nausea and vomiting in 28%, seizures in 24%, visual field defects in 27%, other focal neurological deficits in 18%, altered consciousness in 18%, and cranial nerve palsies in 18%[6]. In a series of 153 patients with CVT from SGPGI Lucknow, 40.5% had self-limiting seizures, 18.3% had status epilepticus (SE), and 41.2% had neither[7]. Seizures were associated with supratentorial lesions, hemorrhagic infarcts, and motor or sensory deficits [8-11]. Urgent treatment of seizures is suggested by Kalita, in her series from Lucknow, who showed that refractoriness of SE is dependent on the pre-treatment duration [7].

Investigation:

D-dimer is elevated in CVT, but is associated with false negativity, especially in patients who present with isolated headache and prolonged symptoms beyond a week[12].

The sensitivity of the plain CT scan of brain to detect CVT was 41 to 73%, but the specificity was 97 to 100% [13] .The crucial role of CT angiography is in patients who cannot have an MRI. Nevertheless, the principal limitation is in detecting cortical vein thrombosis and normal anatomical variations [15].

A unique MRI sequence, T2* susceptibility-weighted imaging (T2*SW) improves the diagnostic accuracy of thrombus detection in the sinuses (90%) and cortical veins (97%) in the acute phase of the illness. Another MRI sequence, 3D T1-weighted SPACE (Sampling Perfection with Application optimized Contrast), a 3D fast spin-echo black blood sequence has high sensitivity and specificity for the detection of thrombus [16, 17]. **Contrast-enhanced MR venography better delineated the cerebral venous anatomy compared to non-contrast**[18].

European Stroke Organization guideline for the diagnosis and treatment of cerebral venous thrombosis is a comprehensive, evidence-based guideline for the treatment of CVT[19].

Low molecular weight heparin (LMWH) is equally effective as unfractionated heparin in the management of cerebral venous thrombosis [20]. Hence, any LMWH is preferred during pregnancy. Both dabigatran and warfarin may be safe and effective for preventing recurrent venous thromboembolisms in patients with CVT[21]. In the nonpregnant state we can choose between dabigatran and warfarin based on the socio economic status of the patient. Seizures can be controlled with phenytoin, lamotrigine, levetiracetam or valproate. Cerebral edema is treated with intravenous mannitol and diamox. CVT patients with life-threatening cerebral edema will benefit from decompressive craniectomy [22]. Mechanical thrombectomy may be beneficial in patients with severe CVT or patients worsening on standard treatment.

Prognosis:

The mortality due to CVT was less among patients with pregnancy/puerperium[2]. Over the years, the mortality for CVT has decreased probably due to better management and detection of milder cases of CVT[23]. Recurrent venous thrombotic events in subsequent pregnancies are infrequent in patients with previous cerebral venous thrombosis in the ISCVT cohort[24]. Martinelli's group from Milan also showed that patients with CVT during previous pregnancy had a low prevalence of thrombosis and bleeding[25]. The risk of subsequent late obstetrical complications was more in patients who had CVT on LMWH, even though venous thrombosis and bleeding complications are less[26]. Patients with CVT presenting with headache alone had a good outcome[27]. Clinical deterioration after admission, midline shift, and bilateral motor signs on follow up predicted more unsatisfactory outcome[28]. Lack of recanalization is associated with poor outcome[29]. Female gender and acute parenchymal lesions were

associated with no return to work in the long run in patients with CVT(29%)[30].

Intracerebral hemorrhage and Sub arachnoid hemorrhage

Stroke, both cerebral infarct and hemorrhage is increased in the six weeks after delivery[31]. **ICH is infrequent in pregnancy but has high mortality rate.** An important cause of ICH is hypertension associated with severe preeclampsia, eclampsia, or HELLP[32]. Three-fourths of the cause of ICH due to the vascular anomaly is due to aneurysmal rupture and the rest is due to arterio-venous malformations (AVM)[33]. Cerebral aneurysms rupture typically present with subarachnoid hemorrhage. They present with thunderclap headache, vomiting, seizure or altered consciousness. Rupture occurs during the third trimester and puerperium. Pregnancy and puerperium periods are associated with an increased chance for rupture of AVM[34].

Definitive management for an aneurysm is indicated if identified. A ruptured aneurysm can be tackled by endovascular treatment or surgical clipping. Microsurgical excision is done for ruptured AVM with presurgical embolization[35]. Alternate management is by endovascular embolization with coiling[35]. Surgical management should be done before subsequent pregnancy[36].

Cesarean section or an assisted second stage of labour with forceps or a vacuum extractor is indicated in case of a ruptured, unsecured aneurysm (neurosurgery performed within a week of delivery,) or incompletely treated AVM. Normal vaginal delivery is possible once the vascular malformation is tackled with a definitive procedure.

Posterior reversible encephalopathy syndrome (PRES)

PRES is a clinico-radiological syndrome charact erised by headaches, seizures, encephalopathy, and visual disturbances, with focal reversible vasogenic edema of the brain[37]. Symptoms progress over 12 to 48 hours[38]. Vasogenic edema is seen maximum in the parieto-occipital area followed by frontal, temporal and less frequently in the cerebellum[37]. Radiological evidence of cerebral edema often lags symptoms[39]. PRES results from a variety of causes during pregnancy like preeclampsia, eclampsia, severe hypertension, and RCVS. Management include control of hypertension, antiepileptic medications, control of fluid, electrolytes and sepsis where needed[40-41].

Reversible Cerebral Vasoconstriction Syndrome (RCVS)

The key to the diagnosis of RCVS is thunderclap headache and reversible segmental vasoconstriction of cerebral arteries. The risk factors for RCVS include preeclampsia and autoimmune disorders [42]. RCVS often occur postpartum.[42-44] The cerebral vasoconstriction is maximum two to three weeks after onset of symptoms[43]. The thunderclap headache subsides in 48 hours with the use of nimodipine[43]. The patient is hydrated. MRI and CT angiogram may be normal in the initial few days of disease. Transcranial Doppler may be used to follow the intracranial vasoconstriction [45].

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CHAPTER

13

Respiratory and Viral diseases including Dengue fever

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Editors Note

The ten years covered in this book have seen devastating results of viral infections especially the ones affecting the respiratory system. We started with H1N1 and lost more than 20 mothers in one year. H1N1 has now become endemic. However, we are currently living through the second wave of COVID 19 pandemic. Already nearly 40 mothers have lost their lives. Management strategies are still evolving.

Added to these respiratory viral scourges was the problems with dengue fever. Its vector Aedes mosquitoes, were not seen in our country when we started our career but it is now present everywhere in the state. Fortunately the infection is not as widespread as covid 19. Still 14 mothers were lost and obstetricians have to be alert about this infection.

The common respiratory problems like asthma also are significant causes of morbidity even though mortality is not that high.

V P Paily

Introduction

The world is shaken as never before by the corona virus pandemic. Probably this has become the most serious respiratory illness in the pregnant woman. We begin this chapter with COVID19 infection in pregnant women.

Pregnancy and COVID 19 infection

COVID19 is caused by SARS-CoV-2 strain of corona virus and was first reported from Wuhan City, China towards the end of 2019. WHO declared it as pandemic on 11th March 2020. The common cold; Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS) are the other common corona virus infections. The mutation of SARS-CoV-2 has resulted in development of new strains of which alpha, beta, gamma, and delta variants are of concern. The delta variant is more transmissible and is associated with more severe disease. The transmission of the virus occurs most often through close contact with infected person and rarely from contaminated surface. As per the current data available, acquiring risk of COVID19 is not increased by pregnancy. However, pregnancy can worsen the clinical course of the disease. Those pregnant women who develop pneumonia have increased need for ventilatory support, higher frequency of preterm birth and likely cesarean section, consequent to severe illness in the mother.

Prevention

All pregnant mothers should avoid getting Covid infection by avoiding crowds, maintaining social distancing and by use of masks and hand sanitizers. Women should be advised to continue their routine antenatal care, although it may be modified, unless they meet self-isolation criteria for individuals or households (including social bubbles) with suspected or confirmed COVID-19. Service modifications are required to enable social distancing measures and where possible good ventilation, to reduce the risk of transmission between women, staff and other clinic/hospital visitors, and to provide care to women who are self-isolating for suspected or confirmed COVID-19 for whom a hospital attendance is essential.

Vaccination

- Vaccination in pregnancy against COVID-19 is strongly recommended and should be offered at the same time as the rest of the population based on age and clinical risk.
- COVID-19 vaccines can be given at any time in pregnancy.
- Pregnant women receiving a COVID-19 vaccine show similar patterns of reporting for common minor adverse effects to non-pregnant people. The rare syndrome of vaccine-induced thrombosis and thrombocytopenia (VITT) has been reported after the Oxford-AstraZeneca and the Janssen vaccines. It is an idiosyncratic reaction not associated with any of the usual venous thromboembolism risk factors. There is no evidence that pregnant or postpartum women are at higher risk of VITT.
- Breastfeeding women can receive a COVID-19 vaccine without having to stop breastfeeding. There is no evidence to suggest that COVID-19 vaccines affect fertility. Women planning a pregnancy or fertility treatment can receive a COVID-19 vaccine and do not need to delay conception.

Categorization of COVID 19 pregnant women

Pregnant patients diagnosed with mild covid19 disease can have home care. Patients with comorbidities or having a moderate to critical disease should be admitted to the hospital. Patients with severe and critical illness should be admitted

in a multidisciplinary critical care. Though all pregnant women with Covid 19 are categorized into category B by ICMR guidelines, a separate set of categories has been formulated specific to pregnancy which would allow better patient treatment plans. A thorough history, especially with regard to covid symptomatology, extensive review of records, and a thorough general and obstetric examination is mandatory before categorizing women into B1, B2 and C.

- **Category B1:** The asymptomatic pregnant woman
- **Category B2**: The pregnant woman with Influenza like illness (ILI), symptoms (fever, cough, rhinitis, sore throat) or diarrhoea or fatigue, or those with co morbidities like hypertension, diabetes, liver disease, renal disease. Categorization should be reassessed every 24-48 hours for Category B1 & B2 based on symptoms and walk test.
- **Category C**: The pregnant woman with either breathlessness, chest pain, drowsiness, or hypotension, haemoptysis, cyanosis [red flag signs]. Severe fatigue, malaise and persistent fever, though not classically red flag signs, usually indicate active disease and it is in these cases that the pro-inflammatory markers need to be looked at closely. One can expect deterioration in this subset. Also, it may be well to understand that the fever in COVID 19 can be prolonged and unrelenting.

Clinical stages of severity

- **Mild**: No breathlessness or hypoxia, RR < 24/ minute, SpO2 > 94% on room air, and otherwise asymptomatic
- **Moderate**: Dyspnoea and or hypoxia, RR 24-29 / minute, SpO2 91-94% on room air, or fever and cough.
- **Severe:** Dyspnoea and/or hypoxia RR > 30 breaths/ minute or SpO2 < 90% on room air or a pulse rate > 125/minute with or without pneumonia.

Management of pregnant patients with Covid 19 infection

Category B1:

- If the pregnancy is less than 34 weeks, home care can be allowed provided they are able to self-isolate and are < 34 weeks of pregnancy. They must preferably procure a pulse oximeter for personal use and must report to the nearest facility if they become symptomatic or find a fall in spO2 < 94%
- They must be taught to do the **walk test** – whereby they walk for 6 minutes or take 40 steps and are told to measure their SpO2 before and after. A fall of > 3 % from baseline is significant and they must report to the health facility.
- Woman with gestational age more than 34 weeks is admitted in CSLTC for proper work up and observation. If stable, she may be discharged to continue care from home with instructions to report if any symptoms of the disease or pain, leaking or bleeding or diminished fetal movements. She is not discharged if close to term.

Category B2:

- She may be cared for in a CSLTC as they will need symptomatic treatment and laboratory investigations. Daily check on vitals including RR and spO2 is a must. Walk test will allow professionals to pick up problems earlier.
- Symptomatic treatment may include paracetamol, anti-tussive, and oseltamivir 75 mg bd x 5days in addition to the routine iron, calcium and folic acid.
- Investigations to be done are CBC, RFT, LFT, RBS, serum electrolytes, ECG, CRP.

- It may be advisable to ask for an Xray chest PA view with lead shielding of the abdomen in all cases having a persistent cough. Additional markers like D dimer, ferritin, CPK are to be sent if symptoms persist.

  MDI/DPI Budesonide 800mcg twice a day can be started if symptoms (fever and/or cough) are persistent beyond 5 days of disease onset. They should be monitored by thrice daily recording of temperature, pulse rate, respiratory rate, SPo2 and Walk test and review of symptoms.

- Once patients have been worked up and are stable with subsidence of symptoms, they can go into home quarantine with the same checks as detailed for others on quarantine.

Category C:

- These patients require multi-disciplinary care and must therefore be admitted in Covid designated hospitals.
- All the investigations mentioned above have to be done. Main stay of treatment in this category includes oxygen administration, steroids, anticoagulants, antibiotics and antivirals
- Steroid trigger: MDI/DPI Budesonide 800mcg twice a day started when the symptoms (fever and/or cough) are persistent beyond 5 days of disease onset.

Parenteral/ oral steroids can be started when:

1. Moderate to severe rise in RR or a fall in SpO2 even without pneumonia
2. 3% desaturation with 6-minute walk test
3. Bronchopneumonia and
4. Marked rise in pro inflammatory markers with symptoms.

For the last two indications, steroids are started as per opinion of the intensivist/pulmonologist. Start with injection dexamethasone 6 mg 12th hourly for 4 doses, followed by Intravenous Methyl prednisolone 0.5-1 mg/kg or 40 mg OD or oral prednisolone 40 mg OD for 10 days or until discharge whichever is earlier. Higher dose of steroids may be needed in severe cases and can be decided by multi-disciplinary team. If lung maturity is not an issue, Injection dexamethasone may be skipped. Monitor sugars while the patient is on steroids and expect a marginal increase in Total count. Methyl Prednisolone does not cross the placenta and hence cannot be a substitute for the dexamethasone that is used to enhance lung maturity.

LMW heparin trigger:

- All admitted patients in category B2 and C in third trimester are to receive prophylactic Enoxaparin at a dose of 40 mg subcutaneously once daily, if between 50-90 kg or 60 mg subcutaneously once daily if between 90-130 kg
- LMWH has to be stopped 12 hours prior to delivery/ C section (24 hours if taking higher doses)
- Higher dose of enoxaparin may be needed in category C severely ill patients and those with very high D dimer values. If the D dimer is very high or shows progressively increasing values, due consideration is to be given to stepping up the dose to 60 mg twice daily provided there is no enhanced risk of bleed.The same may be continued for 10 days in the post-partum period.

Thrombocytopenia may be associated with severe Covid 19 infection. For women with platelet count less than 50,000/mm3, LMWH and aspirin has to be discontinued. Since women tend to be discharged early, and if they can't take the injections at home, low dose aspirin at 150 mg/day at bedtime can be considered a viable option for 2-3 weeks. VTE scoring must be done and duration of thromboprophylaxis to be modified accordingly. Hydration and ambulation are to be ensured. If women are admitted with confirmed COVID 19 infection within 6 weeks postpartum,

thromboprophylaxis should be offered for the duration of hospitalization and continued at least 10 days after discharge. For those with significant comorbidity, duration of thromboprophylaxis may be extended to 6 weeks postpartum

Antibiotics and antiviral drugs policy:

Not many clinical trials are completed and analysed for pregnant women with COVID 19 on this issue till date. Remdisivir (antiviral drug) is recommended and given on compassionate use protocol. Hydroxychloroquine for chloroquine in randomised trials have not shown a benefit.

- Remdisivir is recommended in Category C with bronchopneumonia not responding to steroids and oxygen. Its safety in pregnancy though not yet established, it may be offered on a compassionate basis with written informed consent. It needs to be started within 10 days of onset of symptoms. Recommended dose is 200mg IV on day1 followed by 100 mg daily intravenously for 4 days. RFT and LFT must be normal and it is preferable to do a creatinine clearance.
- Oseltamivir may be offered to Category B2 patients.
- Adding Azithromycin, Inj Ceftriaxone or other higher antibiotics is considered with increasing counts or CRP.
    - Tocilizumab (interleukin-6 receptor antagonist) improve outcomes, including survival, in hospitalized patients with hypoxia and evidence of systemic inflammation (CRP above 75 mg/L). The data on use of tocilizumab in pregnancy is limited, but there is no report of teratogenicity. The decision to start tocilizumab should be taken by multidisciplinary team.
    - Monoclonal antibodies (Casirivimab and Imdevimab) may be considered in pregnant and post-partum high risk patients with COVID-19 and who are vulnerable to severe infection before progressing to hypoxia.
    - Ivermectin and Favipiravir are contraindicated in pregnancy.

Other drugs being tried are lopinavir ritonavir combination,combination of neutralizing monoclonal antibodies (e.g. Bamlanivimab-Etesevimab) .

Timing of delivery:

This should be individualized depending on many factors including the severity of the COVID 19 infection. Timing for intubated patient is challenging and still debated and is decided on an individualised case basis. There is yet no clear evidence of fetal infection by the virus crossing the placental barrier. The general management of labor is not altered in pregnant women with COVID19. Maternal COVID is not an indication to change the route of delivery. Planned induction or cesarean should not be postponed due to maternal COVID infection. On the other hand, COVID infection in the mother is not an indication for cesarean section. The virus has not been detected in vaginal secretions or amniotic fluid. Labour pain can be managed by neuraxial anesthesia which is not contraindicated. It may also be used during cesarean section. But nitrous oxide usage may be suspended.

Postpartum VTE prophylaxis is strongly recommended depending on the risk stratification of the patient. The duration of anticoagulation is debated (till the time of discharge / 10 to 14 days). The virus is not found in the breast milk from small studies, but the data is limited. It is better to avoid direct contact with the child especially during feeding if the mother was severely ill. In many institutions asymptomatic family member/support person can attend labor and delivery if they are tested negative for COVID.

Infant of a known COVID 19 infected mother should be tested and isolated from other healthy infants. As the risk of acquiring COVID infection from the mother is low, mothers with COVID infection need not be separated from the baby. Mother should wear a mask and continue hand

hygiene during her contact with the infant. During other times she should keep 6 feet from the child. Expressed milk can be given as an alternate method till the mother recover from an active disease. After an elapse of 10-20 days (according to the severity of the disease) after the first symptoms, mothers are not considered as a potential risk of virus transmission to the neonates.

Key summary points

- Respiratory diseases are significant causes of maternal deaths
- While interpreting findings, the physiological changes in pregnancy in the respiratory system have to be kept in mind.
- The important causes were H1N1, and Dengue fever
- Early treatment with high dose Oseltamivir (even before virological confirmation) will make a drastic difference in outcome in H1N1 pneumonia.
- Women with bronchial asthma will benefit from pre-pregnancy counseling and getting asthma under proper control before embarking on a pregnancy.

Key recommendations

- Since respiratory diseases in third trimester carry worse prognosis, they should be treated more aggressively, if necessary, by referral to higher centers.
- If there are reasons to suspect H1N1 pneumonia in pregnancies beyond 28 weeks, treatment with oseltamivir at higher doses (150 mg twice daily) should be started without waiting for laboratory confirmation.
- When there is bacterial pneumonia, aggressive antibiotic therapy should be initiated (e.g.piperacillin, tazobactam, meropenem or imipenem).
- When there is no response to adequate higher antibiotics, consider adding antifungals.
- Use of aerosol treatment for severe degrees of asthma is strongly recommended.
- Pulse oximetry, arterial blood gas analysis (ABG) and noninvasive ventilation should be commenced early rather than late in the management of the respiratory disorder.
- Women with respiratory disease like bronchial asthma should get their disease properly controlled before embarking on pregnancy.
- In respiratory disorders when fetal lung maturity is confirmed, accelerating delivery (vaginally or by cesarean section) should be considered to remove the pressure of gravid uterus on diaphragm.

Learning from Examples

Example 1

34-year-old primigravida, married for 1 year, known case of hypothyroidism on thyroxine was detected to have diabetes and hypertension during antenatal checkup. At 26 weeks, she developed fever, cough and breathlessness and was admitted to a private hospital. Patient was found to be hypoxic and auscultation showed bilateral rhonchi and crepitations. She was intubated and after 3 days of mechanical ventilation, her condition did not improve and hence was referred to Government Medical College. She was tested to be H1N1 positive on throat swab and was started on oseltamivir and other higher antibiotics. Although the patient showed signs of improvement, she later developed severe hypotension and had a cardiac arrest. She went in to acute kidney injury and intrauterine fetal demise was also detected at that time. At the time of renal dialysis, she had another cardiac arrest and expired.

Learning points

- H1N1 is associated with high mortality in pregnancy.
- Oseltamivir should have been commenced earlier.
- Timely referral to tertiary care is always indicated.

Example 2

27 year old P1L1, 4 weeks post LSCS was admitted to tertiary care centre when she presented with high grade fever, chills, rigor, cough and breathlessness of 3 days duration. She was a known case of hypothyroidism and had preeclampsia during pregnancy. At admission, she was tachycardic, tachypneic and hypotensive. Wound was healed and uterus was well involuted. On auscultation, bilateral rhonchi and crepitations were noted. A chest X-ray was taken which showed features of ARDS. She was put on assisted ventilation and started Tamiflu, higher antibiotics (Inj. meropenem, tab. azithromycin), Inj. deriphyllin and inj. lasix. She expired on the 7th day after admission.

Learning points

- Oseltamivir should have been commenced earlier.
- Fluid overload should be avoided in preeclampsia.

Example 3

29 year old G2P1L1, previous LSCS was admitted at 36 weeks with history of fever, cough and breathlessness of 5 days duration. She was treated with antibiotics and steroids with no relief of symptoms. Her oxygen saturation dropped on several occasions. On the 4th day of admission, she was referred to tertiary centre. She was admitted to ICU and started Tamiflu but her condition progressively deteriorated. She was ventilated and the next day an emergency cesarean section was done to reduce the stress on the lungs and improve ventilation. A 2.01 kg live baby was delivered in good condition. Postoperative ventilation continued with supportive measures. Her condition deteriorated and she expired on the second postoperative day.

Learning points

- It is recommended to start tab. oseltamivir 150 mg twice daily to all pregnant women when they present with persistent fever, cough and breathlessness.
- Here oseltamivir was started only after 5 days of worsening of symptoms.
- Drop in oxygen saturation was not given due attention.

Example 4

34 year old G5P2 admitted at 32 weeks and 2 days of gestation in the Medical department of MCH with productive cough and loss of weight for 5 months. She complained of breathlessness and had altered behavior for 3 days. No diabetes or hypertension was detected. On admission, she was pale, tachycardic, tachypneic, cyanosed and with bilateral chest signs. Abdominal examination revealed 32weeks size gravid uterus and hepatomegaly. She was investigated for TB and Mantoux was found to be positive. An empirical diagnosis of interstitial lung disease / miliary TB was made and started on anti TB drugs. After 4 days of admission, her condition deteriorated and was ventilated. The next day, she got into spontaneous labor and delivered an asphyxiated male baby of birth weight 1.36kg. After delivery, she developed severe thrombocytopenia and Platelet Rich Plasma (PRP) was given. On the second postnatal day, she had a cardiac arrest and expired.

Learning points

- With respiratory symptoms persisting for more than a month, the patient was not evaluated properly.
- No case sheets available to know the details as to whether X-ray chest was taken, or HIV screening done.

Overview

Physiological changes

Pregnancy induces profound changes in the mother resulting in significant alterations in anatomical and functional changes in the respiratory system. Management of respiratory diseases in pregnancy requires an understanding of these changes. Awareness of these changes is also necessary for interpreting clinical and laboratory manifestations of the disease states. Some of these important alterations in the respiratory system anatomy and physiology during pregnancy are discussed below.

As general information the blood volume increases and reaches a maximum of 40 to 50% above the base line non-pregnant blood volume. The cardiac output (CO) increases to a peak at 20-32 weeks of gestation which is 30-50% above the base line.

1. Hormonal changes in pregnancy produce hyperemia, mucosal edema, hypersecretion, mucosal friability, capillary congestion, tissue edema and hypertrophy of mucous glands of upper respiratory tract and airway.
2. Enlarging uterus displaces the diaphragm cephalad by 4cm, increasing antero-posterior and transverse diameter of thorax and chest wall circumferences. The chest wall diameter increases by 2 cm. There is no decrease in the excursion of the diaphragm (it increases by 2 cm).
3. There is a progressive decrease in functional residual capacity (10-20% by term), mild decrease in residual volume, expiratory reserve volume and total lung capacity. Airway function and lung compliance are not affected.
4. The most important respiratory change is an increase in minute ventilation and alveolar ventilation (by increasing the tidal volume by 30-35%) due to increased production of metabolic carbon dioxide and increased respiratory drive due to high serum progesterone level. Tidal volume increases by 30-35% and the respiratory rate remains relatively constant.
5. Pregnancy results in a compensated respiratory alkalosis (pH 7.4-7.45), decrease in PCO2 (27-32), higher PO2 than non-pregnant state. Respiratory alkalosis seen in pregnancy is due to physiologic hyperventilation. The lower CO2 provides a diffusion gradient which may facilitate the fetus' ability to eliminate waste from aerobic metabolism. Mild hypoxemia occurs in supine position. The oxygen consumption increases by about 20-33% near term. The PaO2 is increased to 106 to 108% in the first trimester and 101 to 104 % in the third. Respiratory alkalosis becomes marked in active labor due to hyperventilation and tachypnea caused by pain and anxiety. This may affect fetal oxygenation by reducing uterine blood flow. In some, severe pain and anxiety lead to shallow breathing with alveolar hypoventilation, atelectasis and mild hypoxemia.

In pregnancy, there is a physiologic dyspnea without any underlying causes like bronchial asthma. This happens in two thirds of the pregnant women. This can be differentiated from a pathological dyspnea by the following features.

1. The physiologic dyspnea is usually slow in its onset.
2. Physiologic dyspnea is not associated with cough.
3. Auscultatory findings like crepitations and rhonchi are not heard in physiologic dyspnea.

It is to be remembered that most of the upper respiratory tract infections occurring in pregnancy are caused by viruses (90%). Antibiotic use is usually not recommended which can lead to antibiotic resistance and other similar problems. Simple measures like heated humidified air, paracetamol and nasal spray (steroid/ipratropium) are enough.

Among antibiotics clarithromycin, doxycycline and fluoroquinolones should be avoided.

Observations on the respiratory causes of maternal mortality

As per the statistics, respiratory diseases were responsible for 8.7% of the maternal mortality during the years 2010 to 2020 (10 years).

There were a total of 94 deaths due to respiratory and viral diseases among the 1076 cases reported to CRMD.

Table 1. Deaths due to respiratory and viral diseases over the 10 year period

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	**Total**
Total deaths	113	85	101	112	117	106	80	138	122	102	**1076**
Respiratory causes	21	3	3	9	7	17	5	19	4	6	**95**

Table 2 Stages of pregnancy when deaths occurred

<24 weeks	>24 weeks	postpartum
21	64	10

Table 3 Agewise distribution

Age group	Number of deaths
<19 yrs	6
20-30 yrs	62
30-40 yrs	27

Table 4. Gravidity

G1	G2	G3	
41	27	27	

Table 5 Time interval between admission and death

Time	0-6 hours	6-24 hours	1-5 days	6-10 days	11-15 days	Unknown
No. of patients	4	8	27	30	19	7

Most of the deaths occurred within 10 days of admission to a hospital

Table 6. The important respiratory diseases	
H1N1 and pneumonia	73
Dengue	14
Varicella	2
Interstitial lung disease	2
Tuberculosis	3
Retropharyngeal abscess	1

Table 7 Associated co-morbidities included:	
Bronchial asthma	7
Gestational diabetes	8
Hypertensive disorders	9
Hypothyroidism	3

Table 8 ventilated patients	
Ventilated	60
Number of referred cases - 49	

No. of patients who received antiviral and time of starting antiviral :

Majority of the cases received antiviral treatment, but only after an interval of three to five days. This was due to the delay in either reporting to the hospital or referring to a tertiary care centre.

Important lessons to be learnt from these data and observations

As most of the deaths occurred in the third trimester, pregnant women with any active disease in the third trimester should be referred early to a tertiary care centre for better care. The disease which manifests or continues in the third trimester should be more carefully managed.

Suggestions

Pneumonia and H1N1 infection were the chief respiratory diseases responsible for the maternal mortality in the period studied. In retrospect, we feel that at least some of these cases would have been saved by starting antiviral drugs even before getting a positive result. It is a definite indication to start oseltamivir for patients diagnosed to have features suggestive of viral pneumonia (normal white cell count, C Reactive Protein and Procalcitonin). It is also very clear that lives can be saved if this drug is started early in a higher dose of 150 mg twice daily.

Patients with **bacterial pneumonia** should be treated with aggressive antibiotic therapy if the clinical condition worsens. Many of the deaths would have been prevented if higher antibiotics (e.g. Piperacillin tazobactam combination, meropenem or imipenem) were used at the correct time. If sepsis is continuing despite starting higher antibiotics for adequate number of days, antifungal medicines should be added. Initially Fluconazole should be tried but if patient can afford higher and newer antifungal drugs (echinocandins like caspofungin and micafungin), they can be used (but only in the second and third trimesters).

Another important disease related to maternal mortality was **bronchial asthma**. Currently the mainstay of management is aerosol treatment. Drugs like deriphyllin and aminophylline are not usually used. The drugs of choice include levo salbutamol or fluticasone/Budesonide. These drugs should be given by frequent nebulization especially when the patient is having acute severe asthma.

Pulse oximetry and ABG (arterial blood gas) should be made more frequently available. There should be more use of NIV (noninvasive ventilation) so that mechanical ventilation can be avoided or postponed.

Most of the patients who died due to respiratory diseases were ventilated. ABG testing could not be done frequently in most patients.

Ventilator setting and management should be by an expert to yield optimum results.

Early referral to a higher centre and early intervention by termination of pregnancy by a cesarean section should be emphasized.

Pre-pregnancy counseling of patients with chronic respiratory illness is very important. Such patients should plan pregnancy once their respiratory condition is properly assessed and managed by a respiratory Physician.

One should be considering COVID 19 infection in every pregnant woman who comes with symptoms of influenza. Severity should be assessed as usual and categorized into A, B or C. They should be referred to COVID treating hospitals if they are in the category C.

Conclusions

Respiratory causes contribute significantly to maternal mortality. As viral pneumonia (H1N1) is more dangerous in the third trimester, aggressive approach to control the infection and provide respiratory support results in better outcome. This problem has taken a twist with the arrival of the currently raging pandemic- COVID 19 infection and one should be very careful and alert regarding this. Those with preexisting conditions like bronchial asthma should seek expert advice before planning pregnancy. In the third trimester (after 28weeks), when respiratory function is compromised, termination of pregnancy should be considered as it will improve respiratory function.

While concluding this chapter, we are now in the second wave of Covid 19 infection in Kerala. As opposed to the first wave, we have now seen nearly 38 maternal deaths due to covid pneumonia and 2 maternal deaths due to covid associated cytokine storm and pulmonary embolism. There have been about 25 near miss events due to covid infection in pregnancy although many are still under reported.

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Dengue in Pregnancy :
Symptoms, Diagnosis and Management

T R Radha

Dengue virus is classified under the genus Flavi virus. There are 4 dengue serotypes designated as DENV 1 to DENV 4. These serotypes may be in circulation in any area singly or in combination at the same time. Immunity to one serotype does not protect from infection by another.

Dengue virus vectors are female Aedes mosquitoes. In India Aedes aegypti is the major vector in many urban areas, A.albopictus also is seen in many states.

Pathophysiology of dengue

1. Antibody dependant enhancement (ADE)
2. Cytokine storm
3. Vasculopathy
4. Coagulopathy

As a result of infection, 2 types of antibodies are produced : Neutralising and non neutralising. The neutralising antibodies can protect against a specific serotype of the illness. The non- neutralising antibodies bind to the virus without neutralising. After the formation of the virus- antibody complex, viral entry into the host cell is enhanced, specifically the dendritic cells and macrophages. Once inside the cell, the virus replicats and generates higher viral titres in the blood. This phenomenon is called **ANTIBODY DEPENDANT ENHANCEMENT (ADE)** of infection. Dengue virus specific CD4+ and CD8 + T cells lyse the dengue infected cells, and produce cytokines such as IFN gamma, TNF alpha, and lymphotoxin all of which results in a **cytokine storm** and ultimately results in a more severe disease. IFN gamma also enhances the expression of immunoglobulin receptors, which augments the antibody dependant enhancement of infection.

Clinical features of dengue

Probable dengue fever : a case compatible with clinical description of dengue fever during the outbreak and NON ELISA based NS1 or Ig M positive .

Confirmed dengue fever : a case compatible with clinical description of dengue fever with at least one of the following :

- Demonstration of dengue virus antigen in the serum sample by NS1 ELISA
- Demonstration of IgM antibody titre by ELISA in the single serum sample.
- IgG seroconversion in paired sera after 2 weeks with a four fold rise of IgG titer
- Detection of viral nucleic acid by PCR
- Isolation of virus (culture positive) from serum, plasma or leucocytes.

The clinical course passes through 3 phases :

- Febrile phase
- Critical phase
- Convalescent phase

Febrile phase :

The onset is with a sudden rise in temperature , which may be biphasic , lasting 2-7 days,

commonly associated with headache, flushing , retro-orbital pain and / or rash , myalgia.

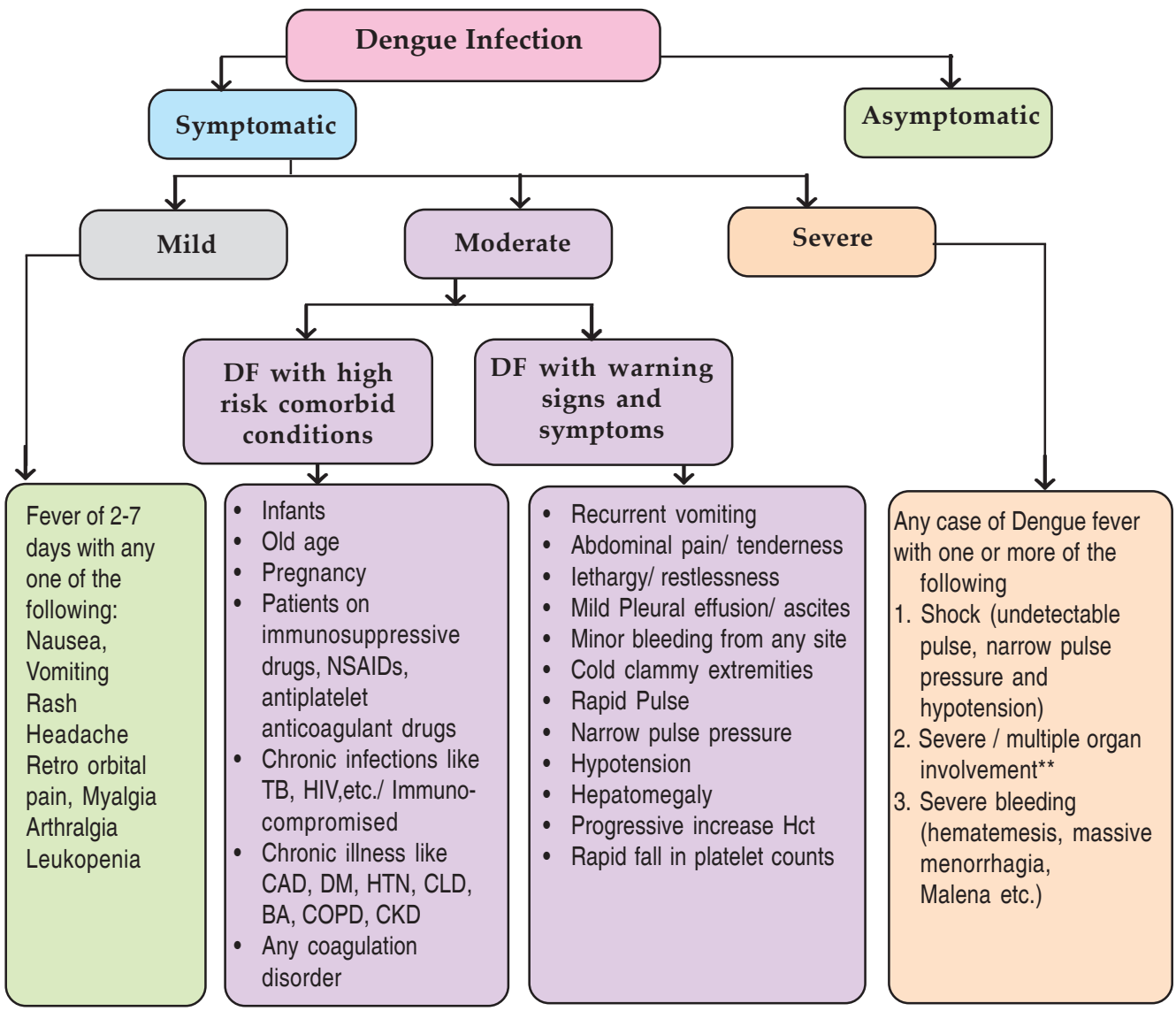
Critical phase (leakage phase)

After 3 to 4 days of onset of the fever, plasma leakage and hemoconcentration occurs, and patients may develop hypotension. Abnormal hemostasis and plasma leakage lead to bleeding, hypotension and fluid leakage into pleural, pericardial and peritoneal cavities. High morbidity and mortality is seen in patients with multiorgan dysfunction or severe metabolic derangements. The period of plasma leakage usually lasts 36- 48 hours.

Convalescent phase (recovery phase)

During this phase , the extracellular fluid which was lost due to capillary leakage, returns to the circulatory system and the signs and symptoms of the patient improve. This usually starts after 6 to 7 days of fever, and lasts 2-3 days. The patient may develop pulmonary edema due to fluid overload in this phase especially if the fluid replacement is not reviewed and revised periodically.

Fig. 1 : symptom chart



Pregnancy and dengue

The occurrence of dengue hemorrhagic fever (DHF) is more in pregnant women with dengue infection and it is more severe.

Dengue fever in 3rd trimester will increase the risk of fetal compromise.

Overlapping clinical / biochemical parameters may lead to misdiagnosis or delayed diagnosis especially with conditions specific to pregnancy, eg: HELLP syndrome, pneumonia, pulmonary embolism, obstetric causes of per vaginal bleeding and other infectious diseases.

Dengue fever has no plasma leakage.

DHF (dengue hemorrhagic fever) has plasma leakage, which is selective, transient, and self limiting usually lasting 24- 48 hours.

Warning features of significant capillary leakage in DHF

Clinical deterioration after fever settles

Severe abdominal pain

Excessive vomiting

Bleeding tendencies

Impaired consciousness or behavioural abnormalities

Cold clammy extremities

Prolonged capillary refill time > 2 secs

No urine output for 4-6 hours

Features of fluid leakage

Narrowing of pulse pressure with elevated diastolic pressure

Tachycardia with low volume pulse

Tender hepatomegaly

Reduced urine output

Hematocrit rise of 10-15 % over the baseline value obtained in the initial phase of fever

Platelet < 1.3 lakhs or rapid drop in PLC

Prolonged capillary refill time > 2 secs

Postural hypotension

USG evidence of fluid leak into pleural/ pericardial/ peritoneal cavities.

Dengue shock syndrome (DSS)

DSS will have the criteria for DHF mentioned above + evidence of circulatory failure (hypovolemic shock)

- Rapid, thready pulse with delayed capillary refilling, cold and clammy skin
- Narrowing of pulse pressure to 25 mm Hg
- Rising Hct > 30 % ; thrombocytopenia
- Systolic BP < 80 with postural dizziness

Special situations in pregnancy.

Resting heart rate >100 without fever warrants further evaluation

Pulse pressure dropping from 30 to 25 is strongly suggestive of impending circulatory collapse.

Postural hypotension due to capillary leak may be misinterpreted as supine hypotension syndrome.

Resp rate > 25 is abnormal.

In a pregnant dengue patient, acidosis persisting after fluid resuscitation warrants early correction. Presence of ph < 7.35 with HCO3 < 15 denotes prolonged shock, likely to develop MODS.

In pregnancy, intense thirst may not appear and urine output may be maintained in spite of intravascular volume depletion. Therefore, UOP may not be a reliable marker of volume status.

Management of dengue in pregnancy

Management is the same as in any other patient.

Frequent monitoring is mandatory.

It is better to admit all pregnant patients with dengue to hospital for close monitoring.

DF without warning signs : (category A patients)

- Monitor temperature, pulse, BP , Pulse pressure 4 hrly
- Urine output 4- 6 hourly (100 ml 4 hrly to be maintained)
- Capillary refill time
- Intake output chart
- Daily CBC including PCV ; other investigations as necessary.

Treatment :

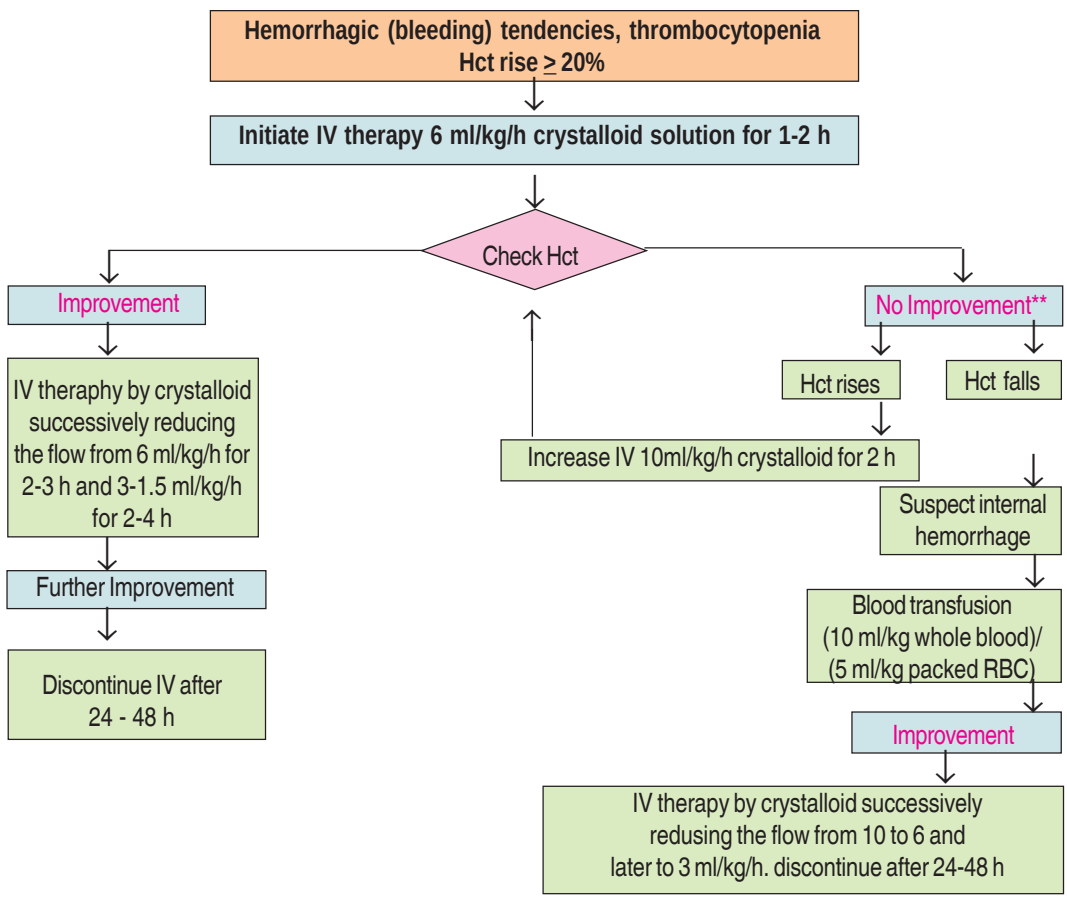
Paracetamol as necessary (avoid NSAID ; also aspirin if patient is on)

Fluid intake 2500 ml/ day

DF with warning signs : (category B patients)

- Monitor vitals hourly
- Catheterise to quantitate urine output (at least 0.5 ml/kg/ hr)
- Fluid resuscitation : normal Saline 5-10 ml / kg/ hr for 2 hours
- Followed by 3-5 ml/ kg/ hr as maintanence.
- **Avoid surgery / induction in this phase**

Fig. 2 : Management DF with warning signs :



Dengue with shock on admission (category C)

These patients need ICU care.

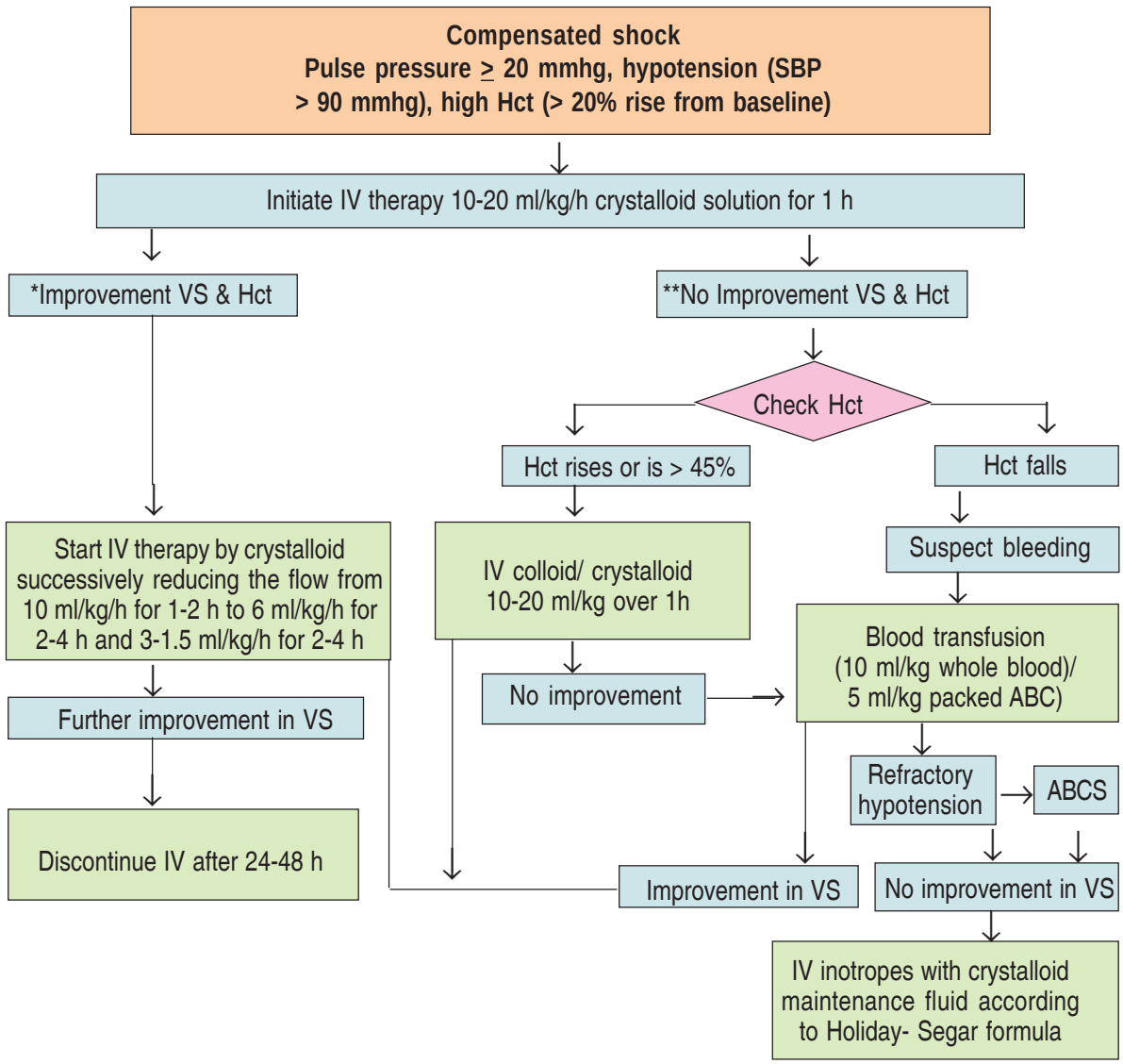
Base line CBC, Liver function , electrolytes, Renal function, blood sugar to be checked.

Fluid resuscitation 10ml/kg to be given over 15 minutes : first bolus

Followed by 10ml/kg over next one hour : second bolus

Further monitoring as per chart attached.

Fig. 3 : Fluid management of shock



Convalescent phase

- Rise of WBC count followed by rise in platelet count
- Stabilisation of HCt marks the convalescent phase
- Watch for signs of fluid overload : cough/ wheeze/ tachypnoea
- Rise of both Systolic and diastolic BP

Discharge from the hospital

- Afebrile for 24 hrs without antipyretics
- Improved appetite
- Normal Hct at baseline
- Rising WBC , platelets to normal levels

Table: 1 Comparison between HELLP and DHF

	Clinical features diagnosis	Hematological findings	Biochemical findings	Management
HELLP Syndrome	Evidence of preeclampsia Hemolysis Elevated liver enzymes Low platelets	Microangiopathic hemolytic anemia Thrombocytopenia	AST / ALT > 70 IU/L LDH > 600 U/L	Termination of pregnancy
DHF	Fever Bleeding tendency Thrombocytopenia Evidence of plasma leakage by USG	Leukopenia Severe thrombocytopenia Rise in HCt	Complicated cases, AST elevated more than ALT ; often rapid rise noted	***Delay delivery till end of critical phase***

Points to note specially :

1. No NSAID for fever. Only paracetamol to be given.
2. NS preferred for initial resuscitation over RL or DNS. 5% dextrose should not be given.
3. Colloids to be given only after the 2 initial bolus NS prove ineffective.
4. Low transfusion trigger in dengue, if blood loss = 500 ml.
5. Drop in HCT without clinical improvement despite fluid resuscitation requires blood transfusion.
6. Prophylactic platelet transfusion not recommended , unless delivery is impending within 6 hours. For normal delivery, count 50,000 and operative delivery 75,000.
7. Low platelet in critical / recovery phase does not warrant platelet transfusion if patient is clinically stable.
8. Platelet < 10,000 with overt bleed may be given platelet transfusions.
9. **No role for STEROIDS/ IV immunoglobulin / prophylactic antibiotics.**
10. Operative delivery only for obstetric indications.
11. ***Avoid planned induction / surgery.***

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CHAPTER

14

Liver Diseases

N Viswanath

Editors' Note :

Liver related problems contributed to a significant number of maternal deaths in Kerala. They were due to mainly two conditions - AFLP (26) and HELLP syndrome (40) out of a total of 1076 deaths in the period of ten years from 2010. Rather than being primarily Liver disease (eg: viral hepatitis) these two conditions are the result of changes unique to pregnancy.

The one thing common to these two conditions is that early diagnosis and prompt delivery will help to arrest further deterioration in the majority of cases. Symptoms of epigastric discomfort, tiredness, vomiting and probably a tinge of jaundice in the third trimester should alert the obstetrician to the possibility of AFLP. Similarly regular check of blood pressure at every antenatal visit and looking for proteinuria during every visit beyond 34 weeks(recommended in the quality standards in obstetric care of KFOG) may help to pick up the HELLP syndrome before it deteriorates to extensive multiorgan damage and maternal death. We would like to repeat the statement by the author of this chapter(N Viswanathan) in the first edition of Why Mothers Die, Kerala

"Early diagnosis is the key. Liver cell failure, massive bleeding and multiorgan failure are the major causes of death among patients with liver disease. The mortality has come down in the West in the last decade or two due to early diagnosis and proper, expeditious management". These words are still relevant to us obstetricians today. We have to follow the path of early diagnosis and prompt expeditious management.

V P Paily

Key Summary points

1. Liver disease is a significant cause of maternal death in Kerala.
2. During the decade 2010-20, there were 41 deaths attributed to liver disease of which 26 were due to AFLP.
3. Hepatic derangements as a result of hypertension complicating pregnancy (eg:HELLP) and viral hepatitis are the other two liver related causes of maternal death.

Key Recommendations

1. All pregnant women should have their blood pressure checked and other investigations done as recommended in the chapter on hypertensive disorders in pregnancy.
2. Close monitoring of patients with pregnancy induced hypertension is essential.
3. Upper abdominal pain, sudden change in clinical status (tiredness, vomiting and apathy) should prompt checking of transaminases, platelets, and renal function. If transaminases are raised check prothrombin time. Repeat this before any intervention such as induction or cesarean section, as changes may occur in a matter of few hours.
4. Any abnormality in the above tests has to be taken as an emergency and senior obstetrician should see the patient promptly. Decision on referral to a higher centre or calling in other specialists should be taken without delay.
5. Referral should be with all the information, so as to avoid delay in the new hospital.
6. A team approach to management of critically ill pregnant mothers is necessary. Telephonic requests for consultations, telephonic discussions after consultation and daily (or more frequent) joint stock-taking could all bring down delays and reduce misunderstanding of instructions. A collective approach to a difficult clinical problem will be more rewarding than "passing the parcel" tradition.
7. Frank honest discussions with the close members of the family and timely clear explanations in lay terms and unambiguous prognostication would reduce anxiety of the family and strain on the caregiver.
8. Requirements for blood and blood components should be anticipated and blood bank should be alerted. If donor assistance is needed from family, they should be motivated and alerted in time.

Summary of findings during the period

Table 1 Types of liver deseases

	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
AFLP	1	1	4	3	3	2	1	3	4	4
Hepatitis A								1	1	
Hepatitis B		1								
Hepatitis E			1						1	
Polycystic liver		1								
Chronic liver disease							1			1
Cirrhosis					1					
Portal vein hypertension				1						1
Extrahepatic portal vein obstruction									2	
Portal vein thrombosis									1	
Probably viral					1					

AFLP was the major reason for hepatic failure and death in this decade (see table). There were 26 cases out of 41 in this group. Very often hypertensive disorders complicating pregnancy affect hepatic function (HELLP) (dealt with in the chapter on hypertension.) Though rare, the different viral infections also contribute to maternal deaths. There were two cases of hepatitis A, two cases of hepatitis E and one case of hepatitis B. Compared to the national average, incidence of hepatitis B is low.

Learning from Examples

(Cases 1 to 5 discussed in this chapter are from the personal collection of the author and 6&7 are from CRMD.)

Example 1 *: 27 years lady at 32 weeks of gestation presenting with alteration of sensorium since 8 hours.*

She had an uneventful pregnancy till 31 weeks. The illness started with tiredness, nausea and occasional vomiting. She felt mildly feverish with body ache four days earlier. Since the preceding eight hours she was found drowsy and responding poorly to stimulus. She has mild icterus and one echymosis at the venepuncture site. Liver is 1 cm palpable. Fetal heart is normal. Hb is 9.4 g%, TC 8600 N74 L23 M 1 E2, platelets 160000 , Bilirubin 2.9 mg, conjugated 1.4 mg, SGPT (ALT) 400 IU, SGOT (AST)520 IU, Prothrombin time 22 seconds to a control of 13 seconds.

This pregnant lady has presented with what looks like acute liver failure (fulminant liver failure). This is defined as rapid development of hepatocellular dysfunction particularly coagulopathy and encephalopathy in a person without hepatic disease. The condition has differing names and different time frame of evolution according to many authorities. I shall avoid that).This is an emergency with very grim outlook for mother and unborn child.

The common causes of acute liver failure in Kerala would include AFLP, HELLP syndrome, viral hepatitis (A or B) and rarely leptospirosis, dengue or very rarely severe sepsis. If there is history of toxic drug intake, that also comes as a differential diagnosis. Western data indicates that the common causes would include AFLP, toxic liver failure, viral or vascular causes very infrequently. In northern India, Pakistan and Bangladesh (Indo Gangetic planes) Hepatitis E infection has been found to be the commonest cause of such a presentation (50-80% in different studies). Hepatits B and A also may cause it. Causes peculiar to pregnancy such as AFLP and HELLP can cause it, but represent a smaller slice of the pie. Vascular causes like acute Budd Chiari syndrome too are seen sporadically. Rarely one can get surprised by a cerebral malaria (falciparum) in pregnancy, however the prothrombin time is generally normal (not a true fulminant liver failure) and features of malaria would be noted if looked for.

Careful systematic evaluation would help in identifying those where expeditious termination of pregnancy can be lifesaving. (Termination may not be helpful and could cause harm in some too). Consider the wider differential diagnosis and get early help from concerned specialists (Internists, Infectious disease specialists, Gastroenterologists and so on). As mentioned earlier, differential diagnosis would vary according to the region and socioeconomic strata. Good, co-ordinated care is suggested.

Example 2 *: 19 year old with twin pregnancy with vomiting, hypoglycaemia and abnormal Liver Function Test (LFT)*

A 19 year old primigravida with twin pregnancy is at thirty weeks of gestation. She had not been on regular antenatal care (ANC) and presented with upper abdominal pain (5 days), nausea with infrequent vomiting. She presented with extreme tiredness and sweating and her random blood sugure GRBS was 36 mg%. She improved

with parenteral glucose. She was rather dehydrated with a suggestion of mild icterus. Her BP was 140/80 mm of Hg. She had a one centimetre liver in spite of the large uterus, but spleen was not palpable. Her SGPT (ALT) was 220 IU, SGOT(AST), 240 IU, Uric acid 9.0 mg%, prothrombin time 20 seconds to a control of 13 seconds and platelets 150,000/ mm3. Ultrasonogram (USG) of upper abdomen showed hyperechoic hepatomegaly. Viral markers are awaited.

Though viral or toxic hepatitis could present like this, the clinical clues (twin pregnancy, sudden onset pain and vomiting, hypoglycaemia, palpable liver, abnormal Liver function test (LFT) with prolonged prothrombin time, raised uric acid) would suggest that **AFLP be kept as the first possibility**. Termination of pregnancy should be expedited taking full precautions preferably after confirmation of negative viral markers.

Example 3 : ***An expectant mother with hypertension developing rising transaminases***

A 23 year old primigravida now at 32 weeks of gestation has been on regular antenatal care. She has been noted to have hypertension four weeks earlier and is stable on Alpha methyldopa. She now comes with rising blood pressure, tiredness and nausea of 2-3 days duration. Her BP is 150/95mm of Hg. She has mild ankle edema. She complains of lethargy and of feeling nauseous. Urine showed 1+ proteinuria. Her SGPT is 132 IU and SGOT is 100 IU. Blood counts including platelets, peripheral smear and Ultrasound of upper abdomen are normal. Viral markers are negative.

The possibilities at this time includes worsening preeclampsia, methyldopa toxicity, hepatitis due to non-classic (Non A-E) hepatitis and early AFLP or HELLP syndrome. Being preterm, an approach could be to replace methyldopa with labetalol, bed rest and administer corticosteroids for readying the fetal lung. She is carefully watched. If she improves clinically and biochemically, the plan is follow up.

However over the next 24-36 hours, the blood pressure continues to remain high and she complains of headache. The transaminases are rising, platelets have dropped to 80000/mm^3 and peripheral smear is now showing early dysmorphic changes in RBCs. The worsening while under close observation and evolving changes in blood suggest **HELLP syndrome** with severe preeclampsia and warrants prompt delivery.

Example 4 : ***28 year old G2 with fever, body ache and vomiting at 12 weeks***

28 year old second gravida in 12th week of gestation, presented with anorexia, nausea and vomiting since two days. Six days earlier, she had a febrile illness and body ache with no respiratory catarrh, which lasted for just over two days. There was no history of recent travel. Two persons in the neighbourhood are now icteric and found to have viral hepatitis. Examination showed a mildly dehydrted person with yellow sclerae and one centimetre hepatomegaly.

Investigations showed mild leukopaenia, normal platelets, SGPT (ALT) of 3800 IU and SGOT (AST) of 4200 IU, Bilirubin4.8 mg% with conjugated fraction of 2.8 mg%. Prothrombin time was normal. Hepatitis A virus antibody IgM was positive.

This person has **typical viral hepatitis A**. Treatment has to be only supportive with nutrition, vitamins and careful follow-up. Hepatitis A (and also B, C and probably D) infection does not significantly affect the maternal or fetal outcome. Pregnancy does not alter the outcome of hepatitis either. However the presentation often may not be so clearcut, for example, if it presents nearer term with failing liver (prolonged prothrombin time) and lower platelets, differential diagnosis can be

difficult. The main worry is that for conditions like AFLP or HELLP syndrome treatment is termination of pregnancy whereas in all incidental causes of hepatic dysfunction, including even Hepatitis E with hepatic encephalopathy, interventions can be disastrous and need to be avoided.

Example 5 ***: A near term mother with distressing pruritus.***

A 35 weeks pregnant mother (G2,P0) presents with intractable itching since 7- 10 days particularly of the palms and soles. She has been unable to sleep since a week as it is worse at night. She has no vomiting, fever, chills or pain abdomen. She has had pruritus in her earlier pregnancy which was otherwise unremarkable, except for a fresh stillbirth at 39 weeks. She has no past history of liver disease. No history of surgery or blood transfusions or intake of drugs other than those given from ANC. Physical examination shows multiple excoriations in skin, shiny nails, doubtful icterus and no organomegaly in the abdomen; uterus was term sized.

Laboratory evaluation shows bilirubin of 3.4 mg% with conjugated of 2.2 mg, SGPT (ALT) 180 IU, SGOT (AST)270 IU, Alkaline phosphatase 410U (normal nonpregnant persons 30-139 iu) Gamma Glutamyl Trans Peptidase(GGTP) is normal. Viral markers are negative and prothrombin time is normal. Ultrasound abdomen showed a normal liver, biliary tree and pancreas. Bile acid level is useful but not available easily in Kerala.

The clinical presentation is highly suggestive of **Idiopathic cholestatsis of pregnancy**. The serology, absence of prodrome and the relatively low transaminases exclude a viral etiology. The history makes drug induced cholestasis unlikely. The normal right upper quadrant ultra- sound and normal GGTP makes biliary tract disease highly unlikely. Normal GGTP excludes autoimmune primary biliary cholangitis as well. (Antimitochondrial antibody (AMA) if tested would have been negative). The history of itching in the earlier pregnancy supports the diagnosis, as ICP tends to recur. The loss of earlier child warns the present caregiver to take extra care. Close monitoring of fetus, serum bile acid levels (where available) and timely intervention will be useful. The risk of fetal loss increases with rising Total Serum Bile Acid (TSBA) values especially when it exceeds 100micromols/L. Ursodeoxy-cholic acid (UDCA) 9-12 mg/ Kg /day in divided doses may help. In patients with longer history of cholestasis, prothrombin time may need watching. Termination of pregnancy may be considered by 36 weeks or after fetal lung maturity is confirmed.

Example 6 :

This 26 year old multiparous lady had her antenatal care at local hospital. At 37 weeks she was admitted there for lethargy and vomiting. Her BP was 150/100, and serum bilirubin 5mg%. She was referred to a higher centre suspecting abruptio placentae. Her BP was 150/100, had flapping tremors and kernicterus. Uterus was tense and tender. Fetal heart sounds were not audible. Vaginal examination findings - cervix 25% effaced, one finger loose. ARM was done straight away and investigation results were awaited. Platelet count was 60,000/cmm, bilirubin 19.1mg%, ALP 3340, LDH 2150.

Immediately, cesarian section was done. Prophylactically bilateral uterine artery ligation was done. Abdomen was closed with a drain.

She had to be on ventilator, developed renal failure. She was seen by nephrologist who initiated hemodialysis. In spite of all resuscitative measures she expired 4 days later.

We do not know for how long the presenting symptoms of lethargy and vomiting were present. By the time she reached the higher centre the

findings were clear to raise the suspicion of abruptio placentae or AFLP – both of these require prompt delivery. The fact that she progressively deteriorated is a sign of severity of the condition.

Any woman in the third trimester complaining of lethargy and epigastric discomfort with vomiting should raise the possibility of AFLP. Treatment is prompt delivery.

Example 7 :

This 32year old $G_3P_1L_1A_1$ with a history of previous cesarean delivery 71/2 years earlier, presented to local hospital at 37 weeks of gestation with vomiting, generalised itching and yellowish discolouration of urine for two days. She was detected to have hypertension and was treated with labetalol. Serum bilirubin was 13.7mg%. Liver function tests were grossly deranged. She was referred to a higher centre where a diagnosis of Acute Fatty Liver of Pregnancy was made. By then she had signs of Disseminated Intravascular Coagulation. Along with giving blood and components, an emergency cesarean section was done. She was put on ventilatory support. She developed metabolic acidosis and acute kidney injury. Hemodialysis was initiated. On 4th postoperative day she showed signs of hepatic encephalopathy. Coagulopathy worsened. On day eight she developed seizures. Cardiac arrest occurred on day nine and could not be resuscitated.

This case shows the sad plight of patients with AFLP. In spite of early intervention she could not be saved. Whether she had any warning signs and symptoms prior to reporting to the first hospital is not known. This case shows the sequential changes that occur in various systems as the disease progresses.

Early diagnosis and termination of pregnancy seems to be the only practical approach. Liver transplant is suggested in western literature but we know how difficult it will be in our setting.

Overview of Liver diseases as a cause of maternal death

Classically liver diseases in pregnancy are grouped under the following headings.

1. Liver diseases unique to pregnancy
   - Intrahepatic cholestatis of pregnancy (ICP)
   - Hemolysis, elevated liver enzymes, low platelets (HELLP)
   - Acute Fatty Liver of Pregnancy(AFLP)
   - Hyperemesis Gravidarum (HG) with liver changes
2. Liver changes occurring during pregnancy – 2 sub groups
   a) Not influenced by pregnancy
      Viral hepatitis A-D
      Drug induced hepatitis
   b) Influenced by pregnancy

Hepatitis E	HEV infection
Herpes Simplex	HSV infection
Budd Chiari Syndrome	Cholelithiasis

3. Persons with pre- existing hepatic disease becoming pregnant.

The first and second subgroups may come insidiously or present with common symptoms such as epigastric distress, nausea, vomiting or abnormalities in investigations. These need objective and logical clinical evaluation, careful targeted investigation, follow-up to arrive at the correct diagnosis and expeditious treatment where indicated. Even many persons who may get grouped under the third heading may present for the first time during pregnancy and need to be differentiated by careful, intelligent evaluation and reassessment later in nonpregnant state. All these

patients may present with similar symptoms. Importance of logical thoughtful analysis of history, clinical data and investigations cannot be overstressed.

History; Crucial Aspects

Onset of symptoms in which phase of gestation as clue to probable diagnosis;

First trimester;

- Hyperemesis Gravidarum (HG).

Late second or third

- preeclampsia
- HELLP syndrome (Haemolysis, Elevated Liver enzymes, Low Platelets),
- AFLP (Acute Fatty Liver of Pregnancy),
- ICP (Idiopathic Cholestasis of Pregnancy).

Any time

- Intercurrent causes.

History of similar illness in earlier pregnancy(ies):

HG, preeclampsia, 25% of AFLP, often in ICP, often in HELLP syndrome.

Coexisting preeclamptic toxaemia;

80% of HELLP syndrome, 25% of AFLP

Family history of similar illnesses;

Often in ICP, occasionally in preeclampsia, HELLP syndrome, HG, AFLP.

Seen in chronic HBV/HCV infections, haemolytic disorders, Wilson's disease.

Multiple pregnancy: Often predisposes to AFLP.

HELLP syndrome less frequently.

History of PCOD, hypertension, diabetes (including DM of pregnancy);

Preeclampsia and NAFLD (Non Alcoholic Fatty Liver Disease) more likely in such persons.

Other past illnesses, transfusions;

Renal, hepatic, joint and skin diseases may offer clues to the aetiology. Transfusions may warn of HBV (hepatitis B virus), HCV (hepatitis C virus), other infections.

Findings

1. *Oedema legs:* Should alert to do careful evaluation. If as part of preeclampsia be alert to rule out developing HELLP syndrome
2. *Yellow eyes;* reassess history, examination and laboratory testing.
3. *Shiny nails and scratch marks*; in third trimester ICP. With pain abdomen, common duct stones.
4. *Petechiae and Ecchymosis;* Assess platelets, coagulation status, HELLP syndrome.
5. *Palpable liver especially in later pregnancy;* significant liver disease likely.
6. *Spider angioma, palmar erythema;* these may occur in normal pregnancy too

Syndromic clusters that should alert caregiver

- Uneventful pregnancy thus far (or stable pre eclampsia on treatment) presenting near term (3rd trimester) with not feeling well, nausea, vomiting, reduced appetite, upper abdominal distress and high coloured or reduced volume of urine, lethargy, drowsiness (a few or many of the above). In preeclampsia, it can come even earlier. ***This is a red flag.***
- Severe, persistent vomiting in first trimester with dehydration.
- Distressing pruritus in third trimester in otherwise well expectant mother.
- Mildly symptomatic patient with 2 times SGPT (ALT) or falling platelets

- Asymptomatic patient with abnormal liver chemistry.
- Fever, chills, upper abdominal pain, vomiting high coloured urine.

Acute fatty liver of Pregnancy

Epidemiology

Prevalence 1 in 7000 to 1 in 16000 deliveries.

Usually after 35 weeks, even as early as 26 wks, occasionally immediate postpartum

Risk factors

Primiparity, Multiple gestation, Male fetus

Clinical presentation

Early symptoms –

Nausea and vomiting (70%),
Epigastric or right upper quadrant pain (60-80%)
Malaise, anorexia,
Jaundice may be seen in 1 to 2 weeks

Late symptoms.

Fulminant liver failure,
Encephalopathy,
Renal dysfunction,
Gastrointestinal and uterine bleeding,
Pancreatitis,
Seizures,
Disseminated intravascular coagulation,
Coexistent pre eclampsia in 50% patients

Etiology;

Association between defects of fatty-acid oxidation in fetus and AFLP in mother is well reported. Toxic effects of abnormal levels of fetal long-chain fatty acids on maternal system believed to play a role in pathogenesis.

As many as 70% of cases in some studies were due to homozygous long-chain 3hydroxyacyl coenzyme dehydrogenase (LCHAD) deficiency in fetus, with a heterozygous mother.

The best characterized mutation is a single guanosine to cytosine mutation (G1528C) in the alpha subunit of the trifunctional protein (TFP) of which LCHAD is a part.

Diagnosis

Clinical, based on history, physical findings and laboratory investigations. Ultrasound scan may show hyperechoic liver. CT which shows decreased attenuation is more reliable than ultrasound scan, but has radiation risk. Definitive diagnosis is by liver biopsy and oil red O staining and electron microscopy.

The "Swansea Criteria"

This combines symptoms and laboratory derangements and have been validated in a large cohort in the United Kingdom. When the Swansea Criteria were applied to a large group of women with suspected pregnancy related liver disease who underwent liver biopsy, the screening tool offered an 85% positive predictive value and 100% negative predictive value for hepatic microvesicular steatosis.

Swansea criteria for diagnosis of acute fatty liver of pregnancy. Six or more criteria required in the absence of another cause

Vomiting

Abdominal pain

Polydipsia/polyuria

Encephalopathy

Elevated bilirubin > 1.2 mg % / >14 µmol/l

Hypoglycaemia <72 mg% / <4 mmol/l

Elevated urea >340 µmol/l / >40 mg/dl

Leucocytosis $>11\times10^6$ cells/l

Ascites or bright liver on ultrasound scan

Elevated transaminases (AST or ALT) >42 IU/l

Elevated ammonia >47 µmol/l

Renal impairment; creatinine >150 µmol/l / >1.6 mg/dl

Coagulopathy; prothrombin time >14 seconds or APPT > 34 seconds

Microvesicular steatosis on liver biopsy

ALT, alanine transaminase; APPT, activated partial thromboplastin time; AST,aspartate transaminase.

Treatment

Non pharmacologic therapy

Patient in ICU for stabilization and monitoring

Fetus is delivered; spontaneous resolution follows delivery. Mode of delivery depends on obstetric indications and clinical assessment

General Management

1. Decrease in endogenous ammonia through dietary restriction of proteins, oral metronidazole to decrease ammonia producing bacteria and lactulose to evacuate colonic contents.
2. Intravenous glucose to maintain plasma glucose levels above 60 mg/dl as hypoglycemia is a killer in AFLP.
3. Coagulopathy corrected with FFP
4. Avoidance or careful use of drugs metabolized by liver.
5. Avoidance and treatment of nosocomial infections.

Obstetric Management

- Once AFLP is diagnosed the definitive treatment is expeditious delivery.
- If quick response to induction is expected, vaginal delivery may be contemplated but in majority of situations delivery will have to be by cesarean section. Because of the existing coagulopathy regional anesthesia may not be a good option. For the same reason we would recommend a vertical midline incision rather than a suprapubic transverse incision and closing the abdomen after leaving a wide bore drain.
- These women may need large dose of intravenous glucose to maintain euglycemia. The coagulation derangement will need close monitoring and large amounts of Fresh Frozen Plasma and other coagulation factors.

  A team of intensivist, hepatologist, obstetrician and neonatologist should be formed to manage such a patient.

HELLP Syndrome

Definition

Haemolysis, elevated liver enzymes, low platelets

Epidemiology

Occurs in 0.2 to 0.6 % of pregnancies. In 10-20 % patients with severe pre eclampsia / eclampsia. Majority of cases between 28-36 weeks. In 70% prior to delivery (80% of these before 37 weeks, less than 3% between 17-20 weeks of gestation). Disease presented postpartum in 30% patients, usually within 48 hours, rarely as late as 7 days postpartum (only 20% had pre eclampsia antepartum)

Etiology

Unknown. Abnormal vascular tone, vasospasm, and coagulation may have a role in pathogenesis.

Symptoms and Signs

Abdominal pain, tenderness, nausea, vomiting, malaise, jaundice hypertension (BP=/>140/90) and proteinuria in approximately 85% pts. Other signs

include pulmonary edema (6%), ascites (8%) and acute renal failure, usually occurring in the setting of disseminated intravascular coagulation (20%).

Diagnostic Criteria

Variable and inconsistent. Hemolysis; defined as presence of microangiopathic haemolytic anemia, indicated by abnormal peripheral smear (schistocytes, burr cells, echinocytes), elevated indirect bilirubin, low serum haptoglobin levels, elevated lactic dehydrogenase(LDH) levels and a significant drop in hemoglobin levels.

Elevated Liver enzymes; Serum AST (SGOT) >70 IU/ L

Low Platelets ; <100,000 / microlitre.

Patients may present with only two of the above. The total clinical setting is important in arriving at a diagnosis.

Investigations

Complete blood count with platelet count, Peripheral smear, Liver function tests: SGOT, bilirubin, LDH. Imaging of the liver, ultrasonogram, CT or MRI needed sometimes.

Obstetric Management

1. Assessment of fetal and maternal status, intervention to stabilize when needed.
2. Delivery is indicated for pregnancies > 34 weeks gestation; nonreassuring tests of fetal status (eg. Fetal heart testing, biophysical profile) or presence of severe maternal disease; multiorgan dysfunction, disseminated intravascular coagulation (DIC), liver infarction or hemorrhage, renal failure or abruptio placentae.
3. Normal vaginal delivery is possible in most patients following induction. Cesarean section can be considered in very preterm gestations (under 30 weeks) when cervix is unfavourable. Magnesium sulphate should be considered to prevent convulsions. It may be stopped 24 hours postpartum or when remission is noted, whichever is later.
4. Control of hypertension
5. Expectant management of stable, preterm pregnancies should be considered investigational.

Table- 2 Clinical features of AFLP and HELLP ; a comparison

	AFLP	HELLP
Glucose	Decreased	Normal
Creatinine	Increased	Normal
Uric acid	Increased	Increased
Bilirubin	(Conjugated)	(occ unconjugated)
LDH	Normal	Increased
SGOT/SGPT	Increased	Increased
Platelets	Normal	Decreased
PTT	Prolonged	Normal
PT	Prolonged	Normal
Fibrinogen	Decreased	Normal
Histology	Microvesicular fatty infiltration	Periportal hemorrhage
Mortality (western)		
Maternal	Around 18%	About 2%
Fetal	About 24%	About 32%

Viral Hepatitis

Hepatitis A Virus is an enterally transmitted RNA virus. The course of hepatitis A during pregnancy is generally similar to that in nonpregnant persons. The disease tends to be more severe in older patients. During severe illness in third trimester, there is increased risk of premature labor. In a review of 80,000 pregnancies, 13 cases of acute hepatitis A during 2nd and 3rd trimester were noted. 69 % of these developed gestational complications including premature contractions, placental separation, premature rupture of membranes, and vaginal bleeding. Eight patients developed preterm labor at a median of 34 weeks. Despite these occurrences, all children had favourable outcomes. Perinatal transmission was not noted in this group. No increased risk of fulminant hepatic failure noted in Hepatitis A.

Hepatitis B

The prevalence of hepatitis B in pregnant women of Kerala is not known. It will vary depending on the socioeconomic class of the population. Hepatitis B infection in pregnancy may be acute or chronic. The concern in these cases is mainly related to its transmission to the fetus and newborn and also the potential for the health care worker to get infected. Screening for HBsAg is mandatory and in the case of those found positive extra care has to be taken to protect the health care worker from getting infected. The most common way to infection to the health care worker is through sharps. Needle stick injuries as well as cuts due to sharp instruments.

Transmission to infant without immunoprophylaxis

When mother is HBsAg +ve and HBeAg-ve, risk of chronic infection in the child has been 40%. When mother is HBsAg and HBeAg+ve , the risk of the child developing chronic infection is 90% . Following 1st trimester acute infection of mother, 10% of neonates became positive. Following maternal infection in third trimester, 80-90 % of neonates became HBsAg+ve . Transmission of infection to the neonate usually occurs at birth.

Protecting the Newborn

- Hepatitis B immune globulin 0.5 ml in one thigh with hepatitis B vaccine in the other thigh within 12 hours of birth protects the child in 90-95% instances. Follow up vaccination at 1 and 6 months after birth.
- Three doses of vaccine alone, the first one at birth, though inferior may be adequate where most HBsAg+ve mothers are HBeAg-ve.

Reducing Mother to child transmission (MTCT) of HBV

Vaccinating the new-born and giving HBIG (Hepatitis B specific ImmunoGlobulin) within 12 hours of birth brought down MTCT by nearly 90%. However, recent review of published literature from 1975 to 2011 demonstrated that active – passive immunoprophylaxis fails to prevent HBV transmission in 8–30% of children born to highly viremic mothers (with high HBV DNA levels; > 10 million copies). Studies showed that antivirals such as lamivudine, telbevudine or tenofovir are safe to the fetus and mother and bring down viral load and reduce transmission to new-born. The recommendation is to start tenofovir 300 mg once a day from 28-32 weeks of gestation till 1-4 weeks after delivery for those mothers with viral load more than 10 million copies. Standard immuno-prophylaxis has to be given to all.

Hepatitis C

- No adverse effect on pregnancy
- Pregnancy does not adversely affect the infection.
- In India approximately 1-1.5% of the general population is chronically infected by hepatitis C virus.

- Rate of transmission from mother to infant is generally low, in the range of 1-5%; higher rates are seen when viral titres are high and with HIV co-infection.
- No effective prophylaxis available for infants.

Hepatitis E Virus is an enterally transmitted acute viral hepatitis, caused by an RNA virus. It is similar to Hepatitis A virus infection in many ways. It is waterborne, but person to person spread is much less common than hepatitis A virus. Epidemiologic data on HEV in Kerala is lacking. However, clinicians observe that HEV infection is uncommon in Kerala, and most of the cases are visitors from or recent travellers to endemic areas (Indo-Gangetic planes or other areas in the North of India). Clinical course is similar to HAV infection in the nonpregnant person. However, for reasons that are not understood, fulminant hepatic failure occurs more frequently during pregnancy resulting in an inordinately high mortality rate of 15-25%, particularly in the third trimester. Increased viral replication has been documented in pregnancy. Data regarding fetal risk is sketchy. One report evaluated eight babies born to mothers with HEV infection in the third trimester. Six infants had clinical, serologic or virologic evidence of HEV infection. Two infants died within 24 hours of birth, one of whom had massive hepatic necrosis at autopsy. Understandably worse obstetric and fetal outcome is noted with HEV infection. Vaccine is in the later phase of development.

Hepatitis E and pregnancy

Though we see HEV infection sporadically only in Kerala, in the Indo-Gangetic plains of the Indian sub-continent, HEV infection particularly in third trimester is a killer. Mortality among pregnant persons during epidemics and sporadic infections may differ. In an epidemic in Kashmir, attack rates among those in first, second and third trimesters were 8.8%, 19.4% and 18.6% respectively as compared with 2.1% among non-pregnant women and 2.8% among men. Further, fulminant liver failure affected 22.2% of the affected pregnant persons. HEV infection adversely affects fetal outcome too with increased frequencies of stillbirths, abortions and neonatal deaths. HEV many suggest is transmitted vertically from mother to infant. In a study, six of eight infants born to mothers with acute HEV infection in third trimester were found to have HEV infection. Such infants were prone to have hypoglycaemia and biochemical evidence of liver injury. Supportive care is all that is possible especially in pregnancy.

Summing up

Hepatobiliary diseases are a major contributor to maternal deaths. The major chunk is due to AFLP. Identifying the problem early and terminating pregnancy timely is essential to avoid maternal death.

Suggested Reading

1 ACG Clinical Guideline: Liver Disease and Pregnancy
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CHAPTER

15

Anesthetic Causes

A K Unnikrishnan, Usha Shenoy, Shamshad Beegum

Editors' Note:

Undoubtedly obstetric anesthesia is a high risk situation; it calls for experience, diligence, and close monitoring of the patient physically even if several types of monitors are available. A.K Unnikrishnan has repeatedly stressed that electronic monitors are no substitute for the anesthesiologist at the head end of the patient. The authors have highlighted with examples the anatomical and physiological changes of pregnancy that make obstetric anesthesia special.

In many centres the anesthesiologist in addition to giving anesthesia will have to take on the mantle of an intensivist and critical care specialist. In this respect he or she is the closest ally of the obstetrician.

The authors have critically looked at several examples with many learning points. These points are equally relevant to the obstetrician just as they are to the anesthesiologists.

V P Paily

Key Summary Points

- Obstetric anesthesia is more challenging than anesthesia for routine surgical patients. Anatomical and physiological changes and serious obstetric complications of pregnancy are responsible for this.
- While anesthesia and surgery should be avoided if possible during period of organogenesis, concern of teratogenesis are unfounded with commonly used anesthetic agents.
- The preferred mode of labour analgesia is epidural.
- If there are no specific contraindications, regional anesthesia is preferred over general anesthesia.
- Electronic monitors are very useful; they cannot be a substitute for the anesthesiologist at the head end of the patient.
- Properly kept intraoperative records will be the best defense, should a medicolegal case arise.

Key Recommendations

- Mandatory, regular and frequent obstetric emergency drills including the entire team (obstetricians, anesthesiologists, staff) will go a long way in preventing mishaps and improving outcomes.
- The anesthesia /neonatal team should be notified early when a potential high risk parturient (medical co morbidities/obese/difficult airway) goes into labour, so as to enable evaluation and preparation of equipment and personnel for potential problems in case an emergency cesarean section is needed.
- Keep /transport pregnant patients in the lateral position whenever feasible.
- Regional anesthesia should be preferred over general anesthesia (GA) unless there is a compelling reason to choose the latter.
- Acid aspiration prophylaxis should be undertaken routinely even if regional anesthesia is planned.
- There is no substitute for eternal vigilance and preparedness by a qualified anesthesiologist.
- All the administered drugs must be cross checked by the administering anesthesiologist. (ref. LASA drugs)
- Anesthetist's/Intensivist's service may be utilized for difficult vascular access, fluid management and care in critically ill patients.
- Use of bedside ultrasonogram (USG) (point of care ultrasound) when available can help in guiding resuscitation especially when the cause is uncertain.
- Awareness and availability of epidural analgesia is lacking. Preemptive/early placement may help avoid airway intervention if emergency cesarean section is needed.

In the period 2010-2019, out of the total cases of reported maternal deaths,15 deaths could be directly or indirectly attributed to anesthetic causes. eight of these were in 2019. Despite advances in anesthetic practices and improved monitoring, this statistic shows an alarming trend. While this could also indirectly reflect the increasing surgical interventions being performed and the increased incidence of co-morbidities and older parturients; majority of the events were in otherwise healthy young parturients. This indicates a definite scope for improvement in anaesthetic care.

Observations:

- Wrong drug, dose administration (intravenous/ intrathecal) could be a factor in 4/5 cases discussed. These are avoidable errors.
- Two of the events occurred following "minor" procedures .This underlines the need to be

aware of peripartum physiology & their increased risk for aspiration

- Despite adequate resuscitation the lack of improvement in outcome, suggests delay in recognition in most of the above cases. This emphasizes one of the main tenets of anesthesia: Eternal Vigilance.
- Experienced anesthetists should be involved in known high risk pregnancies even in tertiary care centres. Adverse events being infrequent, considering the frequency of cesarean section; it is easy to be complacent until the first disaster.
- While most patients needed transfer to a higher center after the initial resuscitation, some of them did not survive the transfer. This suggests urgent need for a transfer protocol which should specify criteria, number and qualification of accompanying staff.
- Identifying and developing dedicated obstetric critical care units in each district, may help improve outcomes of patients who survive the initial insult.

Learning from examples

Example 1

A 25 year old apparently healthy lady who delivered a full term baby normally was posted for postpartum sterilisation (PPS) on the second postpartum day. A pre-anesthetic evaluation on the previous day was unremarkable. The procedure was planned under general anesthesia . After preoxygenation she was induced with thiopentone and paralyzed using suxamethonium. Five minutes later severe hypoxia, hypotension (60/40) and bradycardia (40/mt)were noted. Five minutes following this, the patient arrested, CPCR / intubation was done. After five minutes of cardio pulmonary resuscitation (CPR), vitals were restored with vasopressor support. Patient was then shifted to a higher center, but died during transit.

Possible trigger: Inadequate ventilation and/ or aspiration causing hypoxia

Severe bradycardia and cardiac asystole has been reported in adults following a single dose of suxamethonium. Though the exact mechanism is unknown, this is more likely if preoperative atropine / glycopyrrolate is omitted and /or following intravenous (IV) narcotic drug administration. While the records do not suggest narcotic use in this case, this patient was not given any anticholinergic preoperatively. In most/almost all cases, remission of bradycardia is complete if addressed early. Persistent bradycardia and cardiac arrest suggest this bradycardia was compounded by hypoxia due to inadequate ventilation and / or aspiration. Inadequate mask ventilation is likely if the patient was already in the Trendelenberg position in preparation for PPS. It is not clear if the intention was to complete the procedure with mask ventilation as intubation is documented full 10mts after induction .It was only done at the time of arrest during resuscitation. Death was probably due to hypoxia compounding the bradycardia due to suxamethonium.

Learning Points:

- Premedication drugs should be given before induction of anesthesia
- Endotracheal intubation is the safest way to secure an airway and is advisable in all peripartum females undergoing procedures under GA. If mask ventilation / Laryngeal Mask Airway (LMA) is deemed sufficient, ventilation should be monitored visually and with a capnograph.
- Physiological changes during pregnancy persist during the postpartum period making the mother more prone to hypoxia/aspiration.
- Unstable patients should be accompanied by experienced staff and adequate monitoring if being transferred to higher center.

Example: 2

30 year old second gravida underwent LSCS under spinal anesthesia. 55mts later, towards end of surgery she had bradycardia, mild hypotension which initially responded to pressors. However, she progressed to respiratory arrest in few minutes, for which she was immediately intubated. Despite this, she deteriorated to cardiac arrest and could not be revived despite CPR.

Possible Trigger: ? Wrong drug use followed by delayed recognition of consequent respiratory arrest causing hypoxia

The sequence of events again suggests unrecognized hypoxia, manifesting as bradycardia. The records mention the patient was given Midazolam and Fortwin. The timing of drug administration and patient's saturation are not mentioned. Seizures are documented during the initial bradycardia. However, midazolam and fortwin are unlikely to cause serious problems with the dose mentioned, especially with continuous monitoring with a pulse oximeter. It is however possible if there was inadvertent use of wrong drug, i.e.: suxamethonium instead of midazolam or mephenteramine (ref: LASA Drugs, Appendix) and subsequent delay in recognition. The seizures noted may have been fasciculations following suxamethonium. Once recognized, the resuscitation was systematic according to recommended protocols. The presentation is not typical of amniotic fluid embolism (AFE), which generally presents with a circulatory collapse and respiratory distress (tachypnea) rather than respiratory arrest.

Learning Points

- Need for continuous vigilance, monitoring into the postoperative period
- Need to avoid drug errors
- Need for immediate recognition and adequate management of complications
- Need for adequate training in CPR and Post resuscitation care.

Example: 3

32 year old primigravida underwent LSCS under spinal for failed induction. The patient arrested soon after delivery of the baby. She was revived, intubated and referred to a higher centre. On admission there, she was tachycardic (180/mt), BP: 90/60, with bilateral rhonchi, crepitations, and bloodstained urine. She had features of DIC & seizures. She was relatively stable for the initial few hours but deteriorated from 3rd postoperative day. She was managed by a multidisciplinary critical care team. Despite hemodialysis, ventilator support and laparotomy; she succumbed nearly 2 weeks later.

Possible trigger: Right heart failure due to Amniotic fluid embolism

In this case the sequence of events is typical of an amniotic fluid embolism. To the credit of the initial team, the patient was effectively resuscitated and was relatively stable for the first few hours before she again deteriorated. Retrospectively, we can only presume that she had compensated right ventricular dysfunction in the "interim stable" period. The clinical features were evident only much later when she decompensated and the right ventricle failed. Appropriate timely intervention here may have helped change the course. Diagnosis & management of acute corpulmonale early requires a high index of suspicion and may be more systematic with help from cardiothoracic anesthesia / intensivists team. While this cannot be classified as an anesthetic cause, it highlights the need for dedicated multidisciplinary obstetric critical care units to take care of these patients who survive the initial insult.

Learning Points

- Early involvement of intensivist and evaluation of right heart function in view of ? AFE
- Continue intensive monitoring and care post arrest for atleast 24 hours, even if hemodynamically stable initially.

Example 4

27 year old 2nd gravida underwent LSCS under spinal anesthesia for fetal distress. The patient arrested before delivery of the baby and was immediately resuscitated. Baby was asphyxiated on delivery but was resuscitated. The patient however could not be revived completely and was declared dead after2 hrs.

Possible Trigger: ? Severe supine hypotension ? High spinal

The sequence here is typical of severe supine hypotension syndrome exacerbating hypotension under spinal anesthesia. The records suggest it was a big baby making the possibility of aorto-caval compression more likely. This scenario is unfortunately not uncommon and features in all maternal audits. A wedge can help reduce the aorto-caval compression. Manually pushing the uterus to the left if surgery is in progress, will help more than just giving vasopressors. As per the records, the patient was adequately volume loaded prior to anesthesia, the problem was detected early and resuscitation proceeded according to protocol including delivery of the baby. Asphyxiation of the baby on delivery suggests the hypo perfusion was severe and persistent despite CPR. It is not clear why the patient did not recover despite appropriate mitigation measures, unless there was any underlying asymptomatic severe comorbidity or the initial resuscitation though prompt was **ineffective** due to poor technique. The fatal rhythm was non shockable which points to an unrecognized reversible cause for arrest. An ABG/bedside USG should be considered if facilities permit when the response is not as expected despite prompt recognition/technique.

Learning Points

- Adequate fluids before regional anesthesia or co-loading
- Left lateral tilt of the patient till delivery of baby
- Acute Cardiac Life Support (ACLS) Basic Life Support (BLS) training of all personnel involved in obstetric care

Example 5

19 year old primi on nicardia and labetalol for hypertension diagnosed at 38 weeks, underwent LSCS under spinal anesthesia for failed induction. She developed hypotension after spinal which persisted after few doses of mephentermine and delivery of the baby. She deteriorated to severe circulatory collapse and was resuscitated with noradrenaline infusion and intubation. As the hemodynamic instability persisted after completion of surgery, she was shifted with supports to a higher centre. On arrival there she was in asystole and was resuscitated with CPR. The echo showed global hypokinesia of the left ventricle with normal size/function of the right heart. She had fever and myoclonic jerks. She continued the downhill course and expired after nearly 2 weeks.

Possible trigger: ? Peripartum Cardiomyopathy (CMP) followed by hypoxic arrest during transfer

The sequence of events here suggests the possibility of undiagnosed peripartum cardiomyopathy. The records mention facial puffiness and severe pedal edema which could be manifestations of heart failure. The problem was confounded by coexisting hypertension. The notes suggest appropriate support was instituted intraoperatively. While this again cannot be entirely classified as an anesthetic misadventure, there seems to have been a lapse during transfer resulting in cardiac arrest

on arrival, with a probable delay in resuscitation resulting in severe hypoxic brain injury.

Learning Points:

- Consider routine antenatal echo and cardiac biomarkers in patients with hypertension, severe pedal edema, facial puffiness and family history.
- In case of intractable hypotension, early real time USG on table (if available) will help identify cause and aid management
- Continue high level of support, care during transfer. These patients should preferably be accompanied by anesthetist.

Example 6

22 year old, 2nd gravida underwent Dialation and Currettage (D&C) for retained products under GA. She became hypoxic and arrested in the recovery area. She was subsequently resuscitated, intubated and shifted to a tertiary care center. She was in circulatory shock on arrival with severe Acute Respiratory Distress Syndrome (ARDS). Echo suggested severe LV systolic dysfunction. Lab workup suggested sepsis with high WBC Totol Count (TC) (41000)and procalcitonin levels. She arrested again after 2 hours, was put on ECMO, but died a week later in spite of best efforts

Possible trigger: Postoperative respiratory depression complicating underlying unrecognized severe sepsis

This is again an unfortunate scenario of a "minor" procedure going terribly wrong.

There should be a high index of suspicion of sepsis in patients undergoing D& C for retained products, especially if there is a delay in evacuation .A screening TC/DC here would have raised a red flag and probably stepped up vigilance. It appears from the records that sepsis was not anticipated, and the patient was found in hypoxic arrest .It is possible that the persisting effect of the drugs which might have been innocuous in a healthy patient, inadvertently added insult to injury, triggering severe hypoxic damage which even if addressed quickly and correctly may not respond as expected in the setting of severe sepsis .Aspiration during surgery cannot be ruled out as a cause of hypoxia.

Learning Points:

- Preoperative evaluation of all patients, even those undergoing minor procedures will help detect underlying asymptomatic disorders. Relatively simple inexpensive measures (Vitals/temperature/WBC counts) can help detect potentially serious problems when clinically correlated.
- Monitoring should be continued in recovery
- Utmost care is required in short GA procedures without Endotracheal Intubation to prevent aspiration.

Example 7

35 year old second gravida, syndromic (short stature, short neck, multiple skeletal abnormalities, Turners mosaic) with chronic hypertension, and grade 2 retinopathy was admitted in a tertiary care center at 30 weeks of gestation. Elective Cesarean Session (CS) was done under GA for severe preeclampsia at 36 wks. Intubation was difficult, unsuccessful initially and was completed only after delivery of a deeply asphyxiated baby. She desaturated when extubation was attempted. Was reintubated and was on ventilatory support for 10 days, during which period she arrested twice and was revived before succumbing almost 3 weeks later.

Possible Trigger: Hypoxia due to unprepared airway management in a patient with severe underlying comorbidities.

This patient was admitted early in a tertiary center and pre anesthetic evaluation was done and noted crowding of vertebral spinous process and did not specifically highlight the possibility of a difficult

airway. This suggests the problem was unanticipated and consequently very difficult to manage without adequate help/equipment especially in an obstetric patient. The anaesthetic records do not suggest significant desaturation during the attempts to intubate, but the delivery of an asphyxiated baby suggests perfusion was suboptimal during this period. Aspiration is also a possibility here. Following difficult intubation, it is prudent to follow a 'Difficult extubation" protocol. The records do not suggest this was considered. On the 1st postoperative day, the patient developed a hypoxic cardiac arrest due to blood clots blocking the Endotracheal tube (ETT). This would have been more difficult to prevent, considering the trauma following multiple attempts to intubate. Overall, the records suggest the **problem was underestimated** at various stages and levels, resulting in reduced quality of preventive strategy. Her multiple comorbidities compounded the issue.

Learning Points:

- Patients with multiple skeletal abnormalities/ comorbidities should undergo a formal planned pre anesthetic consultation by senior personnel. Anticipation is essential for adequate preparation for an airway crisis. This problem is always best prevented than managed.
- Feasibility of regionals should be considered to prevent airway problems in all obstetric patients, particularly those with possibility of difficult airway. Crowded spinous process (as noted in this patient) may render neuraxial block difficult, but not impossible. It would have been worth attempting in a patient like this.
- Expert help should be arranged. Adequate plan for difficult intubation should be arranged.
- Supraglottic devices can be used as rescue measure to prevent hypoxia (which probably contributed to asphyxiation in the baby).
- Extubation in this scenario should be done carefully, after the patient is fully awake and stable. Using an airway exchanger, confirming adequate recovery with neuromuscular monitoring may have helped here.(ref appendix)
- Plan for gradual weaning in case of doubt.
- When any difficulty is anticipated, the procedure should be done electively when possible, after adequate planning, preparation and availability of back up equipment and expert staff. While mistakes are possible, appropriate mitigation should be done subsequently preferably by involving more experienced personnel.

Example 8

26 year old 2nd gravida with breech presentation underwent LSCS under spinal anaesthesia. Following intrathecal injection patient had myoclonic jerks with severe gluteal pain. GA was induced, the baby was delivered. She developed tonic, clonic seizures and cardiac arrest. She was resuscitated and referred to a higher center after completion of surgery. She was unresponsive on arrival .She expired there despite continuing resuscitation.

Possible Trigger: Inadvertent Intrathecal tranexemic acid

The entire thread of events is not clear from the records provided. While the seizures could be due to eclampsia (not a known patient of hypertension) or sudden onset of primary seizures, the sequence and refractoriness of seizures strongly suggests possibility of a fatal drug error during intrathecal drug administration. Similar events have been reported with inadvertent intrathecal administration of Tranexemic acid. (ref. LASA drugs in Appendix). Tranexemic acid ampoules resemble Bupivacaine ampoules in size, and appearance. They are also widely used to reduce bleeding during CS, and are therefore a part of obstetric drug trolleys. These two factors may contribute to fatal error in

an emergency, unless a deliberate check is made before drug injection. Case reports advocate administration of anticonvulsants including $MgSO_4$, Intra venously (IV), and inhalational general anesthetic agents, intensive hemodynamic monitoring, and cerebrospinal fluid (CSF) lavage. Continuous infusion of thiopentone, bolus dose of $MgSO_4$, followed by infusion, phenytoin, propofol, benzodiazepines have been used to control seizures. After intrathecal injection of a wrong drug, immediate CSF drainage and early irrigation has been reported with good outcomes as CSF lavage removes and dilutes the injected drug and limits the neuronal toxic damage. To avoid a higher spread of the wrong drug, maintain a head-up position, and first aspirate CSF (with a 22 G needle), from a lower space, and then infuse crystalloids several times into the intrathecal compartment from a higher space.

Learning Points:

- Rule out common causes of seizures (eclampsia, inadequately controlled seizure disorder, hypoglycemia)
- Early supportive therapy, anticonvulsants.
- Ensuring the drug ampoules are verified, broken and loaded by the anesthetist
- Store LASA drugs in a different compartments

Overview:

Anesthetic concerns in a parturient

The obstetric patient usually presents more challenges to the anesthesiologist than any other surgical patient. Fundamental changes occur in maternal anatomy and physiology during pregnancy due to:

- Increased metabolic demands of a growing uterus, fetus and placenta
- Mechanical displacement of viscera produced by an enlarged uterus.
- Altered hormonal activity.

While most of these changes confer obvious adaptive advantages for the gestation and the puerperium, some of the alterations may have a potentially adverse influence on the anesthetic administration during childbirth and for non-obstetric procedures performed during pregnancy. These include:

- Mechanical pressure by the enlarged uterus on the large vessels, the aorta and the inferior vena cava, has the potential to produce the dreaded complication of ***aorto-caval occlusion syndrome.*** Up to 15% of women at term experience bradycardia and a substantial drop in blood pressure when supine, the so-called ***supine hypotension syndrome***. It may take several minutes for the bradycardia and hypotension to develop, and the bradycardia is usually preceded by a period of tachycardia. The syndrome results from a profound drop in venous return for which the cardiovascular system cannot compensate. This is also the basis for the recommendation to keep /shift pregnant patients in the lateral position. Hypotension after spinal/epidural can exacerbate this hypotension when the patient is supine; hence a left tilt is often used until delivery of the fetus during cesarean section. During a maternal cardiac arrest, a Peri mortem cesarean with delivery of fetus within 4mts will help improve response to CPR by relieving the aorto-caval compression
- Increase in intragastric pressure coupled with an incompetent lower esophageal sphincter and increased gastric acidity can precipitate another near fatal complication, acid aspiration syndrome (Mendelsohn's syndrome).The risk is higher in procedures done under general

anesthesia without intubation (i.e. with mask ventilation)

- Upward displacement of diaphragm results in decreased functional residual capacity (FRC) which predisposes the pregnant patient to develop hypoxemia easily and thus compromises both the mother and the fetus. The higher possibility of hypoxia, risk of aspiration and the higher incidence of difficult / failed intubation/airway make regional anesthesia a safer choice whenever feasible.

- Fetal oxygenation depends on maternal oxygen carrying capacity, maternal cardiac output, and uteroplacental perfusion. Therefore, any interventions that compromise these factors may lead to fetal asphyxia

- Underestimation of peripartum blood loss is a key error, masked by the physiologic increase in blood volume and cardiac output during pregnancy, and the subsequent delay may contribute to hemorrhagic death in obstetrics

Thus, in many respects, the obstetric patient is unique compared to other surgical patients and demands specialized attention from the anesthesiologist.

Conclusions:

Analyses of the records provided suggest that a significant number of these catastrophes were preventable with standard protocols, monitoring and vigilance. Response and mitigation of maternal collapse can be improved by drills, training of all involved personnel. A mistake remains one if we do not learn from it. These experiences offer important lessons which will hopefully save lives.

Appendix

Look-Alike and Sound Alike Drugs (LASA)

Many drug names look or sound like other drug names leading to confusion errors. Many of the brand names were similar looking and similar sounding (phonetic).

Various drugs with catchy brand names have been introduced. To make the drug easy to remember and pronounce, branding agencies create a name that consumers will find comforting and fast-acting. The potential for error due to confusing drug names amongst the practicing doctors, pharmacists and patients is significant. New names that are similar to the existing names continue to be approved. So we need to create more awareness about confusing brand names and their implications

Visually, similar packaging for drugs with drastically different uses can lead accidental interchange with catastrophic consequences. Similar packaging for Midazolam, Mephentermine, Heparin, and Rocuronium vials exists. Rocuronium is a skeletal muscle relaxant; Midazolam, an anxiolytic; and Heparin is an anticoagulant. Mephentermine is a vasopressor. Similarly drugs like Bupivacaine (local anesthetic) and Tranexemic acid. Tranexemic acid is a synthetic analog of the amino acid lysine. It acts as an antifibrinolytic and also reduces conversion of plasminogen to plasmin. In some of the cases, convulsions immediately after intrathecal administration may be due to inadvertent administration of tranexemic acid.

Learning Points:

- Avoid the use of confusing drug mnemonics
- Separate storage spaces for muscle relaxants/ LASA drugs
- Color coded labels

- Store used ampoules or vials till the end of the case for verification
- Draw drugs into syringes just before injecting, with a two person check on the process.
- Concentrate on patient safety and vigilance.

[Commentary: TranexemicAcid: Beware of anesthetic misadventures. Gupta Sunanda, Bhiwal Anil K, Sharma Karuna; 2018/Volume8/Issue number 1/Page 1-6: Journal of Obstetric Anesthesia & critical Care]

CHAPTER

16

Renal Diseases

P M Jayaraj, A Vimala

Editors' Note

Renal disease is a relatively uncommon cause of maternal death, especially after wider availability of renal replacement therapy(dialysis). However compromised renal function and the need for dialysis or renal transplant can be the result of many obstetric complications like PPH, severe preeclampsia and maternal collapse as happens after amniotic fluid embolism. Similarly, compromised renal function can lead to problems for fetal growth and maternal safety. In this chapter in addition to the common problems like preeclampsia, HELLP syndrome and Acute fatty liver of pregnancy (AFLP), the relatively rare but life threatening conditions like Thrombotic thrombocytopenic purpura (TTP) and Hemolytic Uremic Syndrome (HUS) are discussed. Common problems like urinary tract infection, renal transplant and post transplantation care are mentioned.

V P Paily

Outline

Introduction — P M Jayaraj

- Renal anatomical and physiological changes in pregnancy
- Assessment of Renal function
- Etiology of renal disease in pregnancy
- Principles of management of renal disease in pregnancy
- Acute kidney injury in pregnancy
- Thrombotic Thrombocytopenic Purpura TTP) and Hemolytic uremic Syndrome

— A Vimala

- Urinary tract infection
- Chronic kidney disease
- Renal Replacement therapy
- Renal transplantation
- Pregnancy in a voluntary donor
- Key summary points
- References

— P M Jayaraj

Introduction

Renal disease in pregnancy is relatively uncommon and the quality of evidence guiding clinical practice is not very robust. Most series consist of case series with modest numbers of subjects. Based on population studies, the prevalence of chronic kidney disease (CKD) in women of childbearing age is 0.03 % - 0.2% of all pregnancies.

In patients with impaired renal function who become pregnant, consideration should be given to the possible harmful effects of pregnancy on kidney function, as well as the impact of renal disease on pregnancy outcome.

Here, three different aspects of kidney disease have to be considered

1. *The effect of low Glomerular Filtration Rate(GFR)* – Even mild reductions in glomerular filtration rate may increase the risk of preeclampsia, gestational hypertension, and possibly premature delivery. The risk increases as GFR declines.

2. *The effect of proteinuria* – Higher levels of proteinuria appear to adversely affect pregnancy outcomes and the odds of preeclampsia and premature delivery were higher in women who had albuminuria >300 mg/24 hours (or total proteinuria > 500 mg/24 hours) compared with those who had albuminuria 30 to 300 mg/24 hours (or total proteinuria 150 to 500 mg/24 hours).

3. *The effect of hypertension* – Fetal survival is lower when hypertension is not controlled (>140/90 mmHg) preconceptionally. The relative risk of fetal death has been estimated to be approximately ten fold higher in women with a mean arterial pressure >105 mmHg at conception compared with those with spontaneous or therapeutically achieved normotension

The role of nephrologist in this context is to assess the risk of worsening renal function in pregnancy; ideally, nephrologist's opinion should be sought before conception. Evaluation and treatment of maternal hypertension are also crucial, as it contributes significantly to the risk of deteriorating renal function and increases the risk of preeclampsia, preterm delivery, intrauterine growth restriction, and perinatal mortality.

The relevant pregnancy outcomes may be divided into

- maternal (e.g., renal deterioration, hypertension, stroke and death),
- fetal (e.g., growth restriction, intra uterine death, or neonatal death with in 28 days of birth), and
- obstetric (e.g., preeclampsia, placental abruption, hemorrhage, sepsis, and thrombosis).

Management of pregnant women with kidney disease may be complicated and requires an understanding of the physiologic changes associated with pregnancy, as well as close teamwork between the obstetrician and nephrologist.

Renal anatomical and physiological changes in pregnancy

For the proper interpretation of the investigations, a better understanding of the anatomical and physiological changes is essential. There is an increase in kidney size by 1cm,and dilatation of collecting system- right more than the left. If not aware, this can be mistaken for pathological obstruction.

Table 1. Alterations in renal physiology

	Normal changes	Consequence	Implication
1.	Increase in GFR at 4 weeks of gestation. Peak increase above 50% at second trimester· Mild decline near term	Normal creatinine level in pregnancy reduced to 0.4-0.8mg%	S.creatinine values of > 0.8mg% suggests kidney injury in pregnancy
2.	Increase in plasma volume of 1.25L by 32 to 34 weeks of gestation	Dilutional anemia	Over diagnosis of anemia

Table 2. Changes in Common indices in pregnant and non pregnant state

Indices	Nonpregnant	Pregnant	Implication
Hematocrit	41%	33%	Overdiagnosis of anemia
Serum protein(g/L)	7.0	6.0	Overdiagnosis of hypoproteinemia
Plasma osmolality(mOsm/Kg)	285	275 mmol/L	Overdiagnosis of hypoosmolar state
Serum sodium	140 mmol/L	135 mmol/L	Overdiagnosis of hyponatremia
Serum Cr(mg/dL)	0.8	0.5	Underdiagnosis of AKI
Serum urea(mg/dL)	27	20	Diagnosis of azotemia missed
Serum uric acid(mg/dL)	4.0	3.2	Diagnosis of hyperuricemia missed
Serum bicarbonate(mmol/L)	25	20	May be interpreted as abnormal metabolic acidosis/ compensation to respiratory alkalosis
Arterial pH	7.4	7.44	Overdiagnosis of pathological alkalosis

Blood pressure - Normal changes in pregnancy

In clinically healthy pregnant women, BP falls gradually at first trimester, reaching a nadir around 22–24 weeks, rising again from 28 weeks, and reaching preconception levels by 36 weeks of gestation.

Assessment of renal function:

Glomerular Filtration Rate (GFR) and creatinine clearance increase by 40-65% in pregnancy. The average values of normal createnine are 0.8mg% in nonpregnant as compared to 0.74, 0.58, and 0.53 mg% in first, second and third trimester of pregnancy respectively[1]. In the nonpregnant women, GFR is calculated using CKD- EPI equation. This canot be applied to pregnant women due to change in body weight and surface area in pregnancy.[(2)] The creatinine clearance measured by 24 hr urine collection still remains the most, well validated method for measuring renal function.

Due to the increased GFR in pregnancy, the tubular transport maximum is exceeded, hence there is decreased reabsorption and, therefore, increased excretion of glucose, amino acids, calcium and protein in urine. The upper limit of normal for urinary protein is 300mg/d in pregnant versus 150 mg/d in nonpregnant women. Although many consider the 24 hr urine protein measurement the standard, both albumin/creatinine, and protein/ creatinine ratios are acceptable and convenient for outpatient settings.

A 24-hr protein level of >300mg correlates with a urine dipstick 1+, but could be fallacious because of variations of urine concentration.[(3)]

Classification of Renal disease in pregnancy :

- Pre-existing renal disease diagnosed before conception.
- Chronic kidney disease that was unappreciated before pregnancy and diagnosed for the first-time during pregnancy.

- Renal disease that develops for the first-time during pregnancy.

There could be overlap between these groups. For example, lupus nephritis may be a pre-existing condition, or it may develop for the first-time during pregnancy.

Principles of management in pregnancy for all forms of renal disease include

- Frequent follow up with assessment of blood pressure and proteinuria
- Treatment of hypertension with agents which are safe in pregnancy. Blood pressure treatment targets in women with renal disease should be somewhat lower than pregnant hypertensive with no renal risk. Home blood pressure monitoring is recommended.
- Patients have to be advised regarding signs/ symptoms of preeclampsia. Investigations are routinely performed to screen for preeclampsia. There are unfortunately not many preventive measures to avoid hypertension and preeclampsia. Of possible benefit is the use of low dose aspirin (75-150mg/d) which lowers the risk of preeclampsia and other adverse pregnancy outcomes by about 10%[4].

Acute Kidney Injury(AKI)

Definition

It is defined as serum creatinine level greater than 0.8mg% or doubling of serum creatinine from baseline occurring during antenatal period, intra-partum or postpartum period.

Why PR-AKI (Pregnancy related acute kidney injury) should be recognized early?

Even with prompt recognition and management of conditions producing AKI, maternal and fetal mortality is at 20% and 22% respectively. With better antenatal care the current incidence of PR-AKI has dramatically decreased from 20-40% in the 1960's to less than 10%. Incidence in developed countries is 1-2.8% while in developing countries it is around 4.2-15%. Women hospitalized with AKI had a mortality rate of 2.6%, compared to 0.01% of those without AKI, 14-fold higher risk of in-hospital mortality and a 16-fold higher risk of cardiovascular events. The AKI-related hospitalization rate was ten times higher for patients with diabetes [5]. Acute kidney injury often occurs in a setting of other pregnancy-related complications such as preeclampsia or infections. Retrospective observational study on maternal mortality due to renal disease was conducted from 2010 to 2020 in Kerala. Going through the causes of death in Kerala, we observed a dramatic decrease in deaths due to renal disease from 2010-20. There is an increase in acute fatty liver of pregnancy, from 1 in 2010 to four in 2018-2019. Hypertensive disorders as a cause of mortality have also declined from 16% to 9%. Most of the deaths are preventable and can be brought down to zero.

But unlike AKI in non-pregnant patients, PR AKI (Pregnancy related Acute Kidney Injury)- has certain important management issues.

1. Diagnosis of renal disease in pregnancy requires a prompt knowledge of normal anatomical and physiological cardiovascular and renal adaptations during pregnancy. This is discussed earlier.
2. In AKI both maternal and fetal outcomes have to be taken into consideration

So, judicious management of PR-AKI is mandatory for better outcome of both the mother and the fetus, which can be achieved with the help of a multi-disciplinary team comprising of obstetrician, nephrologist, neonatologist and critical care experts.

Let us briefly review the causes of AKI which vary depending on the trimester of pregnancy,

AKI in early in pregnancy (<20 weeks) is most often due to:

- Hypovolemia due to hyperemesis gravidarum
- Acute tubular necrosis (ATN) resulting from a septic abortion
- AKI associated with either viral (eg. influenza) or bacterial infection and/or sepsis

With adequate fluid management in hyperemesis gravidarum, and legalisation of abortion by MTP act, the incidence of AKI due to these causes have decreased.

Causes in third trimester and post-partum period

- Severe preeclampsia
- Severe preeclampsia with HELLP syndrome
- Acute fatty liver of pregnancy (AFLP)
- Thrombotic thrombocytopenic purpura (TTP, acquired or hereditary) or complement-mediated hemolytic uremic syndrome (HUS))
- APLA syndrome, systemic diseases like Diabetes mellitus, SLE,
- ATN (Acute tubular accrosis) or acute cortical necrosis associated with hemorrhage (placenta previa, placental abruption, prolonged intrauterine fetal death, or amniotic fluid embolism)
- Hepatitis
- Acute pyelonephritis and less commonly, urinary tract obstruction
- Nonsteroidal anti-inflammatory drugs (NSAIDs) in any trimester
- Worsening of pre-existing kidney disease

Aims of the management include:

1. Stabilization of patient
2. Identifying the underlying cause
3. Treatment and prevention of progression of kidney damage
4. Assessment of multi organ failure and providing adequate support
5. Optimizing fetal health.

We will discuss a case scenario.

Case Scenario 1

27 year old woman admitted on the 5th day of delivery with history of seizures, severe hypertension and documented to have creatinine of 2.1 mg%. She gives no history of oliguria or bleeding tendencies. She was on regular antenatal checkup and there is no history of preeclampsia, gestational hypertension, arthritis, skin rash or other symptoms to suggest SLE. She had no antepartum hemorrhage or PPH. Her first delivery and postpartum period were uneventful, she was discharged with a normal creatinine of 0.9 mg%.

Table 3. Investigations done

Variables	values
Urinalysis	Protein +RBCs 2-3/hpf, WBC 8-10/ hpf,no casts, Culture no growth
Hemogram	Hb 9.5g%, TC 7500/cmm, Platelet 2,25000/cmm,
Urea	45mg%,
Creatinine	2.1mg%
Na	132mEq/l
K	3.8mEq/L
Ca	9mg%
Mg	1.5mEq/L
Alb	4g%
Uric acid	5mg%
AST	25
ALT	30
Bilirubin	1.2mg%

To summarize, she had postpartum acute kidney injury with seizures, hypertension, and no features of HELLP.

Differential Diagnosis

- Late onset eclampsia
- Preeclampsia with severe features
- HELLP syndrome
- AFLP
- TTTP/HUS
- Sepsis syndrome

This lady had no features of HELLP syndrome, pre eclampsia with severe features or AFLP. In postpartum period, TTP/HUS should also be considered. She had normal platelet count and no features of hemolysis.

Most probable diagnosis is late onset eclampsia and acute kidney injury.

Her hypertension was controlled with labetalol and nifedipine. She was also treated with magnesium sulphate infusion, monitoring serum magnesium levels. She was discharged on the 4th day of admission with normal blood pressure, and creatinine. She was advised regular follow up (to exclude any systemic disease like SLE).

We will briefly discuss TTP/HUS syndrome

Thrombotic thrombocytopenic purpura (TTP)

Thrombotic thrombocytopenic purpura (TTP)[6] is a thrombotic microangiopathy (TMA). It is caused by accumulation of VON WILLEBRAND FACTOR (VWF) MULTIMERS. This is due to severely reduced activity of the von Willebrand factor-cleaving protease ADAMTS13. This will lead to small-vessel platelet-rich thrombi, thrombocytopenia, and microangiopathic hemolytic anemia.

TTP can occur in any stage of pregnancy and is of highest risk in second and third trimester. Presentation is with neurological manifestations like seizures and alteration of sensorium. Renal involvement is rare. Investigations show thrombocytopenia and schistocytes in peripheral smear.

Pathogenesis

TTP is usually due to severe deficiency of ADAMTS13. ADAMTS13 deficiency can be hereditary or acquired. Acquired TTP is more common than hereditary TTP in pregnancy. ADAMTS13 activity decreases normally during pregnancy and fall below 50% near term. Hence ADAMTS13 deficiency is defined as activity less than 10%. Hereditary TTP can also present for the first time in pregnancy.

HUS syndrome[7]

Onset of HUS is usually in the last trimester of pregnancy more towards term and can also present in the postpartum period. Unlike in TTP, AKI is the predominant life threatening manifestation. Neurological manifestations are rare.

Pathogenesis - HUS can be due to abnormality of complement regulation or shiga toxin producing organism

Complement mediated HUS

It is due to the activation of complement on endothelial cells. A neutralizing auto antibody or an inherited mutation in a complement regulatory gene such as complement factor H (CFH) results in dysregulation of complement. This leads to development of microthrombi throughout vasculature. Kidneys are mainly involved, hence AKI may be the presenting feature. CTMA (Complement mediated microangiopathy) presents very similarly to HELLP syndrome and TTP. Differentiation can be challenging. Key diagnostic features include MAHA (Micro Angiopathic Hemolytic Anemia), thrombocytopenia, raised serum creatinine. ADAMTAS 13 activity is not severely deficient in C-TMA (10% or more present) and stool studies are negative for shiga toxin producing organisms. Clinical course of TMA is not affected by delivery.

Shiga toxin HUS

This is usually preceded by a prodrome of abdominal pain and bloody diarrhea. Clinical presentation is similar to complement mediated HUS.

Diagnostic features of TTP/HUS syndrome

- Neurological Manifestation (Example Coma, Seizure) and Fever in TTP
- Acute Renal Failure in HUS
- Microangiopathic hemolytic anemia
- Thrombocytopenia
- Features of Disseminated intravascular coagulation will be absent in both conditions

Case scenario 2

28 year old primigravida, on regular antenatal checkup was admitted for induction of labour in 38th week of gestation. Indication was fetal distress. She delivered a normal male child weighing 3.5 kg. Twelve hours later she developed altered sensorium, hypotension and seizures. She was drowsy, temperature 99^{0} F, pulse 102/mt, BP 90/60mmHg, HR 102/mt. No obvious bleeding per vaginum, no hematoma. Investigations are shown below in table 4

Table 4

Variables	values
urinalysis	Protein ++, RBCs 6-8/ HPF,WBCs 3-4hpf, culture-no growth
Hemogram	Hb 6.5g%, TC 4500/cmm Platelet 65000/cmm
Peripheral smear	Normocytic normochromic anemia with schistocytes, Burr cells
Haptoglobin	0.3g/L
Ferritin	285 µ/L
Prothrombin time (PT)	10 sec
APTT	33
Creatinine	0.8 mg/dL
Urea	34 mg/dL
Albumin	2.1 g/dL
Bilirubin	1.8 mg%
GGT	9 U/L
AFP	112 U/L
AST	64 U/L

To summarize, she had anemia with evidence of hemolysis, thrombocytopenia, with relatively normal LFT. Her platelet count decreased further and she also showed signs of deterioration. Because of deteriorating platelets, lack of spontaneous improvement after delivery as expected in HELLP

syndrome and no severe liver enzyme abnormalities, HELLP syndrome was excluded and a diagnosis of TTP was made.

Differential diagnosis of TTP/HUS syndrome

- Acute fatty liver of pregnancy
- HELLP syndrome/ preeclampsia with severe features
- Exacerbation of lupus erythematosus
- Catastrophic antiphospholipid syndrome
- Sepsis syndrome
- Disseminated intravascular coagulation(DIC)

Table 5. Differentiating features of TTP, HUS, AFLP, HELLP

	TTP	HUS	HELLP	AFLP
Abdominal pain	++	++	++	++
Low ADAMES 13 Activity	+/++	-	++	++
Anemia	++	++	+	+
Elevated lactic dehydrogenase	++ very high values	++ very high values	++	+/++
Elevated transaminases	-/+	-/+	++	++
Fever	+	-	-	+
Headache or visual disturbance	++	-	++	-/+
Hypertension	+/++	++	++	-
Jaundice	-	-	+	+
Nausea and vomiting	++	++	+	+
Proteinuria and hematuria	+	++	++	-
Thrombocytopenia	++	++	++	+
Von Willebrand Factor	++	++	-	?
Hypoglycemia	-	-	-/+	++

Differentiation is important because management is more specific and aggressive in TTP-HUS syndrome. End organ injury persisting for more than 3 days after delivery is strongly suggestive of TMA. In contrast pre-eclampsia/HELLP syndrome usually resolves after delivery. Fetal outcome is good in TTP/HUS though rarely intrauterine fetal death can occur due to placental infarction caused by thrombosis of decidual arteries.

Management of Acquired TTP during pregnancy (or postpartum)

Untreated TTP is rapidly fatal. Mortality in the pre-plasma exchange era was more than 90%. Currently, plasma exchange therapy is the cornerstone of TTP treatment and has reduced mortality to less than 20%. Thrombotic thrombocytopenic purpura (TTP) is a medical emergency. Plasma exchange (PEX) is the treatment of choice.

Additional therapies include glucocorticoids, rituximab, and caplacizumab;

- **Glucocorticoid therapy**- prednisone 1 mg per kg daily orally or, for more severe disease, methylprednisolone 125 mg IV 2-4 times daily. The glucocorticoid is continued until the patient has fully recovered and then tapered over 1-2 weeks. Glucocorticoids are thought to reduce production of the ADAMTS13 inhibitor (autoantibody) by mechanisms similar to those in other autoimmune diseases.

- **Rituximab**- anti CD 20 antibody should be given after PEX. Usual dose is 375mg/m^2 intravenously weekly for four weeks. Patient should be strictly monitored for infections.

- **Caplacizumab**- humanized monoclonal antibody fragment that binds to VWF and blocks VWF interaction with glycoprotein Ib-IX-V. Dose- 10mg intravenous on day 1 followed by 10mg s/c on day 1 after PEX and continued for 30 days after PEX has been stopped.

Indication for termination of pregnancy is only for obstetric complications, since delivery does not cause resolution of TTP.

Indications for prophylactic plasma infusion

- Patients with hereditary TTP become pregnant, dose and frequency of plasma infusion is guided by platelet count.
- For postpartum patients, continuing prophylactic plasma infusion every 2 weeks for a total of six weeks. Breast feeding is not contraindicated during these 6 weeks of plasma infusion. Usually platelet count comes to normal within 1 to 2 days; if not, other causes for thrombocytopenia should be searched for.

Management of Complement mediated TMA (atypical HUS) /shiga toxin associated HUS

involves the following

Supportive care

Specific treatment

Supportive care — Supportive therapy is same for both complement mediated HUS and shiga toxin associated HUS and includes the following:

- Red blood cell transfusions for anemia when clinically indicated (eg, hemoglobin level <6 g/dL).
- Platelet transfusion for patients who have significant clinical bleeding or if an invasive procedure is required.
- Appropriate fluid and electrolyte management to maintain adequate intravascular volume and correct/avoid electrolyte abnormalities.
- Stop nephrotoxic drugs or those that are implicated in the etiology of HUS.
- Initiation of dialysis therapy in patients with symptomatic uremia, azotemia (defined as a blood urea nitrogen >80 mg/dL [29 mmol/L]), severe fluid overload, or electrolyte abnormality that is refractory to medical therapy.
- Provision of adequate nutrition.
- Avoid aspirin and NSAIDS

Complement mediated HUS - Specific treatment includes Plasma exchange (PEX) and Anticomplement therapy – Eculizumab

Anticomplement therapy – Eculizumab : anti CD5 antibody. Is a monoclonal antibody directed against the C-5 complement component. It blocks the formation of membrane attack complex that is thought to mediate the microangiopathic changes and renal injuries in C-TMAs. Dosing is 900mg once weekly for 4 weeks. Followed by 1200mg after 1 week and 1200mg once every two weeks. Important side effects include meningococcal meningitis and other infections.

Combined liver and kidney transplants in patients that progressively develop end stage liver and kidney disease.

Shiga toxin HUS- There is only supportive treatment which includes anti-diarrhoeals fluid management, and renal replacement therapy if required.

Urinary tract infections in pregnancy

Urinary tract infections are common in pregnant women when compared to general population. This can be either asymptomatic bacteriuria, acute cystitis or acute pyelonephritis. 20 to 30% will progress to symptomatic urinary tract infection including pyelonephritis.

Asymptomatic bacteriuria

Increased recurrence of pyelonephritis is associated with adverse pregnancy outcomes – pre term birth and low birth weight infants. Hence asymptomatic

bacteriuria should be diagnosed and treated in pregnancy. Screening for asymptomatic bacteriuria is performed at 12 to 16 weeks gestation (or the first prenatal visit, if that occurs later) with a urine culture[8]

Method of collection of urine - In order to minimize contamination of the voided specimen, it is often recommended that the patient collect a clean-catch (after local cleansing of the urethral meatus and surrounding mucosa) midstream (collection of the second portion of the voided urine after discarding the initial stream) specimen.

Diagnostic criteria — For asymptomatic women, bacteriuria is formally defined as two consecutive voided urine specimens with isolation of the same bacterial strain in quantitative counts of $>10^5$ colony-forming units (cfu)/mL or a single catheterized urine specimen with one bacterial species isolated in a quantitative count of $>10^2$ cfu/ml [9]. However, only one voided urine specimen is typically obtained, and diagnosis (and treatment initiation) is made in women with $>10^5$ cfu/mL without obtaining a confirmatory repeat culture. Asymptomatic bacteriuria occurs in 2 to 7 % of pregnant women. 75 % of cases are diagnosed in the first trimester and only 25% are diagnosed in the second and third trimester.

Risk factors:

- History of previous urinary tract infections
- Diabetes mellitus
- Increased parity
- Low socioeconomic status

Management[9]

Table 6: Antibiotics used for treatment of asymptomatic bacteriuria

Antibiotic	Dose	Duration	Remarks
Nitrofurantoin	100 mg orally every 12 hours	5 to 7 days	Does not achieve therapeutic levels in the kidneys so should not be used if pyelonephritis is suspected. Avoid use during first trimester and at term if other options are available.
Amoxicillin	500 mg orally every 8 hours or 875 mg orally every 12 hrs	5 to 7 days	Resistance may limit its utility among gram negative pathogens
Amoxicillin-clavulanate	500 mg orally every 8 hours or 875 mg orally every 12 hrs	5 to 7 days	
Cephalexin	250 to 500 mg orally every 6 hours	5 to 7 days	
Cefpodoxime	100 mg orally every 12 hrs	5 to 7 days	
Fosfomycin	3g orally as a single dose		Does not achieve therapeutic levels in the kidneys so should not be used if pyelonephritis is suspected.
Trimethoprim-sulfamethoxazol	800/160 mg (one double strength tablet) every 12 hours	3 days	Avoid during first trimester and at term.

Follow-up

Up to 30 percent of women fail to clear asymptomatic bacteriuria following a short course of therapy[10]. Repeat culture is generally recommended a week after completion of therapy for asymptomatic bacteriuria [11].

If repeat culture has no growth, there is no indication for further testing for bacteriuria in the absence of symptoms suggestive of urinary tract infection.

If repeat culture is positive for bacterial growth ($>10^5$ cfu/mL), same antimicrobial antibiotic as administered the first time is given for a longer course (eg, seven days, if a three-day regimen was used previously) or a different antimicrobial for a typical duration. Continuous testing for asymptomatic bacteriuria following this second treatment course is not recommended.

Acute cystitis

Cystitis is the symptomatic infection of the bladder. Presenting symptoms include dysuria, urinary urgency and frequency. Urine analysis may show hematuria and pyuria but symptoms like fever is absent.

Diagnosis: Urine analysis and culture should be performed at the onset of dysuria. Almost all pregnant ladies with urinary tract infections(UTI) will have pyuria. In the absence of pyuria other causes should be searched. Quantitative count $>10^3$ cfu/mL in a symptomatic pregnant woman is an indicator of symptomatic UTI. If bacteria that are not typical uropathogens (such as lactobacillus) are isolated, the diagnosis of cystitis is typically made only if they are isolated in high bacterial counts ($>10^5$ cfu/mL).

Differential diagnosis: Vaginitis or urethritis can also produce same symptoms but the presence of bacteria in urine differentiates cystitis from vaginitis. In pregnant women with dysuria without bacteriuria or women who have persistent dysuria even after successful treatment of bacteriuria, should be tested for sexually transmitted diseases like chlamydia and gonorrhoea.

Management: Antibiotic treatment is as shown in table 2. Short course of antibiotics are preferred (3 to 4 days). Follow up culture of urine should be done to confirm eradication of bacteria, usually done one week after completion of treatment.

Recurrent cystitis

If there are 3 or more episodes of cystitis during pregnancy antibiotic prophylaxis should be given during pregnancy. Drugs usually used are nitrofurantoin 50mg orally post coital or at bed time; or cephalexin 250mg orally post coital or at bed time.

Acute pyelonephritis

This is an infection of upper urinary tract and kidneys. Fever >104 F, flank pain, nausea, vomiting and/or costovertebral angle tenderness are clues to the diagnosis. Usually occurs during second and third trimester of pregnancy. Pyuria is a pathognomonic finding.

Complications: Unless recognised and treated early, they are at risk of both medical and obstetric complications. Twenty percentage of women with severe pyelonephritis may develop septic shock or acute respiratory distress syndrome. Anemia, acute kidney injury associated with micro abscess and suppurative pyelonephritis can rarely occur.

Diagnosis: In the setting of clinical symptoms as described above with presence of bacteriuria confirms the diagnosis.

Investigations: Urine analysis shows pyuria, absence of pyuria may suggest an alternative diagnosis or complete obstruction. Patient without pyuria, but culture positive for organisms is consistent with diagnosis of pyelonephritis. Blood culture should be done in patients with signs of sepsis or comorbid conditions like diabetes.

Indications for imaging: not done as routine

1. Severely ill patients who have symptoms of renal colic
2. Renal stones
3. Diabetes mellitus
4. History of prior urology surgery
5. Immunosuppression
6. Repeated episodes of pyelonephritis

Imaging: Renal ultrasound scan

Obstetric complications include placental abruption.

Management: Patient has to be admitted for intravenous antibiotic therapy for 24 to 48 hours. Outpatient treatment is advisable only if there are no comorbid conditions or recent antibiotic use. Treatment is shown in the table 7.

Table 7. Mild to moderate pyelonephritis – Antibiotics used

Antibiotic	dose	frequency
Ceftriaxone	1 gm	Every 24 hrs
Ampicillin + Gentamicin	1 g to 2 g 1.5 mg/Kg	Every 6 hrs every 8 hours
Cefepime Aztreonam	1 gm 1 gm	every 12 hours every 8 hours
Ampicillin + Gentamicin	1-2 gm 1.5 mg/kg	Evert 6 hrs Every 8 hrs

Severe pyelonephritis with an impaired immune system and/or incomplete urinary drainage

Piperacillin-tazobactam	3.375gm	every 6 hours
Meropenem	1gm	every 8 hours
Ertapenem	1gm	24 hours
Doripenem	500mg	every 8 hours

Oral antibiotics should be continued for the rest of the duration of pregnancy. If symptoms persist more than 48hrs after treatment, repeat culture and renal USS should be done.

Prevention in women with recurrent UTI

If there is history of recurrent UTI prior to pregnancy and if it is related to sexual intercourse, post coital prophylaxis should be given. Preferred regime is single post coital dose of cephalexin 250mg or nitrofurantoin 50mg.

Antibiotic safety in pregnancy

Penicillins, cephalosporins, aztreonam are safe in pregnancy. **Ceftriaxone should not be given before delivery because there is a possibility of bilirubin displacement and subsequent kernicterus.** Meropenem, carbapenem, doripenem and fosfomycin are safe. **Imipenem should not be used.**

Side effects of antibiotics used

1. Nitrofurantoin – birth defects not proved. Incidence of haemolytic anemia in patients with G6PD defect is 0.004% only but should be avoided near term.
2. Trimethoprim-sulphamethoxazole should be avoided in first trimester and near term.
3. Aminoglycosides- prolonged fetal exposure leads to ototoxicity.
4. Tetracycline and fluroquinolones- should not be used in pregnancy.

Chronic Kidney Disease (CKD)

Women with advanced kidney disease often have anovulatory cycles due to elevated prolactin and impaired hypothalamic – pituitary function. Fertility and ability to sustain a pregnancy are related to the

degree of the renal functional impairment, rather than the specific underlying disorder. (Table1). The greater the functional impairment, and greater the blood pressure, less likely the pregnancy will be successful. In a landmark paper by Jones et al., 82 women with renal insufficiency and pregnancy, the effects on maternal renal function, obstetric and fetal outcomes were described. Those with mildly elevated serum creatinine 1.2 to 1.4 mg/dL had a 16% reduction in renal function following pregnancy. Those with creatinine of 1.4 to 2.5 mg/dL were at increased risk of preeclampsia (20 to 30%) and preterm delivery. Of these women, 50% had a 25% fall in CrCl, and the decline in renal function persisted after delivery.

Women with severe renal dysfunction (creatinine> 2.5 mg/dL) should be discouraged from conceiving, because 70% experienced preterm delivery, 40% developed preeclampsia, and 40% experienced postpartum deterioration in renal function leading to dialysis. About 37% of babies were small for and there was a 7% fetal loss.[12]

The risk of preeclampsia is increased in women with CKD. The risk in unselected gravidae is 5%, and this rises to 25% in women with hypertension and still higher with CKD stage 3-4.

Urine protein excretion markedly increases in women with underlying renal disease. There is some evidence that proteinuria can be an independent risk factor for poor pregnancy outcome. The rate of decline of GFR accelerated in the subgroup who had proteinuria >1gm/d.[13]

The level of blood pressure at the time of conception is also an important variable in pregnancy outcome. In the absence of hypertension, there is significantly less chance of irreversible deterioration of renal function during pregnancy.

So also, in patients with renal disease where eventual renal transplant is anticipated, pregnancy may result in immune sensitization leading to greater difficulty in locating a suitable donor.

Pregnancy and renal diseases associated with systemic illnesses

Diabetes:

Diabetes is one of the most common medical disorders of pregnancy. If the diabetes is long standing, as in Type1 Diabetes Mellitis, may have diabetic kidney disease. Diabetic women with microalbuminuria, preserved renal function and normal blood pressure have a good prognosis of pregnancy although are at an increased risk of preeclampsia and urinary tract infection [(14,15)]. But when baseline renal function and blood pressure are normal pregnancy is unlikely to accelerate the progression of diabetic nephropathy [(16)]. They may develop significant proteinuria during pregnancy, even to nephrotic range, but generally reverses postpartum. But women with overt proteinuria may deteriorate.

Blood pressure control is important, but choose agents with care. ACEs and ARBs are contraindicated in all the three trimesters, because of a 2.7 times increased rate of fetal malformations when given in the 1st trimester[(17)], and 64% rate of neonatal renal failure or mortality in 2nd and 3rd trimester[(18,19,)]. Women should be switched to other agents safe in pregnancy like methyl dopa, labetalol or nifedipine before conception. There is a small series of women with overt nephropathy treated with diltiazem showed lower proteinuria and less fetal growth restriction [(20)]. There is some evidence from retrospective observational studies that optimum blood pressure control is associated with improved perinatal outcomes [(21)]. After delivery if an ACE is to be started and patient wishes to breast feed, both enalapril and captopril are considered safe by the American Academy of Pediatrics.

Lupus Nephritis (LN) :

LN presents unique problems during pregnancy especially with its unpredictable course due to its tendency for flares. Recent data suggest that, disease duration, disease activity and renal damage before

pregnancy are associated with increased organ damage postpartum[22]. It appears that pregnancy is associated with greater chance of disease exacerbation[23]. Women with lupus nephritis (LN) are advised not to conceive unless their disease has been "inactive" for the preceding six months, as there is higher incidence of fetal demise with active disease, especially nephropathy with fetal losses of 25-50% of cases.[24]

Additional complications associated with lupus and pregnancy include placental transfer of maternal auto antibodies, which can cause a neonatal lupus syndrome characterized by heart block, transient cutaneous lesions, or both. Women with lupus are also more likely to have clinically significant titers of antiphospholipid antibodies (anticardiolipin and lupus anticoagulant) which are associated with a fetal loss rate of 50%-75%, hypertensive syndromes indistinguishable from preeclampsia and thrombotic events including deep vein thrombosis, pulmonary embolism, myocardial infarction and strokes[25]. Thus all women with lupus have to be screened for antiphospholipid antibodies before pregnancy or early in gestation. And when titers are elevated daily low dose aspirin is recommended. If there is a history of thrombotic episodes or pregnancy loss, then heparin in combination with aspirin is recommended.

Sometimes it is difficult to differentiate increased activity in lupus from preeclampsia. Both are characterized by an increase in proteinuria, decrease in GFR, hypertension and most often thrombocytopenia. Impaired liver function is a feature of preeclampsia and reduced complements and active urinary sediment that of lupus.

The approach to treatment of lupus nephritis during pregnancy is largely on anecdotal experience, principles of treatment in nonpregnant patients, and knowledge of fetal toxicity of immunosuppressants. Corticosteroids and azathioprine are the mainstays of treatment. Hydroxy chloroquine use in pregnancy is associated with better outcomes, controls flares, and does not appear to be toxic to fetus. Cyclophosphamide is generally not recommended due to fetal toxicity. Mycophenolate is teratogenic and was found to be embryotoxic in animals[26].

Chronic Glomerulonephritis (CGN):

Child bearing women may be afflicted with any of the forms of CGN, but most studies do not have sufficient sample size to relate to specific histologic subtypes of CGN with pregnancy outcomes. It is the baseline renal function and the blood pressure rather than histology that dictate outcome.

IgA nephropathy is probably the commonest CGN and may be complicated by hypertension despite normal blood pressure and renal function before pregnancy.[27,28] The incidence of preeclampsia is about 25-30%. Pregnancy does not lead to worse long term renal outcomes in women who conceive when their renal function is well preserved.[29]

Chronic Pyelonephritis (CPN)

It includes a group of nephropathies associated with recurrent urinary tract infection, often associated with urinary tract abnormalities like vesicoureteral reflux (VUR). CPN worsens during pregnancy due to dilatation and stasis in the urinary tract. Preeclampsia was present in 24% of patients with VUR, most commonly in patients with preexisting hypertension [30]. Deterioration in renal function occurred in 18% and those with preexising renal dysfunction were at added risk. One third were delivered preterm and 43% had VUR. Pregnant women with urinary infection should have high fluid intake, should be screened with urine cultures at least monthly for bacteriuria and if present should be treated promptly. After a first infection, suppressive antibiotic therapy for the duration of pregnancy may be warranted.

Polycystic kidney Disease (ADPKD)

Young women with autosomal dominant polycystic kidney disease (ADPKD) are frequently asymptomatic, with normal renal function and normal blood pressure and may be unaware of their diagnosis.[31] Preexisting hypertension was the most common risk factor for maternal complications during pregnancy. They are also at an increased risk of urinary tract infections and surveillance urine cultures have to be considered. Estrogen is reported to have liver cysts to enlarge and repeated pregnancies will be a risk. Given the association between cerebral aneurysm and ADPKD, screening for aneurysm is to be considered before labour. All patients should undergo genetic counseling before pregnancy to ensure that they are aware that their offspring have a 50% chance of being affected.

Impact of chronic kidney disease in pregnancy

Maternal

- Worsening kidney function and/or proteinuria
- Potential flare of underlying disease
- Hypertensive disorders of pregnancy
  - Gestational hypertension
  - Preeclampsia
  - HELLP syndrome
- Complications of immunosuppression
- Miscarriage

Fetal

- Preterm birth
- Stillbirth or neonatal death
- Low birth weight
  - Fetal growth restriction
  - Small for gestational age

Renal replacement therapy and pregnancy:

Dialysis:

Fertility is reduced in dialysis patients, due to abnormalities of pituitary LH release, leading to anovulation. Pregnancy that does occur in patients undergoing maintenance dialysis is extremely high risk for the fetus, and conception should not be encouraged due to very high fetal mortality. In large surveys only 42 to 60 % of such pregnancies resulted in a live-born infant. Intrauterine growth restriction, very low birth weight, and premature birth was common.

Management of pregnancy during dialysis includes several considerations but the single most important factor influencing fetal outcome is the maternal urea concentration[32]. In patients undergoing dialysis the frequency has to be increased to 20 hr/wk aiming for a predialysis urea of 30 -50 mg/dL. In a small series daily nocturnal dialysis has also been used with success[33]. Heparinization during dialysis to be kept minimum to prevent obstetric bleeding. If peritoneal dialysis is being used, decreasing exchange volumes and increasing frequency is advisable or use a cycler[34]. Adequate calorie and protein intake are required.1gm/kg/d and an additional 20gm/d is recommended. Antihypertensive therapy should exclude ACEi and ARBs and maintain a maternal diastolic pressure of 80-90 mm Hg with methyl dopa, labetalol and sustained release nifedipine. Anemia should be treated with supplemental iron, folic acid and erythropoietin. EPO is safe in pregnancy, but dose may have to be increased by 50% to overcome resistance. Maintain Hb ~ 11gm/dl. Due to placental 25-hydroxylation of Vit D3 requirement decreases. Sevelamer should not be used in pregnancy due to the possibility of reduced or irregular fetal ossification in animal studies. If MgSo4 is to be used for seizure prophylaxis in preeclampsia, the loading and maintenance dose

has to be modified, since doses will accumulate, and Mg levels may rise rapidly.

Renal transplantation:

Menstruation and fertility return in most women 1-12 months after transplantation. Several thousand women have undergone pregnancy following renal transplantation, and pregnancy in this population appears to have much lower risk to mother and baby than in patients on dialysis. It is advisable to ask women to wait for a year before attempting pregnancy. Best practice outlines have outlined criteria for considering pregnancy in renal transplant recipients [28,29,30]. Those contemplating pregnancy should meet the following.

a. Good health and stable renal function for 1-2 years after transplantation with no recent acute or ongoing rejection or infections.

b. Absent or minimal proteinuria (< 0.5g/d)

c. Normal blood pressure or easily managed hypertension.

d. No evidence of pelvicalyceal distension on ultrasound.

e. Serum creat <1.5mg/dL

f. Drug therapy: prednisolone 15mg/d or less; azathioprine 2mg/kg or less; cyclosporine <5 mg/kg/d

Most pregnancies (>90%) that proceed beyond the 1st trimester succeed. There are, however, maternal and fetal complications due to immunosuppression, preexisting hypertension, and renal dysfunction. There could be maternal complications of steroid therapy such as impaired glucose tolerance, hypertension (47-73%) preeclampsia (30%), and increased infection. Fetal complications include 45-60% incidence of preterm birth and intra uterine growth restriction. Management of such pregnancies has to be done in a high-risk obstetric unit. We really do not have data on an optimum cyclosporine dose. Generally, cyclosporine levels decrease during pregnancy but no real advisory to increase dose. Experience with tacrolimus is increasing, appears to be safe, with similar side effect profiles to cyclosporine[31]. Mycophenolate mofetil and sirolimus are not considered safe in pregnancy. Currently there is no target BP for pregnant post-transplant patients. A blood pressure of <140/90 is recommended. Rejection is difficult to diagnose in pregnancy and renal biopsy may be needed. The consensus of opinion is that steroids are safe in pregnancy as is IV Ig, but the safety of anti-lymphocytic globulin and rituximab in pregnancy is unknown.

Pregnancy rarely negatively affects renal allograft, provided renal function is well preserved at conception and hypertension is well controlled, although there could be minor increase in serum creatinine post-partum which does not impinge on long term prognosis[32]

Pregnancy in a voluntary renal donor:

Outcomes after kidney donation appear favorable for the mother and baby, although there may be a slightly increased risk of hypertension in pregnancy and preeclampsia. Such donors should have more frequent clinical surveillance than normal low risk pregnancies, to evaluate hypertension, appearance of proteinuria and fetal growth[33].

Key summary Points:

- Asymptomatic bacteriuria should be treated in pregnancy to prevent obstetric and fetal complications.
- Short course 3days/7days antibiotic is sufficient in acute cystitis
- Hospitalized care should be given for severe pyelonephritis and patients who develop AKI
- To prevent teratogenicity antibiotics should be carefully selected
- It is well known that women with significant chronic kidney disease (CKD), are much less likely to become pregnant or have an uncomplicated pregnancy. But remember, even mild renal dysfunction is associated with a higher risk of adverse maternal and fetal outcomes, including worsening of maternal kidney function, proteinuria, and hypertension, as well as preterm birth and fetal growth restriction.
- But there had been instances of patients on dialysis becoming pregnant and is always associated with greater morbidity for the mother and the fetus and sometimes becomes a big challenge for the treating physicians.
- After successful renal transplantation, the prognosis for the mother and fetus is much better, provided the patient is only on moderate doses of immunosuppression, renal function is normal and hypertension well controlled.
- Pregnancy for a live renal donor, generally, is uneventful, but may have higher incidence of hypertension and preeclampsia.
- The risk for adverse maternal and fetal outcomes increases as GFR declines and in the settings of proteinuria and hypertension.
- All kidney disease patients who are considering becoming pregnant, should have a multidisciplinary evaluation that includes a nephrologist and a maternal-fetal medicine specialist (high-risk obstetrician). Women with reproductive potential and not using contraception should be followed closely for pregnancy
- Angiotensin-converting enzyme (ACE) inhibitors and angiotensin receptor blockers (ARBs) should not be used during pregnancy, since they are associated with fetal abnormalities. In general, as soon as a patient expresses desire for pregnancy, ACE inhibitors or ARBs to be stopped and transition to other medication (eg, nifedipine, labetalol, methyldopa) for blood pressure control. However, for CKD patients who have significant proteinuria and no immunological treatment options (eg, diabetic kidney disease or kidney scarring), we continue ACE inhibitors or ARBs up until the detection of conception (at which time they are stopped). ACEI may be restarted postpartum.
- Diuretics can be used in pregnant women with CKD if they have volume-mediated hypertension or signs of volume overload. Consider dose reduction, if appropriate, to avoid possible volume contraction
- For obstetric care, patients are seen at least monthly during the early first trimester, every two weeks by the second trimester, and weekly by the third trimester. Some patients require even closer follow-up throughout pregnancy
- Patients with CKD are considered to be at high risk for preeclampsia. Low-dose aspirin therapy has been shown to decrease the risk of preeclampsia in women at moderate to high risk of the disease, but studies have not included patients with CKD.
- Vaginal delivery is the preferred mode of delivery if there are no obstetric

contraindications. In most women, elective delivery is indicated if labor has not occurred by the estimated date of confinement. Even for low-risk women schedule delivery at 38 to 40 weeks of gestation. Cesarean delivery is performed for standard obstetric indications.

- Significant potential complications specific to pregnant women with CKD include preeclampsia, gestational diabetes mellitus (GDM), and infection. The diagnosis of preeclampsia is challenging in this patient population because of preexisting proteinuria, reduced GFR and hypertension.
- Postpartum care is similar among women with and without CKD. There are no contraindications to breastfeeding among CKD patients

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CHAPTER

17

Early Pregnancy Problems

Vinayachandran, K J Jacob

Editor's Notes

This chapter was originally assigned to Dr.T Narayanan along with Dr.Vinayachandran and Dr. K J Jacob. Unfortunately, Dr.Narayanan's health deteriorated during this period and he could not contribute. While writing this, he is reported to be improving; we wish him speedy recovery.

There are mainly three problems in early pregnancy contributing to maternal deaths – ectopic pregnancy, hyperemesis and septic abortions. Of these ectopic gestation is rapidly taking the central stage with newer dimensions.The undiagnosed ectopic becomes a rarity. At least in some centres an insistence to tackle all ruptured ectopics laparoscopically is seen. We would recommend that in a collapsed patient with lot of blood and clots in peritoneal cavity a quick laparotomy will be a better choice. More of scar ectopic is a price we are paying for the high cesarean rates; I am sure new thoughts on its management will evolve in the coming years.

V P Paily

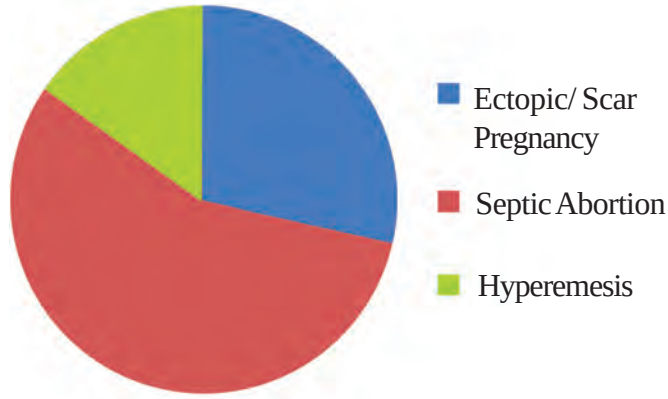
Introduction

Maternal mortality, though declining, still remains unacceptably high. Sub Saharan Africa and South east Asia accounted for almost 86% of the maternal deaths in 2017. At the same time, Southern Asia achieved the greatest overall reduction of nearly 60%. (WHO, 2019)[1] In this chapter, we discuss early pregnancy problems causing maternal death. As we know, mortality in early pregnancy is less common and the major causes are ectopic pregnancy and septic abortion. Hyperemesis gravidarum, if neglected, can cause dyselectrolytemia and dehydration, which can be dangerous. Very rarely infections, especially pyelonephritis following untreated urinary tract infection (UTI), can be a cause. Deliberate self- harm is also on the rise; this will be dealt with in the chapter on mental health and suicide.

Table 1.Common causes of death in Early Pregnancy

Year	Ectopic /scar pregnancy	Septic abortions	hyperemesis	Total deaths analysed
2010/11	nil	2	nil	113
2011/12	1	2	1	85
2012/13	1	2	nil	101
2013/14	nil	2	1	112
2014/15	2	3	nil	117
2015/16	1	2	1	106
2016/17	3	nil	1	80
2017/18	nil	3	2	138
2018/19	3	6	nil	122
2019/2020	2	nil		102
Total	**13**	**22**	**6**	**1076**

Fig 1. Common causes of death in Early Pregnancy



Ectopic pregnancy as a cause of mortality

Although a common cause of mortality earlier, deaths due to ectopic pregnancy have declined with the earlier use of ultrasonogram (USG) for diagnosis and medical management with methotrexate. However, a delay in diagnosis or a mistaken diagnosis may result in unacceptable near miss situations or even mortality. A US study from 2004 to 2008 has reported an ectopic pregnancy mortality ratio of 0.48 per 100000 live births. In our series in 2004-2005, 1.9% deaths were due to ectopic pregnancy and in the 2006-2009 series it was about 2.1%. In the current series from 2010-2020, it remains at around 1% of all deaths. There are 13 deaths, which include a ruptured cesarean scar pregnancy, a ruptured accessory horn pregnancy and a case of post-operative pulmonary embolism. The common factor in most of the cases was a delay in diagnosis, especially from the centre where the patient first visited.

Unusual presentations which may increase chances of mishaps are:

Heterotopic - Risen from 1 in 30000 to 1 in 3900 pregnancies. With an intra uterine pregnancy, the potential for missing the diagnosis is high, so the patient may present with rupture, acute abdomen and hemodynamic shock, with a potential for mortality, if not immediately and expertly managed.

Abdominal ectopic - Usually detected late, so first trimester problems rare. Since only small volume of placenta is usually seen, massive hemorrhage is not common.

Cesarean Scar Pregnancy (CSP)- Occurs in approximately 1 in 2000 pregnancies. If implanted deep in the scar, it predisposes to rupture in the first trimester, where there could be excessive hemorrhage.

Example 1

35 year old woman, 13 weeks gestation, with a history of two previous cesareans and one ectopic pregnancy for which salpingectomy was done, was brought to the local private hospital. She complained of lower abdominal pain radiating to right shoulder and giddiness off and on. She had a fall in the bathroom the previous day. Bedside USG showed live fetus 12 weeks and moderate amount of free fluid in the abdomen. Suspecting sepsis antibiotics were started. As her urine output was decreasing and she was not improving she was referred to a tertiary care centre the next day. Emergency USG showed placental separation. Immediately laparotomy was done. Lower segment had given way and placenta was bulging through the scar and bleeding. Products were removed and bladder injury was sutured. While closing the abdomen she had a cardiac arrest and could not be revived.

Interstitial pregnancy and Cervical pregnancy also might lead to excessive hemorrhage.

Key recommendations

1. Think ectopic for any patient presenting with the classic triad of abdominal pain, amenorrhea, and bleeding per vaginum.
2. Remember, all of these need not be present in every patient. So it might be prudent to rule out ectopic in all reproductive age group patients who come with abdominal pain irrespective of their last menstrual period.
3. Offer beta hCG and trans vaginal scan in all suspected cases, hospitalisation preferable, that too, in centre with facility for early surgery and medical management.
4. Those with risk factors for ectopic pregnancy should have an early USG.
5. Early diagnosis and medical management helps prevent morbidity.
6. Always ask for location of sac in USG especially in case of previous cesarean.
7. Imaging an intrauterine gestational sac does not exclude a heterotopic pregnancy. Complete USG evaluation is a must for all patients, especially for those with high risk factors or those with persistent symptoms, because conditions like cesarean scar pregnancy, abdominal pregnancy, cervical pregnancy, accessory horn or interstitial pregnancy may be missed unless there is a high index of suspicion. An MRI or 3D scan may help confirm the diagnosis.
8. In a hemodynamically unstable patient, immediate surgery with simultaneous resuscitation, adequate blood and component replacement as per shock index, will be life- saving. Laparoscopy may be suitable in some cases but has to be chosen depending on the case.

Example 2

33year old gravida 2 with gestation of five weeks (1st abortion at 12 weeks) was admitted to the local hospital with abdominal pain and diarrhoea. As her pain was increasing she was referred to a tertiary care. Clinically diagnosed as ectopic and emergency USG confirmed ruptured ectopic. Immediate laparoscopy was done under general anesthesia. There was two litres of blood in the peritoneal cavity. Left isthmial pregnancy noted. Left salpingectomy was done. She developed severe dyspnea postoperatively and was shifted to ICU but she could not be saved.

In this case we do not have the details of the surgery to opine whether a quick laparotomy would have been better than a laparoscopy. When there is massive hemoperitoneum with clots laparoscopic clearance of these clots take much longer than a quick laparotomy.

Ectopic pregnancy in malformed uterus can lead to relatively late rupture with massive hemorrhage and its consequences. See this example.

Example 3

32 year old gravida 2 P1 L1 with a gestational period of 15 weeks and five days was brought to the emergency department with severe abdominal pain. She was in shock. She is a known case of Rheumatic heart disease (MR). USG showed intraperitoneal bleed and floating fetus. She was resuscitated and shifted to the operation theatre, but developed cardiac arrest. She was revived again and laparotomy was done. She had a bicornuate uterus with rupture of left horn. There was about one litre of blood and 500 gms of blood clots in the peritoneal cavity. The ruptured horn was resected, blood and blood products were transfused. Postoperatively she was in Critical care Unit. Developed renal failure (Dialysis done), DIC. Relaparotomy was done but she developed cardiac arrest again and expired.

Due to rupture of the accessory horn pregnancy at around 16 weeks of gestation, developed massive intra peritoneal bleed and hypovolemic shock which initiated DIC and MODS. The critical situation is complemented by the already compromised cardiovascular system (Known case of RHD-MR). The reason for relaparotomy (not given) could be suspected as continued intraperitoneal bleed which further worsened the condition and culminated in the death of the mother.

What could have been done?

- The problem should have been detected by the first trimester scan and interfered electively at an earlier date. This emphasises the importance of looking for all possible problems in the pelvis while doing a scan (especially in predisposed patients like additional non gravid horn, an additional pregnancy in the adnexa etc).
- Warning symptoms requiring medical attendance like abdominal pain, fainting, bleeding, should be taught to the pregnant women so that delay in reaching and also initiation of management is avoided.
- Even though it is not evident from the record what necessitated a relaparotomy, it could be suspected hematoma or on-going bleed or vital organ injury. Improvement in surgical skills and calling for senior supervision at difficulties may be considered

Septic abortion

In the review covering the period 2006 - 09, there were no cases of septic abortion. Dishearteningly however, there are 22 cases in the ten year period under review now, giving an incidence of almost 2%.

Overview

When a spontaneous or more often induced abortion is accompanied by intra uterine infection, it is called a septic abortion. Unsafe abortions performed by people lacking necessary skills / using hazardous techniques / in an environment that does not meet minimum standards can also lead to sepsis. This can be severe and life threatening, with case fatality rates of 3.3% reported in a systematic review of 43 studies, and hence it is important to be aware of the clinical presentation.Young and poor women from developing countries, and those who lack partner support are more likely candidates. A proper history of any intra uterine manipulation, followed by fever, chills, pain in abdomen, foul smelling discharge or bleeding per vaginum with adnexal tenderness on examination, progressing to a frank picture of septic shock should warrant early initiation of corrective measures.

Ensure hemodynamic and electrolyte stability with adequate fluids or blood products. Administer broad spectrum antibiotics.

USG to identify retained products and surgical evacuation of the same should be done promptly, under antibiotic cover, preferably suction evacuation, taking care to minimise the risk of perforation and avoiding excessive curettage to decrease

the risk of intra uterine adhesion formation.

Patients who do not respond to antibiotic, or those with pelvic abscess or clostridial necrotising myonecrosis (gas gangrene) or traumatic lacerations may need surgical intervention like laparotomy, laparoscopy or colpotomy. Products to be sent for culture and sensitivity tests and antibiotics modified accordingly. Good multidisciplinary postoperative care is essential. Apart from instrumentation leading to perforation, hemorrhage, sepsis and coagulopathy also add to the morbidity and mortality. Other causes of mortality include cardiac / renal toxicity of mixtures such as creosol, phenol etc, vaginal and rectal chemical injuries and abdominal trauma due to vigorous massage.

With the advent of misoprostol, many complications have reduced, but unsupervised and over the counter use has created problems due to drug quality and toxicity due to overdoses. Retained products, prolonged bleeding, and not seeking medical care increase risks of sepsis.

Key recommendations:

1. Medication abortion is the better option for terminating early pregnancies. USG may be done to rule out ectopic pregnancy. Manual Vacuum Aspirator (MVA) should be used where possible.
2. Strict aseptic precautions for all surgical procedures and antibiotics as per institutional policy.
3. Proper training for correct techniques of surgical evacuation.
4. USG mandatory if suspecting incomplete evacuation.
5. All patients undergoing termination to be advised to report if they have fever, abdominal pain, foul smelling discharge, etc.
6. In cases, with sepsis, institute septic care bundle immediately with supportive therapy, cultures, escalating antibiotics as per reports, cross consultations and surgical interventions when indicated (evacuation, laparotomy or colpotomy)

Hyperemesis gravidarum

Severe vomiting in the first trimester with hypovolemia and weight loss is infrequently seen and given the level of antenatal care in our state, should not usually account for mortality. Unfortunately however, in the present series, hyperemesis, mostly with other aggravating factors, accounts for six cases of mortality, giving an incidence of roughly 0.6%. The fact that there were no cases in the previous four years, make it even more unpalatable.

The mortality cases include two with Wernicke's encephalopathy, one who had cardiomyopathy with hypothyroidism and electrolyte imbalances and one who had viral encephalitis with severe dehydration and cortical venous thrombosis and seizures (ignorance of the dangers and lack of financial resources led to a delay in seeking care in this last patient).Availability of enteral and parenteral nutrition has reduced morbidity from this condition worldwide, but Wernicke's encephalopathy, esophageal rupture, splenic avulsion, pneumothorax, hepatic insufficiency, venous thrombosis, acute tubular necrosis have been mentioned in the literature, all with a propensity for morbidity and mortality.

Example 4

29 year old primi, IVF conception, gestation of 14 weeks. She was referred from the local hospital as having hyperemesis with fever and high BP on 11th. On evaluation she had low grade fever and altered sensorium, She was dehydrated and electrolyte imbalance was seen. Consulted the physician and was diagnosed as Wernicke's Encephalopathy.

Management - Electrolyte imbalance corrected; Thiamine was given, she showed initial improvement and was stable for 24-30 hrs. But later developed generalised weakness and altered sensorium. MRI/MRV

–Normal. Shifted to ICU on the 15th. Developed cardiac arrest, and could not be revived.

Cause of death - Hyperemesis Gravidarum (HEG), dyselectrolemia, ? Wernicke's encephalopathy.

Patient had severe HEG which resulting in dehydration, electrolyte imbalance and Thiamine deficiency manifested as Wernicke's encephalopathy. Failure to recognize the electrolyte imbalance, neurological problems, renal failure and liver failure and seriousness of the situation and thus inadequate management (details from local hospital not available) causing further worsening of the condition in the local hospital may be reason for her unfortunate death in the Tertiary centre, in spite of starting appropriate management.

What could have been done? –All patients with HEG should be monitored for Hypovolemia-dehydration, appropriately corrected in addition to administration of parenteral antiemetics, IV Fluids and Thiamine (as prophylaxis)

Key recommendations:

1. Do not treat this common complaint with disrespect.
2. Determine the severity of the disease and prevent serious complications like dyselectrolytaemia, vitamin deficiencies (Eg Wernicke's encephalopathy) and extreme weight loss by early intervention and treatment with dietary modifications and medications like doxylamine succinate and / or pyridoxine.
3. Changing to H1 antagonists (meclizine or diphenhydramine) or dopamine antagonist (metoclopramide or promethazine) or adding a serotonin antagonist (ondansetron) along with acid reducing agents may be tried.
4. In patients with severe vomiting with hypovolemia, it's necessary to exclude other causes, give intravenous fluids and antiemetics, assess and correct electrolytes and acid-base balance. (Ringers lactate initially and then 5% DNS may be given to maintain a urine output of at least 100ml/ hr). Emotional support and psychosocial counseling is necessary. Relocation from their environment may also contribute to relief.
5. It's very important to give thiamine (100 mg-200mg daily IV, initially, with the isotonic saline and repeated for two to three days) before giving dextrose to prevent Wernicke's encephalopathy. Then continue with oral thiamine 100 mg bd for 1-2 weeks. When a patient is having wernickes encephalopathy or wet beriberi treatment dose is higher dose 200-500 mg IV tid for 3-7 days and then 250 mg IV for 5 days and then oral.
6. Potassium, sodium, magnesium, calcium levels should be assessed and corrected.
7. Multivitamins may be added. Diet should be restored gradually.
8. A short course of steroids may be effective in refractory cases (hydrocortisone 100 mg IV twice daily for three days).
9. Women with diabetes require special care.

Prevention

- Early diagnosis of ectopic pregnancy
- Prevention of unwanted pregnancies by access to contraception and safe abortion services
- Health Education - so that problems like hyperemesis, psychiatric issues etc are not neglected
- Social support, which may be a factor in delayed access to care

Reference

1. Trends in maternal mortality: 2000 to 2017 estimates by WHO ,UNICEF, UNFPA , World bank group & the united nations population division Geneva : WHO 2019

CHAPTER

18

Suicide as a cause of Maternal Deaths

K S Shaji, Megha Jayaprakash, P P Ramesh Kumar

Editors' Note

There is an alarming increase in the number of maternal deaths due to suicide that peaked in the year 2019 -20. Twenty three suicide deaths out of 133 total deaths is worrying. The tragedy is that details of almost all these deaths are not available to us. As far as we know there is no system in place to go into the details of these tragedies. CRMD cannot analyse these cases because no records are available. A clear plan to spot the potential candidates who will end up in self harm is essential. Once identified there should be a mechanism to offer effective help without attracting stigma. This needs involvement of multiple departments outside of health services but department of health has to co-ordinate such activities and bring these stake holders to a common platform. What we need is an attempt to learn lessons from the real cases of suicide that happened in our state. The preliminary information we have is that many of these are not due to the classical postpartum depression. So, the tools developed to identify postpartum depression will not pick them up. Nor is it possible to employ counselors in the large number of antenatal clinics spread out across the government and private hospitals and clinics.

Marital disharmony due to drunken husbands, domestic quarrels due to dowry system, wide use of mobile phones which facilitate contact between emotionally unstable youngsters leading to extramarital sexual contact and pregnancy etc seem to be the background to many of the suicides. How can we effectively do anything to reverse these trends. Many stake holders have to be involved to do anything effective in this. Departments of social welfare, child welfare, education, police etc have to come together to chalk out practically useful steps in this regard. Obstetricians are not the key players.

The questionnaires given in this chapter may help in identifying those needing help. But once they are identified, do we have a machinery to guide these people away from depression and self-harm? A collective effort is urgently required.

V P Paily

Introduction

Maternal suicide is a 'direct cause' for maternal death according to ICD-MM developed by the WHO working group (2012) even if the diagnosis of postpartum depression or puerperal psychosis is not established. An important forerunner for suicide could be the presence of depression in the antenatal period.

Depression and anxiety affects an estimated 10 to 20% of pregnant women worldwide and this is more so among mothers from low and middle-income countries. Antenatal depression can persist after child birth. Depression causes functional impairment. Persistent maternal depression can have adverse impact on child development. Women exposed to psychosocial adversity are known to be at a higher risk. Though common, depression remains a hidden problem during pregnancy. In a study conducted in Government Medical College Thrissur, the prevalence of depression in the antenatal period was as high as 53 %.

Unrecognised and untreated antepartum and postpartum depression are important risk factors for suicide. About 50% of women with a previous mood disorder and 70% of those with a family history of postpartum psychosis develop a relapse during a subsequent pregnancy.

Key Summary Points

1) Maternal deaths attributed to suicide averaged 9 % in Kerala during the decade 2010 to 2020.

2) Majority of the cases of suicide occurred in early antenatal period and did not have a history of any psychiatric illness.

3) Some of the major risk factors identified were known history of psychiatric illness, young age, unmarried status and domestic violence.

Key Recommendations

1) Follow Government of Kerala recommendation to screen for mental health atleast once in each trimester of pregnancy and atleast 3 times in the postnatal period (at 6 weeks, 14 weeks and 9 months postpartum coinciding with the vaccination schedule)

2) Use the questionnaire scale provided by Amma Manass programme or any validated screening tool that is easy to administer like PSQ-4D (Refer Annexure for Malayalam and English versions). A score of 2 or more is considered as positive screen. **Use Mental Health Screening Seals on all antenatal cards** (Refer Figure-1) to ensure enforcement and to assure privacy. Maintain Registers for data collection and audit.

3) Screening should be done by a trained social worker or first contact health worker which can also be the JPHN or ASHA worker. If screen positive, she should be referred to the next level of care for further evaluation.

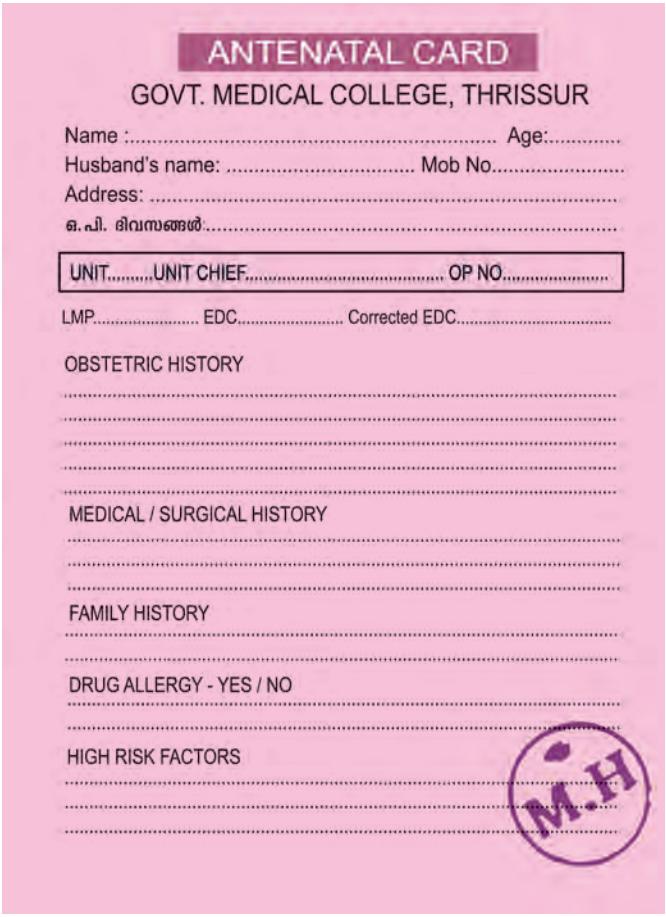
4) Those women with history of mental health problems should be referred directly to a mental health specialist for assessment of her present mental state and to review medications.

5) Ideally preconceptional assessment and counselling should be done for women with known psychiatric illness.They should be advised contraception if found necessary. High dose periconceptional folic acid and switching to safer medications should be advised.

6) Importance of Adolescent health education and counseling in schools should be emphasised and should be carried out by the respective gynecological societies in each area.

7) Distress helpline numbers and posters to raise awareness of mental health and importance of seeking help should be displayed in hospitals and public places

8) Cases of maternal suicide should be reported and a team consisting of the District Mental Health Nodal Officer and the District RCH officer should conduct a psychological autopsy of each reported death as per Government of Kerala guidelines.


ANTENATAL CARD

GOVT. MEDICAL COLLEGE, THRISSUR

Name :..... Age:.....

Husband's name: ..... Mob No.....

Address: .....

ഒ.പി. ദിവസങ്ങൾ:.....

UNIT.....UNIT CHIEF..... OP NO.....

LMP..... EDC..... Corrected EDC.....

OBSTETRIC HISTORY

MEDICAL / SURGICAL HISTORY

FAMILY HISTORY

DRUG ALLERGY - YES / NO

HIGH RISK FACTORS

M.H

Figure 1: Antenatal card showing the seal

Recent trends

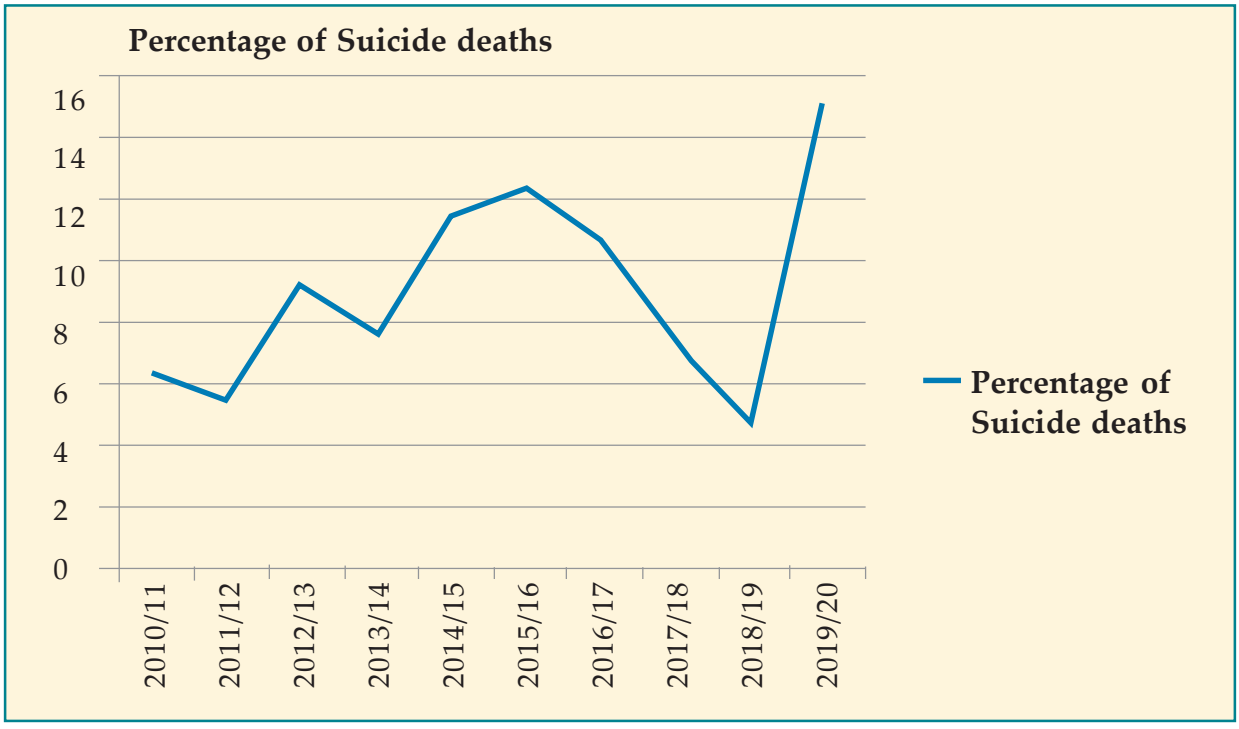
Perinatal suicide is a major contributor to the maternal mortality in Kerala and the incidence is almost similar to the developed world.

Majority of the perinatal suicides are under estimated and under reported. The social stigma and medico legal implications of suicides leads to cover- up of perinatal suicides and attribution of these suicidal deaths to other causes. Wide

difference in the incidence of perinatal suicides in literature (0% in South Africa and Vietnam to 23% in Argentina) could be due to these factors. Most of these women didn't receive the mental health evaluation and treatment at the crucial moment. The incidence of perinatal suicides are markedly reduced in women who received such treatments.

In Kerala, though suicide is an important contributor to maternal mortality, mental health evaluation of all antenatal and postnatal women is rarely undertaken. Busy professional schedules and crowded outpatient and inpatient departments are contributory. The lack of awareness (mental health consciousness) on the obstetrician's part is an equaly important reason.

Figure 2. Run chart showing Trend in Kerala(Data from CRMD-KFOG)



Learning from examples

Example 1

A 19 year old teenager became pregnant before marriage, underwent MTP in an undisclosed location, was admitted in a government hospital for evacuation of retained products and discharged after 7 days. She was found dead after one month having consumed poison.

Example 2

A 15 year old school girl, unmarried primigravida committed suicide by burning herself using kerosene.

Teenage and unmarried status are known risk factors for maternal suicide.The importance of adolescent health education and counselling in educational institutions regarding the dangers of social media has to be emphasised. Parental guidance and peer group support plays a key role.

Example 3

A 21 year old second gravida, 26 weeks pregnant from a second marriage, known to have frequent quarrels with husband, committed suicide by hanging.

Intimate partner violence, emotional abuse, loneliness, lack of social and family support, and unwanted pregnancies increase the vulnerability of these women. Dowry issues, substance and alcohol abuse and dysphoric temperament contribute to risk of suicidal attempts. Antenatal screening could possibly have detected mental health issues and averted this unfortunate outcome.

Example 4

A 24 year old primigravida in second trimester of pregnancy, known to have Bipolar disorder, consumed organophosphorous poison and succumbed to death.

People with Bipolar disorder are prone for relapses. Episodes of depression can be missed as the clinical features of depression can be less obvious to others unlike manic episodes. It is possible that this mother had a depressive episode. Depression is an eminently treatable condition. All patients with history of mood disorder should have an evaluation by a psychiatrist. It is also important to look for episodes in the postpartum period.

About one third of women with a history of bipolar disorder illness will have a relapse in the post partum period. So all expectant mothers with history of psychiatric illness should be referred for evaluation by a mental health specialist preferably preconceptionally or atleast at the booking visit. Further antenatal reviews can be combined with review by a mental health specialist. Close monitoring, and prompt interventions can prevent relapses. The close relatives should also be counseled regarding patient care and support and need to adhere to the psychotropic medications prescribed.

Example 5

31 yr old Para 2 post LSCS developed abnormal behaviour on day 3 and jumped to death from the hospital ward on day 4.

We do not know about past history of mental health problems in this mother. First postpartum week has the highest incidence of mental health problems. Traumatic birth experiences like prolonged labour ending in difficult operative vaginal deliveries or second stage cesarean sections with ICU admissions for mother and baby or perinatal death as well as insomnia are known risk factors for depression in the postpartum period. Emergency perinatal mental health interventions may be needed in such situations. Mothers with sleep problems, mood and behavioural symptoms during the first post partum week need monitoring and detailed evaluation. Psychiatric consultation should be sought if psychiatric symptoms emerge during the post partum period.

Conclusions

Mental health screening using validated tools can be performed effectively during the antenatal and postpartum period. It should become an integral part of routine antenatal care if deaths due to mental disease are to be reduced. At the same time, deaths due to social factors that are beyond the obstetrician's purview point to the need for a more concerted effort from all key stakeholders.

Annexures

'അമ്മമനസ്സ്' – മാതൃ-ശിശുമാനസികാരോഗ്യസംരക്ഷണപദ്ധതി

മാനസികാരോഗ്യ ചോദ്യാവലി

ക്രമ നം	ചോദ്യം	1 (1st Trimester)	2 (2nd Trimester)	3 (1rdTrimester)	4 (6th week immunisation)	5 (14 th week immunisation)	6 (9 th month immunisation)
1.	മാനസിക സമ്മർദ്ദം/ ടെൻഷൻ						
2.	ഉറക്കകുറവ്, വിഷാദം, കരച്ചിൽ എല്ലാത്തിലും താൽപര്യകുറവ്						
3.	ആത്മഹത്യാ ചിന്തകൾ/ പ്രവണത സ്വയം ഉപദ്രവിക്കൽ						
4.	നെഞ്ചിടിപ്പ്, വെപ്രാളം, ശരീരം വിയർക്കൽ, ഉത്കണ്ഠ						
5.	മുൻപ് എപ്പോഴെങ്കിലും മാനസിക പ്രശ്നങ്ങളോ, അപസ്മാരമോ ഉണ്ടായിട്ടുണ്ടോ						
കൂടെയുള്ളവരോട് ചോദിച്ച് അറിയേണ്ടവ							
6.	അമിതമായ ദേഷ്യം, അമിതമായ സംസാരം						
7.	അകാരണമായ സംശയങ്ങൾ, ഭയം						
8.	ഒറ്റക്കിരുന്നുള്ള ചിരി, സംസാരം പിറുപിറുപ്പ്						
9.	കുഞ്ഞിനെ പരിചരിക്കാനുള്ള താൽപര്യകുറവ്, അപാകത						
10.	ശ്രദ്ധയിൽപെട്ട് മറ്റെന്തെങ്കിലും മാനസിക പ്രശ്നങ്ങൾ						
സ്ക്രീൻ ചെയുന്ന നഴ്സിന്റെ പേരും ഒപ്പും							

Primary care Screening Questionnaire for Depression (PSQ4D)*

പ്രാഥമികാരോഗ്യ തലത്തിൽ വിഷാദരോഗം കണ്ടെത്താനുള്ള ചോദ്യാവലി (PSQ4D)

1.	മനസ്സിന് സങ്കടവും വിഷമവും കഴിഞ്ഞ രണ്ടാഴ്ചയിലധികമായി തുടർച്ചയായി അനുഭവപ്പെടുന്നുണ്ടോ	ഉണ്ട് / ഇല്ല
2.	കാര്യങ്ങൾ ചെയ്യാൻ താൽപര്യകുറവും ഉത്സാഹകുറവും കഴിഞ്ഞ രണ്ടാഴ്ചയിലധികമായി തുടർച്ചയായി നീണ്ടുനിൽക്കുന്നുണ്ടോ	ഉണ്ട് / ഇല്ല
3.	അമിതമായ ക്ഷീണവും തളർച്ചയും രണ്ടാഴ്ചയിലധികമായി തുടർച്ചയായി അനുഭവപ്പെടുന്നുണ്ടോ	ഉണ്ട് / ഇല്ല
4.	ഉറക്കകുറവ് രണ്ടാഴ്ചയിലധികമായി തുടർച്ചയായി നീണ്ടുനിൽക്കുന്നുണ്ടോ	ഉണ്ട് / ഇല്ല

മൂന്നോ അതിലധികമോ ചോദ്യങ്ങൾക്ക് ഉണ്ട് എന്നാണ് ഉത്തരമെങ്കിൽ വിഷാദരോഗം ആകാൻ സാധ്യതയുണ്ട്. സ്ഥിരീകരണത്തിനായി ഡോക്ടറെ സമീപിക്കുക
രണ്ട് ചോദ്യങ്ങൾക്ക് ചോദ്യങ്ങൾക്ക് ഉണ്ട് എന്നാണെങ്കിലും ശ്രദ്ധിക്കണം

* Indu PS, Anilkumar TV, Pisharady R, Russell PS, Raju D, Sama PS, Remadevi S., Amma KL, Sheelamani A, Audrade C, Primary care screening Questioniare for Depression (PSQ4D) : reliability and valadity of a new for item tool, British Journal of Psychiatry open 2017 3.91-95. illni 10.1192

Table 1. Items in the Primary care screening Questionnaire for Depression (PSQAD)
Q1. Have you been experiencing sadness or depressed mood,during the last 2 weeks or longer? **Yes/No**
Q2. Have you been experiencing loss of interest or loss of pleasure in doing things during the last 2 weeks or longer? **Yes/No**
Q3. Have you been feeling excessively tired or without energy during the last 2 weeks or longer? **Yes/No**
Q4. Have you been suffering from sleeplessness , during the last 2 weeks or longer?**Yes/No**

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CHAPTER

19

Less common Causes of Maternal Deaths

S Ajith, P V Jose , Simi Kurien, Hariprasad

Editors' Note

Even though captioned as "less common causes", collectively they constitute the second largest group, second only to hemorrhage. However, each one of the conditions in this miscellaneous group is relatively rare and would demand the support of a non-obstetrician specialist in diagnosis and management. This highlights the need for the obstetrician to keep an "eye" on other systems and the general welfare of the woman.

Some of these conditions are not all that rare and have regional focus. For example Sickle cell Disease (SCD) is almost exclusively a disease of the tribals in our state. They are settled in the eastern parts of our State, spread over almost all the districts but focused mainly in Wayanad, Kozhikode, Malappuram, and Palakkad districts. Obstetricians serving in these areas have to look out for SCD and take appropriate steps. After all, there are only 4.8 lakhs tribals in our state as per the 2011 census and there were 10 deaths due to SCD , a very significant number.

The 15 deaths due to immunological causes like Systemic Lupus Erythematosus (SLE) (8) or Sjogren's Syndrome (2) also constitute an important entity because of the vagaries of the symptoms of presentation.

The 24 deaths due to malignancies is another matter of concern especially with three of them being due to carcinoma of the breast and two of them due to choriocarcinoma. With the rising incidence of carcinoma breast in the young women in the community we should expect more of such cases in the coming years. It is high time that we incorporate the routine practice of breast examination during the first visit itself. Incidentally this will help pick up the retracted nipple and counsel her regarding manipulative correction in the last few weeks of pregnancy.

V P Paily

Introduction

Whenever the issue of maternal deaths in obstetrics is under discussion, one tends to weigh rather heavily upon PPH, hypertension, cardiac diseases etc. Often overlooked are those causes of maternal deaths which are assigned under less common causes. These include Systemic Lupus Erythematosis (SLE), Sickle cell anemia, Malignancy, Ovarian hyper stimulation syndrome (OHSS), Inflammatory bowel disease, Pancreatitis, Postpartum collapse, Anaphylaxis, HIV, Thrombophilia, GI bleed, Hemolytic anemia, Transfusion reaction, Hyperemesis, Volvulus, Disseminated Tuberculosis, Diaphragmatic hernia, Bowel perforation, Leptospirosis, Diabetic ketoacidosis, Thyrotoxicosis, Malabsorption ,Intraperitoneal bleed, Sjogren's, Muscular dystrophy, Coagulopathy & Vasculitis, Pan hypopituitarism, Postpartum angiopathy, Ogilvie's syndrome and AV malformation lung.

Key summary points

- There were a total of 98 cases in this group
- Among the Less common causes, gastrointestinal problems were the most common.
- Malignancy as a cause of maternal death is also of concern.

Table. 1 Less common causes of maternal death 2010 - 20
Total : 98 cases

Gastro intestinal	**15**
Pancreatitis	3
GI bleed	2
Congenital Diaphragmatic Hernia	3
Bowel perforation	1
Repture stomach	1
Malabsorption	1
Ogilvie's syndrome	1
Volvulus	1
Inflammatory bowel diseases	1
Int. obstruction	1
Malignancy	**24**
Lymphomas and leukemias	8
Ca.Breast	3
Choriocarcinoma	2
Bone Tumours	2
Ca Ovary	1
Ca Colon	1
Ca Lung	1
Ca Pancreas	1
Ca Liver	1
Pheochromocytoma	1
Synovial sarcoma	1
Brain tumor	2
Endocrine	**5**
Diabetic keto acidosis	1
Panhypopituitarism	1
Thyrotoxicosis	2
Pitutary macro adenoma	1
Hematological	**15**
Sickle cell disease	11
Thrombophilia	1
Hemolytic anemia	1
Transfusion reaction	2
Coagulopathy and vasculitis	2
Infective	**8**
HIV	2
Disseminated TB	2
Leptospirosis	4
Immune system	**16**
SLE	9
Sjogren's syndrome	2
Anaphylaxis	3
Overlap syndrome	1
Mixed connective tissue disorder	1
Miscellaneous	**15**
Spinal muscular atrophy	1
Ovarian Hyperstimulation	1
Lymphangio Leiomiomatosis	1
Guillan Barrie	3
Postpartum collapse	6
A V Malformation lung	1
Aspiration	2

Table 2 Less common causes during the 10 year period 2010 -20

	2010/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Malignancy	1	2	1	4	5	4	2	0	2	3
GI	2	1	2	0	0	2	2	0	1	5
Endocrine	0	0	0	1	3	0	0	0	1	0
Hematological	2	3	2	0	2	0	0	2	2	3
Infective	1	0	1	2	0	0	0	2	1	1
Immunological	2	0	3	3	3	0	1	1	2	0
Miscellaneous	2	0	1	1	1	1	0	6	1	2
Total	**10**	**6**	**10**	**11**	**14**	**7**	**5**	**11**	**10**	**14**

Gastrointestinal causes

Anatomic and physiologic changes in the gastrointestinal tract often give rise to significant maternal changes even in normal pregnancies. It is quite difficult to differentiate normal physiological changes of pregnancy from pathological entities.

Nausea and vomiting are quite common in pregnancy but other pathologic causes like hepatitis, cholecystitis, appendicitis, intestinal obstruction, pancreatitis, pyelonephritis, uncontrolled diabetes need to be ruled out especially in refractory cases or in cases with undue abdominal pain. In patients with hyperemesis gravidarum, multiple pregnancy and gestational trophoblastic disorders also need to be ruled out.

Asymptomatic hiatal hernias are common during pregnancy and post-partum period. Although largely uncomplicated, they can very rarely lead to a life threatening diaphragmatic rupture.

Congenital diaphragmatic hernia is an unusual condition in the adult population as it is chiefly a neonatal diagnosis. There are reports of diaphragmatic hernia presenting as surgical emergency in term pregnancy and in post-partum period. There were three such cases in the present series.

Acute appendicitis is a significant cause of acute abdominal pain in pregnancy. Fetal and maternal morbidity and mortality are higher in pregnancy, particularly if perforation occurs. Appendiceal perforation rates are higher in pregnancy owing chiefly to delay in diagnosis. High index of suspicion and prompt surgical intervention is the standard treatment.

Inflammatory bowel disease (IBD) include Ulcerative colitis and Crohn's disease. If a woman conceives during quiescent period, the pregnancy is expected to proceed with no added complications. Around one third of patients with active disease will experience a flare during pregnancy. Pregnant patients with IBD should be advised to continue the medications keeping them in a state of remission. Methotrexate is contraindicated; however, sulfasalazine, steroids and azathioprine may be continued.

Acute pancreatitis is another rare and serious condition which can complicate pregnancy. Although chiefly attributed to alcoholism in non-pregnant individuals, gall stones are the main culprits in pregnancy. Other causes ascribed are hyperlipidemia, medications, alcohol consumption and an association with AFLP. The disease is more common in third trimester and puerperium. The

differential diagnosis include peptic ulcer disease (including perforation), acute cholecystitis, biliary colic, intestinal obstruction and ovarian torsion. Epigastric pain, which radiates to flanks, back or shoulders along with abdominal tenderness, should prompt immediate investigations.

Elevated white blood cell count, serum lipase, serum amylase, serum transaminases, lactate dehydrogenase, blood sugar, blood urea nitrogen and base deficit and decreased serum calcium and partial pressure of oxygen are the usual laboratory findings in pancreatitis. Ultrasound is quite sensitive in diagnosing cholelithiasis in the setting of acute pancreatitis. Ultrasound imaging of pancreas may be difficult due to overlying bowel gas, in which case, MRI may be required which could give further details such as presence of pseudo cysts or hemorrhage within the pancreas.

Acute pancreatitis usually resolves spontaneously within several days, but 10% may have a more severe course requiring ICU care. The principles of management are bowel rest with or without nasogastric aspiration, IV fluids with electrolyte replacement and parenteral analgesics (Meperidine is the drug of choice for analgesia). As often associated with gall stone disease, ERCP may be beneficial especially if common duct obstruction has occurred. Early surgical intervention is advocated for gall stone pancreatitis in all trimesters. Perinatal morbidity and mortality is also increased in severe disease, hence regular fetal monitoring is mandatory and early delivery may be considered if maternal condition is found deteriorating.

Bowel obstruction is an important cause of non-obstetric abdominal emergencies. Important causes of small bowel obstruction include adhesions from previous surgeries, neoplasm, hernias, volvulus and intussusception. Adhesions, malignancies, diverticulitis and volvulus can cause colonic obstruction. Volvulus is quite rare in non-pregnant patients (<1%). It can be seen in about 9% as small bowel obstructions and in 25% cases as colonic obstruction in pregnant patients. Intestinal obstruction classically presents with a triad of abdominal pain, vomiting and constipation. Abdominal examination reveals distension and tympanic note on percussion. Bowel sounds are high pitched, hypoactive and tinkling in early phase and become absent in late phase.

The management is akin to that in non-pregnant patients, however urgent decisions need to be taken since both fetus and mother are at risk. Delay in diagnosis and treatment may result in septic shock and even death.

Learning from Example

Example

Mrs D, 24 year old, G2P1L1 (first preterm delivery 1yr 6 months back) presented with upper abdominal pain at 26 weeks of pregnancy. She had no other symptoms. On examination vitals were stable, uterus 26 weeks, relaxed, fetal heart-good, diffuse tenderness in upper abdomen, no guarding or rigidity. She was diagnosed as a case of gastritis. She vomited once, pain subsided initially but resumed again. USG showed normal pregnancy, minimally distended gall bladder and bulky pancreas. Serum amylase and lipase were normal. Surgery consultation was done. Kept nil orally and started on antibiotics (Cefazolin). However by noon she developed hypotension and tachycardia, which responded to fluid challenge. Repeat USG showed minimal free fluid and distension of bowel loops. X-ray abdomen showed gas under diaphragm. Surgery review done and shifted to surgical ICU and managed conservatively. Pain subsided with sedation.

However pain recurred in the evening and was not responding to sedation. Examination showed tachycardia, BP 90/60, diffuse tenderness over abdomen, no distension, guarding or rigidity. Bowel sounds +. Repeat USG showed moderate free fluid and dilated bowel loops. She was taken up for emergency laparotomy suspecting peritonitis secondary to appendicular perforation. On laparotomy there was malrotation of gut with midgut volvulus, small bowel twisted at 4th part of

duodenum around superior mesenteric artery, gangrenous bowel without viability up to ileocaecal valve, caecum to right of superior mesentric artery (SMA) origin. Release of all bands, untwisting of volvulus and laparostomy with urobag sutured to fascia done with a plan to review after 48 hours. (In laparostomy peritoneal cavity is deliberately left open, abdominal contents are exposed and protected with a temporary coverage. This is done to facilitate healing or prevent complications like abdominal compartment syndrome. Nevertheless it is a morbid procedure requiring highly skilled and dedicated postoperative care. Post operatively antibiotics were stepped up, ventilatory care continued. Patient expelled preterm IUD baby next day and expired on 2nd postoperative day.

Learning points

- A very high index of suspicion is needed in patients who present with abdominal pain in pregnancy.
- Quick decisions and prompt treatment are of prime importance. Hence it is imperative not to overlook any complaint in pregnancy as physiological or dismiss them as functional.
- In suspicious cases sonologist should be requested to specifically look for bowel peristalsis and vascularity.

Ogilvie's syndrome

Acute Colonic Pseudo-Obstruction (ACPO) or Ogilvie's syndrome was the cause of one maternal death in 2018. This is a rare but serious complication that can occur after cesarean section. It is a disorder of colonic motility usually presenting as progressive abdominal distension and discomfort following cesarean or sometimes after vaginal delivery. It may follow any pelvic surgery. In early stages, symptoms and signs may mimic normal post-operative complaints and ileus, later may look like mechanical bowel obstruction or bowel perforation. The median time of onset is 48 hours but it can occur as early as 6 hours. Clinical features that support a diagnosis of ACPO over others include significant abdominal distension with minimal nasogastric aspirates, some degree of bowel movement (diarrhea or presence of bowel sounds), mild pyrexia and rising CRP level without an obvious source of infection.

Hypokalemia secondary to increased potassium secretion into the intestinal lumen is often seen. Caecal dilatation, followed by ischemia and perforation are the chief complications leading to maternal mortality. Diagnosis is mainly by imaging. Abdominal X-ray shows caecal and large bowel dilatation. Ileus mostly affects the small bowel. Contrast CT is often the first line mode of imaging wherein significantly dilated large bowel loops are seen and an abrupt transition point suggestive of mechanical obstruction is lacking. Majority of patients with ACPO will improve with supportive care which includes close observation and monitoring of vitals, nil by mouth, naso gastric drainage, hydration, correction of electrolyte imbalance, early mobilization or frequent positional changes and DVT prophylaxis. The other options are medical management with neostigmine or bowel decompression via colonoscopy. Intestinal perforation will present with peritonitis and sepsis, necessitating urgent laparotomy.

Though it is rare, it can be catastrophic. Hence we have to keep every diagnosis in mind, no matter how rare. It may just save a precious life!

Malignancy

There were 24 cases of maternal deaths caused by malignancy during 2010 -2020.

Pregnancy Associated Breast Cancer (PABC) is on the increase. When breast cancer is diagnosed in women aged 30 years or less, 10–20% of cases

may be associated with pregnancy or occur within 1 year postpartum. Diagnosis may be difficult in women who are pregnant or lactating. It is most often detected as a palpable mass. If a suspicious mass is identified, a breast ultrasound can help characterize the mass and identify any concerning features. Once a diagnosis is made, it is imperative not to delay treatment. If the patient is near term, it is reasonable to proceed with delivery prior to treatment. However, if the patient is remote from term, treatment must be initiated. Surgery is the first line of treatment for breast cancer in pregnancy, with modified radical mastectomy being the treatment of choice for operable disease. Chemotherapy as adjuvant treatment has also been shown to be beneficial in patients with high-risk breast cancer. After the first trimester, chemotherapeutic agents typically used for treating breast cancer have not been associated with any fetal malformations.

Examination of breast should be routinely done as a part of antenatal checkup not only to rule out retracted nipple, but also for the presence of any lumps.

There was also a case of AML, who presented at 28 weeks with recurrent fever and tonsillitis, not responding to antibiotics. On evaluation, diagnosed to have AML with metastasis.(There were 8 cases in the leukemia, Lymphoma group).

Pregnancy can often result in delay in diagnosis as early symptoms of leukemia are usually nonspecific, such as fatigue, weakness, dyspnea and pallor which are easily attributed to the physiological changes occurring during pregnancy. The physiological changes associated with pregnancy can also mask certain laboratory abnormalities that are typically associated with AML, such as anemia of pregnancy, leukocytosis, or gestational thrombocytopenia .So in anemia refractory to Iron therapy, doing a peripheral smear is of utmost importance. Once diagnosed; therapy should be started without any delay. Therapeutic abortion should be offered to all patients developing AML during the first trimester. However, successful treatment of AML in pregnant mothers is possible with the fetus in utero as cytotoxic agents appear to be increasingly safer as the pregnancy approaches term.

Avoiding delay in diagnosis and therapy in case of pregnancy related cancers could definitely improve maternal and neonatal outcome.

Endocrine causes

Diabetic ketoacidosis (DKA) :

Even though DKA is associated with high fetal mortality, maternal loss due to DKA is very rare. However it can be as high as 5-10 %, if mother develops cerebral edema as a complication of rapid correction of DKA. So rehydration to correct fluid deficit is as important as treatment with insulin. Too rapid control of blood sugar with insulin may lead to complications like cerebral edema in DKA.

DKA in pregnancy is most often seen in unrecognized new onset Diabetes. It is usually precipitated by hyperemesis, infection, beta agonists, steroids and errors in insulin administration. OGTT should be done at first visit itself in all high risk patients for GDM and should be repeated at 24-26 weeks and 32-34 weeks. Monitoring with FBS & PPBS should be continued even if it is normal in GDM patients, as blood sugars may increase in third trimester.

Thyrotoxicosis

There were two cases of Thyrotoxicosis leading to maternal death. Thyroid storm is a rare complication of hyperthyroidism, which can be life threatening, with a high mortality rate of 10% to 30% due to maternal cardiac failure, if not recognized immediately and aggressively treated. This life-threatening condition is more likely to occur along with other precipitating factors such as labor and delivery, infection, or trauma. Thyroid

storm most often occurs in patients with undertreated or undiagnosed hyperthyroidism.

Hematologic Causes

Sickle Cell Anemia

There were 11 cases of Sickle cell anemia during 2010-20 leading to maternal death. The deaths were chiefly due to direct complications of the disease. In majority of the cases acute chest pain was the presenting symptom due to Acute Chest Syndrome (ACS).

Pregnancy poses a high risk for patients with sickle cell anemia even with mild disease**.** The physiological changes of pregnancy like increased metabolic demand, increased blood viscosity and hypercoagulability are aggravated in Sickle cell disease patients leading to increased incidence of complications like vaso-occlusive crisis, acute chest syndrome, osteonecrosis, hepatic necrosis, leg ulcers, and thromboembolic events.

In women with Sickle cell disease, who become unwell, Sickle cell crisis should be excluded expeditiously. She should be assessed rapidly for medical complications requiring interventions such as ACS, Sepsis or dehydration. Treatment is with Analgesics, IV antibiotics, adequate hydration and oxygenation. There is increased risk of thrombosis and pulmonary embolism among women with SCD. So consider low dose aspirin from 12 weeks of gestation and LMW heparin during the time of hospitalization.

Anaphylaxis :

There were 3 cases of anaphylaxis during 2010 – 20. Careful history taking at the booking visit about the drug allergy is very important and it should be recorded prominently in red on the antenatal card and case sheets. More often, there may not be any suggestive past history. Always give a test dose of the drug before administering full dose intravenously.

Adrenaline, the lifesaving drug should be available in the emergency tray of the LR and the dose and route of administration should be known to all medical and nursing staff. Intramuscular injection is the preferred route for initial administration of adrenaline for anaphylaxis in most settings. Dose is 0.5 mg (½ ampoule of1:1000). IM injection is preferred over IV bolus because it is faster in many situations and safer (ie, lower risk of cardiovascular complications, such as severe hypertension and ventricular arrhythmias).

Infections

Infectious diseases in pregnancy also play a significant role in causing maternal morbidity and mortality. The major causes which led to maternal mortality during the study period were H1N1 Influenza and Hepatitis. Leptospirosis, HIV and disseminated TB were the less common causes. There were 4 deaths due to leptospirosis and one each due to the other two.

All pregnant and postpartum cases with respiratory infection should be promptly started on oseltamivir 75 mg BD for 5 days. In severe cases double dose can be used.

The majority of leptospiral infections are either subclinical or result in very mild illness and patients recover without complications. In a few cases it may manifest as multiorgan failure where the mortality can go up to 40%. Infection in pregnant women may be grave leading to severe fetal and maternal morbidity and mortality. The presentation may mimic other viral, bacterial, and parasitic infections, acute fatty liver, pregnancy-induced hypertension, and HELLP syndrome. Owing to the unusual presentation, leptospirosis in pregnancy is often misdiagnosed and under-reported. Preventive public education pertaining to hygiene, personal practices, source reduction, environmental sanitation, early diagnosis, and treatment of the condition are needed to avoid perinatal and maternal mortality.

Nonpregnancy related infections, particularly tuberculosis, malaria, and pneumonia, are important causes of maternal death in HIV infected pregnant or postpartum women. There is also an increased risk of development of sepsis and mortality from both puerperal sepsis, especially after cesarean delivery, and abortion related sepsis.

Immunological causes

The autoimmune connective tissue disorders affecting pregnancy are rheumatoid arthritis (RA), systemic lupus erythematosis (SLE), antiphospholipid antibody syndrome (APS), systemic sclerosis (SSc), primary Sjogren's syndrome (PSS) and inûammatory myositis. There were 8 cases of maternal deaths due to SLE.

Ideally, all pregnancies in women with SLE should be planned during periods of disease quiescence for at least six months prior to conception. Prior to pregnancy, it is essential to assess disease activity (especially renal) in a patient, to know which treatment she is taking for SLE (to switch to medications allowed in pregnancy) and be aware of whether she is anti-Ro- and La-positive and has APS. Active SLE at the time of conception is a strong predictor of adverse maternal and obstetrical outcomes.

Women who are primigravidas and women with a history of lupus nephritis or active nephritis are at highest risk of flare. Higher rates of complications such as preeclampsia, preterm birth, fetal loss, growth restriction, neonatal lupus syndromes and prematurity are seen in lupus pregnancy. Management of pregnant women with SLE should involve close collaboration between a rheumatologist and an obstetrician experienced in caring for high risk mothers. Periodic assessment for disease activity should occur throughout pregnancy and the postpartum period.

For all pregnant women with SLE, continuation of Hydroxychloroquine will reduce the risk of SLE flare. . Women with SLE are at higher risk of preeclampsia than the general population, hence recommendations for prophylactic use of low dose aspirin for preeclampsia. Lupus nephritis flares during pregnancy can mimic preeclampsia, and differentiating one from the other can be challenging. Low complement levels might be the only differentiating feature.

The treatment of active SLE during pregnancy is guided by the severity and degree of organ involvement, similar to patients in the non-pregnant state. Treatment should not be withheld due to pregnancy.

Conclusions

Even though, the above discussed were less common causes for Maternal Mortality, such cases do occur in our practice especially presenting often with minor or vague symptoms. An open mind, sound knowledge regarding the underlying possibilities and a high index of suspicion may eventually help an obstetrician to save a valuable life in the long run.

Approach to Sickle Cell Disease in Pregnancy

Mobin Paul

1. **Outcome** – Hb SS worse outcome compared to Hb SC
2. **Pre – pregnancy care**

- Discuss about the pregnancy and contraception in detail in each visit, Consider proper baseline diagnostic work up.
- Consider Vaccination early / Penicillin prophylaxis
- Stop the use of hydroxycarbamide/ hydroxyurea 3 months prior to the expected conception.
- Stop angiotensin converting enzyme inhibitor [ACEI] – if she is on for pulmonary artery hypertension
- Partner screening
- Baseline work up – Blood group, Antibody screening – if positive do a detailed 11 cell panel antibody identification and phenotype the group ideally. Blood pressure monitoring, urine protein assessment, Pulmonary artery Hypertension [PAH] assessment. Iron overload assessment, Retinal screening.
- Avoid possible precipitation events.

3. Antenatal care

- Vaccination – Influenza
- Drugs –

  Folic acid,

  Penicillin prophylaxis to continue.

  STOP hydroxyurea,

  Oral iron – only if demonstrated deficiency

  Role of Ecosprin [75 mg OD] from 12 weeks to completion of pregnancy. Most of the data favours the use.

  Consider thromboprophylaxis during admission or with risk factors like – obesity, advanced age [> 35 years], systemic infection, prolonged immobilisation, multiple pregnancy or multiparity.

- During crises –

  Hydration

  Analgesia [avoid pethidine, NSAIDS]

  Oxygen based on the requirement.

  Thromboprophylaxis.

- Transfusion – adverse effects like alloimmunisation and Hemoltic Disease of the New born (HDN). No clear benefit of prophylactic blood transfusion on selective approach. However it is associated with reduced maternal mortality, veno- occlusive pain episodes, pulmonary complications, neonatal mortality and pre-term birth [Malinowski Blood 2015].
- Reasonable indications for blood transfusions – Decompensated anaemia, Hb< 6 gm %, Twin pregnancy, previous documented severe SCD related complications. Blood should be matched by extended phenotyping if facility is available.

4. Intrapartum and post-partum care

- Intrapartum - Consider induction by 38-40 weeks. Vaginal delivery is preferred.

- Hydrate well in warm environment.
- Post-partum –
  - Increased incidence of SCD crises noted , keep well hydrated and warm. Monitor saturation closely.
  - Consider thromboprophylaxis for 7 days routinely. High risk cases – 6 weeks or more based on expert opinion.

  (Adapted from RCOG guidelines)

PART 4

PRACTICE POINTS

CHAPTER

20

Antenatal Care

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Parvathi Deth, Jayasree Thankachi

Antenatal care is preventive healthcare which should ideally start with preconception counseling and care .This aims at optimizing maternal health prior to and during pregnancy for a positive pregnancy outcome.

Preconceptional counseling

It should be available to all women with reproductive potential and all pregnancies should be planned ones. This ensures that women start pregnancies in optimum health – physical, mental and social.

Involves assessment of patient, advice on lifestyle changes, diet and exercise, folic acid supplementation as well as stabilization of health problems well before conception.

Antenatal visits:

The booking visit should be ideally as soon as pregnancy is diagnosed.This helps in risk stratification and outlining the plan of pregnancy care [timely referral/multidisciplinary care as indicated]. This should be informed to the pregnant mother and her family in simple, clear terms. A properly recorded antenatal chart has to be maintained. Further visits are planned based on risk stratification. As a general rule it is good to have at least one

visit in first trimester, two visits in the second trimester and three visits in the third trimester.

Clinical assessment at each visit

History, BP, SFH [symphysiofundal height].
Any others as indicated

Investigations

First trimester :

Complete blood count, Blood group & Rh
OGTT [DIPSI], TSH
VDRL, HBsAg, HIV, HCV
Urine analysis
Double marker to be offered [optional]

Second and third trimester trimesters :

Hb
OGTT [DIPSI]
Urine analysis

Ultrasound scans :

11-14 weeks scan
Dating
Screening for chromosomal anomalies
Screening for preeclampsia
18-20 weeks
Anatomy [anomaly]scan
Placental localization
32- 34 weeks
Fetal growth

Medications

Folic acid, Iron, Calcium

Injection tetanus toxoid [tetanus and diphtheria toxoid] 2 doses

Inform that all medications should be taken under supervision and to avoid 'Over the counter' medications

Education and support

Antenatal classes are the best way to communicate important information to the pregnant woman and her family. Every woman should be encouraged to attend atleast two classes - one in the beginning of pregnancy to discuss various aspects of pregnancy care and the other class closer to term to discuss labour and delivery and postnatal issues including care of the baby. The partner should be encouraged to attend the classes. In addition to the obstetrician, the nurse midwife, neonatologist, dietician, physiotherapist etc also should participate in the discussions. These classes can be used to discuss –

- Diet, exercise, travel, work, rest, sexual intercourse
- Common ailments and how to cope
- To clear misconceptions
- Danger signals
- Encourage them to open up regarding sensitive issues by building a rapport
- To plan labour, delivery and postnatal care .

CHAPTER

21

Safe practice of Labour and Delivery

Vasanthi Jayaraj, Geetha A P, Parvathi Deth, Jayasree Thankachi

Introduction:

Childbirth is a complex and stressful process and a normal labour is a retrospective diagnosis. It is essential to maintain a teamwork that provides safe and respectful maternity care [RMC]. A properly filled antenatal card highlighting the risk factors should be available and should be perused by the labour room staff when the woman reports in labour. The labouring woman as well as her companion (husband, mother, sister or friend) should have attended the antenatal classes.

In the labour room:

Obstetric triaging : Receive the patient with respect and a smiling face. Triaging the patients is essential for effective allocation of resources and manpower. A quick but thorough history, reviewing the records and examination should be carried out. Examination should include temperature, pulse, respiration, BP, auscultation of cardiovascular system (CVS) and Respiratory system (RS) and obstetric examination. An admission cardio tocography(CTG) is preferable. However in situations

where this is not practical, hear the fetal heart for one full minute and record it in the admission records. Recognizing true labour pains helps to minimize unnecessary interventions. Only patients in active labour should be kept inside the labour room. This ensures more effective care.

Speculum and vaginal examinations should be done under aseptic precautions. Limit vaginal examinations to the minimum. {routine P/S needed} Before vaginal examination fetal heart (FH) to be auscultated. Enema is not advocated. Instead of shaving, clipping of hairs should be practised

First stage of labour :

Patient can be ambulated during the first stage. Clear fluids can be allowed. Keep the patient well hydrated. A birth companion may be allowed to be with the patient (husband, sister or mother who has attended AN classes). A 16/18 G cannula should be in place for all patients in labour. Intravenous fluids if at all required should be given at 125 ml/ hour preferably normal saline (NS) or ringer lactate (RL). Reduce to 75ml/hr RL/NS in hypertensives and heart disease patients.

Respectful care should be given maintaining her dignity and privacy. Partogram should be used to record all events of labour.

Fetal heart monitoring should be done every 30 minutes in low risk mothers in 1st stage and every 15 minutes in high risk. A continuous CTG should be used in case any abnormality is detected on auscultation.

Maternal pulse, BP, temperature, respiration and urine output should be monitored periodically. Patient should be encouraged to empty her bladder. Reduce catheterisation to the minimum.

Adequate analgesia should be offered either as opioids [pethidine, tramadol], entonox, or epidural analgesia.

ARM should be done only when the cervix is at least 4 cm dilated or in women with abnormal labour. Wait for one hour after ARM before starting oxytocin. Routine antibiotics are not needed after ARM. If labour continues for more than 8 hrs after ARM or patient has temperature >38° C, antibiotics have to be given.

Oxytocin infusion in a titrated manner preferably using an infusion pump may be commenced if contractions are not adequate. If prostaglandins are used for ripening, keep a minimm interval of 4 hrs before starting oxytocin. Once contractions are adequate, the dosage of oxytocin can be reduced.

Strictly avoid using smooth muscle relaxants like hyoscine, drotaverine or valethamate bromide in active labour. They have been found to cause an increase in maternal complications like amniotic fluid embolism and PPH.[CRMD]

Second stage of labour :

Refrain from asking the patient to bear down in the passive phase of descent in the second stage. This will only lead to maternal exhaustion and possible increased number of instrumental deliveries. Encourage the patient to bear down in the active or perineal phase of second stage. The position of the patient during the second stage can be as per her and the obstetrician's convenience.

During the second stage, fetal heart rate has to be monitored every 5 mts or after each contraction for one minute. All equipment for baby resuscitation should be in place.

Episiotomy :

A restrictive approach should be adopted towards episiotomy. Ironing out the perineum and controlled delivery of the fetal head maintaining the flexion may help to reduce the need for episiotomy. A small increase in the number of first

and second degree perineal tears may be acceptable in the bargain. If episiotomy is to be given, it should be timely [during crowning] and mediolateral is preferable with an angle of 60 degrees from midline.

Delivery of shoulders:

Once head is delivered, wait for restitution and external rotation, watching out for telltale signs of shoulder dystocia. Deliver the shoulder avoiding excessive traction and angulation.

Oxytocics should be given at delivery of anterior shoulder [as part of AMTSL]. Deliver the rest of the body of the baby slowly. Clamp the cord after one minute in an unasphyxiated baby. Warm the baby either by skin contact with mother or on a warmer.

AMTSL-Active Management of Third Stage of Labour -3 parts

1. Oxytocics at delivery of anterior shoulder or within 1 minute of delivery of the baby.

   KFOG recommends 5 units oxytocin in 5 ml normal saline given intravenously taking about 5 seconds at the delivery of the anterior shoulder. In addition give 10 units oxytocin IM and 20 units in 500 ml normal saline at 60 drops /mt for two hours.

2. Placental delivery by controlled cord traction after confirming placental separation

3. Massage the uterus .

Delivery of the placenta should be by controlled traction along with counter traction on a contracted uterus. Make sure the cotyledons and membranes are removed [expelled] entire and that the uterus is well contracted and retracted. Inspect for any vaginal or cervical tears if there is excessive bleeding or in induced and instrumental deliveries. The ideal time would be before the separation of the placenta when the field will be clearer .

Episiotomy should be sutured restoring the anatomical alignment. The first stitch should be taken well above the apex. Continuous or interrupted sutures of catgut 1/0 or vicryl rapid [2/0] may be used. A tailed tampon should be used to pack the vagina while suturing the episiotomy. The tail of the tampon will help to avoid forgetting to remove the tampon. A rectal examination should be done at the end of suturing. If there is any extension of an episiotomy, rectal examination should be done before the start of suturing.

Postpartum monitoring :
(Fourth stage of labour)

The first two hours after delivery should be intensively monitored by recording her pulse, BP, fundal height and vaginal bleeding every 30 mts. This will help to avoid missing the event of an atonic PPH (See chapter on postnatal care). Encourage the mother to breastfeed. Once the patient has emptied her bladder, the uterus is well contracted and retracted and vitals are stable, she can be shifted to her room [2 hrs after normal delivery.]

Document every aspect of care. To maintain continuity of quality care, regular obstetric drills, audits and monthly departmental meetings should be conducted.

CHAPTER

22

Postpartum Care

Sangeetha Menon,
Sheila Balakrishnan, T L Sujatha

Editors' Note

The authors have brought out with examples, the common pitfalls in the management of postpartum patients. The importance of systematic observations to pick up any concealed hemorrhage is highlighted with example. Similarly the need for thromboprophylaxis and keeping an eye on developing sepsis are all highlighted. The need for emotional support for the postpartum woman who is stressed with the demands of the baby is also emphasized.

Care of the postnatal woman is shrouded in a lot of traditional practices. Some of them seem to be innocuous whereas a lot of those practices are positively harmful. Regular bath in hot water (even though the water may sometimes be unbearably hot) with lots of green leaves of various medicinal plants may be comfortable. But many of the soups, rasayanams and potions that the woman is forced to consume are positively harmful if she had diabetes or hypertension. We should positively warn about such practices when she goes home. Similarly a widespread practice is not to allow drinking water for fear that it will prevent the distended abdomen from getting back to normal. We know that this is a recipe for disasters like thromboembolism. In addition, in some places the postnatal woman is forced to lie on her back for hours preventing any type of mobility, again asking for postnatal thrombosis.

V P Paily

Introduction

Often a much neglected entity, postnatal care plays a crucial role in preventing maternal and neonatal mortality and morbidity. The important fact to remember is that there is no place for complacency once the patient is delivered. This is the crucial time when care and monitoring can save many a life. Every minute counts.

What kind of care needs to be offered once a woman is delivered?

The patient should be observed for a minimum of two hours in the labour ward, during which time her vital signs are to be monitored closely; at least every thirty minutes and recorded on a pre typed format.It should be ensured that there is no bleeding. Immediate postpartum checks must include a uterus on palpation that is central, below the umbilicus, hard and contracted and on a gentle push per abdomen should reveal no clots/ blood per vaginum.

Fig 1: Postpartum Monitoring Chart

TIME	½ hour	1 hour	1½ hour	2 hr
Pulse Rate				
BP				
Uterine Fundus				
Bleeding				
Urine output				
Sign & Emp ID				

These points will go a long way in the early detection and management of postpartum hemorrhage. The baby should be put to the breast as soon as possible after delivery. Once she has passed urine and after the perineum and episiotomy site is inspected, she may be shifted to the post-natal ward. On transferring out of the labour ward, accurate documentation is vital especially with regard to any particular point requiring extra attention like a third degree tear. Any specific medications should also be documented. Cesarean patients are usually kept in the immediate postoperative ward or in an intensive care unit if there are complications.

In the postnatal ward, she should be taught the correct technique of breast feeding. The baby should be seen by a pediatrician daily until discharge from hospital. Early ambulation must be encouraged. She can get out of bed a few hours after delivery or the day after a cesarean. A normal diet can be commenced immediately after a normal delivery and she should also be encouraged to take plenty of fluids. After a cesarean section, oral fluids were usually started the next day; but now we encourage taking clear fluids within few hours and allow her to ambulate even on the same day.

If postpartum sterilization is desired by the woman, she should be offered the procedure after adequate counseling.

At the time of discharge from hospital, she should be advised of the options regarding contraception and that it can be considered at the subsequent postnatal visit at six weeks. She should also be advised to take iron and calcium for the subsequent 6 months. It is important to make her understand that the care of her child is her responsibility. She should specifically be told that ambulation is of paramount importance once she is home and that complete bed rest is unnecessary and can lead to major problems. She should also be encouraged to drink plenty of water at home.

Learning from Exapmle

Example 1

Mrs A 23 years old, had an emergency cesarean section for cephalopelvic disproportion after 8 hours of labor. She was transferred to the post operative ward after an uneventful cesarean section. The nurse on duty recorded her vital signs and checked the IV fluids. The

patient was sedated and was seen by the doctor once the days theatre list was done, only to realize the patient was pale, in shock, with blood all over the sheet which was not recognized as the cover sheet was never removed to look at the abdomen.

Cause of death - A case of PPH that was missed!

Learning points

1. This point can never be overemphasized - the importance of feeling a contracted uterus and checking for bleeding. Nurses and paramedical staff should be educated about this too. Where there is shortage of staff the bystanders can be taught to do this.
2. The vital signs should be closely monitored and recorded on a pre-typed format.
3. In the light of the importance given to a companion in labour, the attendant person should be educated about the importance of periodic checking of the pad for soaking.

Example 2

Mrs B 32 years old, a primigravida with a pre-pregnancy BMI of 27 was admitted in spontaneous labor and delivered uneventfully after 9 hours of labour. She had been married for 10 years and had conceived following treatment for infertility and this was a very precious baby to her. She had no medical disorders and was discharged from hospital on day 3 with the mother and baby in good condition. Unfortunately, she returned the very next day with severe breathing difficulty, and desaturation. She suffered a massive cardiac arrest and succumbed.

Cause of death - Autopsy revealed it to be a case of massive pulmonary embolism.

Learning points

1. The fact that she had taken bed rest throughout her pregnancy was completely overlooked. Women and obstetricians alike must be educated about the harmful effects of bed rest and more so that it has no benefit at all except in conditions like placenta praevia.
2. Risk factors like obesity and thrombophilias should always be considered. Here a BMI of 27 is very significant as she is definitely obese according to the South Asian guidelines.
3. Every obstetric unit must have a thromboprophylaxis protocol in place which must be displayed at key points for ready reference. Each clinical examination should be an opportunity to review if the woman requires thromboprophylaxis. VT(venous thrombosis) score to be recorded for each patient.
4. General indications for postpartum thromboprophylaxis. (See chapter on pulmonary embolism and venous thrombo-embolism)

- Elective cesarean section with any one minor risk factor
- Vaginal delivery with any 2 minor risk factors
- All cesarean sections in labour

Example 3

Mrs C 28 yrs of age developed Gestational diabetes (GDM) from 28 weeks onwards, required insulin, and was on labetalol and nicardia from 30 weeks for pre-eclampsia. She was induced at 36 weeks and had an emergency cesarean section for failed induction. Postnatally her sugars were normal and insulin was discontinued as expected. But her BP recordings were erratic and a third antihypertensive- prazopress - was started. No preeclampsia profile was sent postnatally and she was discharged on day 8 with advise to check BP at a local hospital close to her home and adjust medication accordingly – which she never did! She was readmitted a week after discharge with convulsions

preceding which she had a severe headache for a day. She had a BP of 190/120 mm Hg and neuroimaging revealed an intracranial bleed. She was under ICU care but unfortunately never recovered.

Cause of death- massive intracranial hemorrhage

Learning points

1. When the third antihypertensive was added alarm bells should have rung loud and clear and she should not have been discharged without stabilizing her blood pressure.
2. A complete preeclampsia profile with a minimum of hematocrit, platelet count, peripheral smear for hemolysis, liver enzymes and serum creatinine should be sent postnatally for all women with preeclampsia after 48 hours and all the more so for women whose pressures are not under control. If abnormal they should be repeated and the patient should be discharged only when the BP is controlled and all the laboratory parameters are normal.
3. Postnatally enalapril can be used with proper monitoring of renal function and serum potassium. If possible, avoid using diuretics or angiotensin receptor blockers to treat hypertension in women in the postnatal period who are breastfeeding or expressing milk.
4. Women can be sent home once their blood pressure is near normal and they are stabilized on one or at the most two antihypertensive drugs.
5. Patient and family education is very important; they should be impressed upon the need for close monitoring at a local centre; at least twice a week.
6. The woman should be educated about the importance of the symptoms of headache, blurring of vision, dizziness and epigastric pain and asked to report to the hospital immediately if any of these are present.
7. At 6 weeks the blood pressure should be checked and if still not normal, should be rechecked at 12 weeks. Proteinuria should also be checked for if it was present earlier. At 12 weeks if the blood pressure is not normal or if she still has proteinuria, she should be referred to a cardiologist or nephrologist for further evaluation of an underlying problem like chronic hypertension or kidney disease.
8. A fasting 75 g oral glucose tolerance test must be done at 6 weeks to assess if the woman was having GDM. Health education is very important and she should be advised to continue the same dietary regimen as in pregnancy and to avoid becoming overweight in order to prevent/delay the appearance of overt diabetes. She should be asked to check her blood sugars at least once a year. If the values are abnormal at the 6 week visit she should be referred to a diabetic specialist.
9. Patients must be well informed that she has a 1 in 5 chance of recurrence in the next pregnancy and a 15% more chance of developing hypertension, cardiovascular disease or stroke later on in life. Hence she must adopt life style changes like reducing weight, stopping smoking and embrace a regular fitness regime.

Example 4

Mrs D, a 19 year old primigravid woman, married for a year, was delivered by cesarean section on account of a breech presentation. All went well until she was discharged. Then we read in the papers that she had set fire to herself with kerosene and succumbed to severe burns. When we reviewed her notes, it was recorded that she was not feeding her baby and required a lot of coaxing to do so. What went wrong?

Suicides as a cause of maternal death is now a worrying phenomenon and Kerala is seeing more antenatal deaths from suicides rather than post natal.

The "Ammamanasu" should go a long way in reducing such deaths. (See chapter on Mental health and suicide)

Learning points

1. Refusing to feed or hold the baby may be a very important clue as to the womans' mental status. This should have been given more importance and she should have undergone counselling.
2. Differentiating postpartum depression and psychosis from just 'postpartum blues' is very important and may be like walking on a thin rope.
3. Pregnancy and puerperium see women in their most fragile state and it is important to be careful how we talk to them. Casual comments like "Aren't you eating anything-your baby is not growing" or "it's a shame that you can't feed the baby – poor thing !"may be all that is needed to tip the scales .
4. Often psychiatric treatment and depression are considered taboo in our society and such history is hidden from spouses and doctors. Gentle yet firm probing will bring this out! This much neglected area should be part of the antenatal check-up.
5. Mental health should be given prime importance in pregnancy and the puerperium and any worries must be promptly addressed. Joint clinics with a psychiatrist or an easy reference pathway to one must be drawn up.
6. Health personnel rarely know the personal side of the patient's problems. It would do good to use a drop box system in the out patient department to encourage patients to speak out their minds – and then contact them over the phone and arrange counseling sessions.

Example 5

Mrs E 30 years underwent an emergency cesarean section after 10 hours of labor at full dilatation. She had an ARM – delivery interval of 9 hours. She was given Inj. Taxim IV after the ARM – single dose. Was fever free intra partum. Taxim was continued in the postoperative period and Inj. metrogyl was added too. On day 3 she developed abdominal distension after she started oral feeds. Bowel sounds were sluggish and her temperature was 101 degree Faranheit. The abdominal wound was clean. She was kept nil per orally and antibiotics were stepped up to Piperacillin - tazobactam and metrogyl. Laboratory tests revealed a total count of 17200 with predominant neutrophilia. K+ was 2.5 meq/L. Renal and liver function tests were normal. Surgical consultation was asked for. The bowels were distended and there was paralytic ileus. Ultrasound of the abdomen showed a mixed echogenic mass suggestive of a pelvic hematoma 4x5 cm to the right of the uterus. Antibiotics were stepped up again in 24 hrs to Cefaperazone / Sulbactum. The total count continued to rise, patient deteriorated, multiple consultations were sought and liver and renal function started worsening. Swabs from the vagina were taken and blood culture was sent. Antibiotics were stepped up further to Teicoplanin, but she developed multiorgan failure and DIC and eventually succumbed to cardiac arrest.

Cause of death : Sepsis

Learning points

1. The rule in sepsis is – hit fast hit hard !
2. No amount of antibiotic can replace safe hygienic and aseptic practices in the labour ward and operation theatre.

3. When an emergency cesarean section is being done in labour – it is recommended that the abdomen be cleaned with chlorhexidine and the vagina be painted with betadine solution prior to surgery.

4. The choice of the pre-operative antibiotic and its dose must be carefully structured. It will vary with the weight of the patient and the duration of surgery. It should also conform to the hospital antibiotic policy.

5. Best surgical practice must be adhered to at all times according to hospital protocols– the angles of the uterus need an extra tie – especially on the right corner of the incision. Haemostasis must be complete.

6. At the earliest sign of sepsis, a full sepsis profile must be sent including procalcitonin and serum lactate. This should have been done on the third day.

7. Blood cultures should have been sent simultaneously. Isolating the organism by culture must receive paramount priority – only then can antibiotic regimes be structured.

8. While changing antibiotics, either the culture results should be adhered to or an antibiotic with a broader spectrum should be chosen.

9. Arterial blood gas should also be sent as and when thought necessary.

10. A multidisciplinary team approach is vital for decision making and the intensivists and infectious disease specialists should also be involved.

11. When a mass was seen on ultrasound, a CT scan may be indicated to rule out foreign body.

CHAPTER

23

Cesarean Section

Sareena Gilvaz, Bindu Menon, Briji S. Panicker

Editor's note

With the very high prevalence of cesarean delivery in Kerala, it is only natural that many maternal deaths occurred in women delivered by cesarean section. It does not automatically mean that cesarean delivery was the cause of death; rather cesarean would have been chosen as a means to avoid the maternal or fetal demise which unfortunately did not succeed. All the same, some association of cesarean delivery with maternal death cannot be ignored. About one third of PPH deaths were in those delivered by cesarean section (see chapter on obstetric hemorrhage). In 35 out of 61 PPH deaths, re-laparotomy was done. Add to this the numbers of women in near miss cases who were saved by re-laparotomy after having had intraperitoneal bleed following cesarean delivery. These emphasize the importance of correct technique of cesarean delivery especially the way the uterine and abdominal wounds are closed. One important aspect regarding cesarean wound closure pertains to the angles. We strongly recommend that the angles should be closed with box stitches. If there is any extension of the incision, even if it is superficial involving the peritoneum, the operator should look for any torn vessels. These vessels run superficial to the myometrium and may remain in spasm only to reopen and cause catastrophic bleeding later.

The authors have emphasized the importance of taking care of any torn vessel under the rectus muscle or lateral to it, before closing the abdominal wound.

Sepsis is the other major contributor to maternal death where there is a direct link to cesarean delivery. Forty four out of 96 sepsis deaths were in those who had cesarean section. This highlights the importance of taking steps to prevent infection in women undergoing cesarean delivery. In addition to proper skin preparation using chlorhexidine rather than povidone iodine, clipping the hair instead of shaving them may be another nitty gritty to be looked into.

One additional recommendation that has come up recently is to paint the upper vagina and cervix with povidone iodine before taking up for cesarean delivery. This is relevant not only in those with ruptured membranes but even in those with elective cesarean delivery.

Enhanced Recovery after Surgery (ERAS) is the new wave in all types of surgical procedures and has been recommended even after cesarean delivery. This will bring about many changes in our routine practices. Recommendations like allowing clear fluids till two hours before anesthesia, early ambulation, removal of the wound dressing by next morning, allowing enteral feed within few hours after surgery are all very practical steps. Not only, will such changes enhance recovery, but also it will make the experience more pleasant for the woman.

V P Paily

Introduction

Cesarean is the surgery that evolved initially to save the life of the mother, and later became the procedure of choice in many high risk situations to reduce both maternal and perinatal morbidity and mortality. The quoted optimal cesarean section rate by World Health Organization (WHO) in 1985 was 10-15%. Since then, there has been a fivefold increase in the rate, both in the developed and developing world.

At the Confidential Review of Maternal Death (CRMD) during the period 2010-2020, we got to analyze 1076 maternal deaths in Kerala. Out of this, there were 398 cesareans (290 emergency, 102 elective procedures and 6 perimortem cesarean) and 313 vaginal deliveries. The remaining included miscarriages, ectopic, undelivered cases etc. So the total percentage of cesareans in our study, during this ten year period was 36.98%. This slightly higher rate could be due to the high risk scenarios involved, as many of them have landed in maternal death. We would also like to make a mention that there were six perimortem cesarean sections in this period.

We have made a short analysis of cases and grouped them into 3 categories :

(1) Where in, if the cesareans were done earlier, it could have been life saving

(2) In a few, if a timely perimortem cesarean was done, it could have prevented a catastrophe.

(3) Still more, those that had technical lapses.

So in the following write up, we have elaborated on the above scenarios.

Timely Cesarean Section could have made a difference

It's not enough that we do a cesarean, but in many situations the timing of it is very crucial for it to be life-saving. The below mentioned situations are proof of this. In all of them, probably if the cesarean was done a little earlier, it could have averted a maternal death.

Example 1

A 33 year old woman, G3 P2, I st pregnancy - full term normal delivery (FTND) and 2nd Lower segment cesarean section (LSCS). She was found to have hypertension at 36wks of pregnancy (140/100) and was started on antihypertensive and sent home. One week later she came with pain abdomen. On examination, her BP was 210/140Hg. She was given intravenous labetalol and magsulph. On vaginal examination os was closed. Suddenly patient became breathless with frothy secretions, bilateral crepitations ++, SPO_2 -82%. Inj. deriphylline, lasix, and hydrocortisone were given and referred to medical college hospital. She died on the way.

Postmortem report - complication of abruption and hypertension

Points to ponder:

- It would have been better to admit the lady when she was seen at 36 weeks with high BP recording.
- When she presented with abdominal pain and a very high BP after one week, the pregnancy could have been terminated immediately by a cesarean keeping in mind the possibility of abruption and eclampsia.

Example 2

21 year old primi gravida, who received antenatal care at a local hospital, was admitted at 32 weeks with fever and cough of two weeks duration and decreased fetal movements for one week. On examination she was drowsy, tachypnoeic, tachycardia+, Fetal heart sounds (FHS) present, and SPO_2 was 78%. Shifted to medical ICU, started on tamiflu and higher antibiotics. She was diagnosed to have bilateral bronchopneumonia with consolidation, respiratory acidosis and metabolic alkalosis. She was managed in the ICU with ventilatory support for four weeks. She progressively worsened, developed hypoxic seizures, and she later developed cardiorespiratory arrest and died (Throat swab sent for suspected H1N1 came positive).

Points to ponder:

A primi at 32 weeks of gestation presented with fever, cough, decreased fetal movements and was diagnosed with bilateral pneumonia. She was drowsy and tachypnoeic with low SPO_2 of 78%. Suspected H1N1. She was on ventilator for four weeks after admission. Then she worsened and died. A cesarean section earlier on may have helped to relieve the stress on the respiratory system.

Perimortem cesarean may have helped !

In many situations, a perimortem cesarean could be a life-saving procedure. The following scenarios have been picked up to explain this.

Example 1

A 32 year old woman, G5P3L0A1, her LMP not known, on irregular antenatal check up was referred from FRU to a tertiary care centre with generalised tonic clonic seizures. BP 200/ 100 Hg, even after giving lorazepam, eptoin, magsulf and labetalol. On

admission there, pulse rate was 64/minute, feeble; BP- not recordable; SPO_2 -70%; uterus 34weeks. Fits not controlled. She was managed by emergency medicine team in labour room. Patient had cardiac arrest thrice, resuscitated each time and later was shifted to ICU. With inotropes and supportive measures BP picked up, but she had already developed severe hypoxic features and expired four days later.

Points to ponder:

A perimortem cesarean section at the time of first cardiac arrest itself may have helped in better resuscitation and also may have aided in preventing neurological deterioration.

Example 2

A 31 year old woman, *G3 P2 L2, both FTND, was admitted at 38 + weeks gestation. On examination cervix was uneffaced and os one finger loose. PGE_1-25µgm inserted vaginally on the day of admission at 12 noon. Artificial Rupture of Membranes (ARM) done at 8.20pm at 4cm dilatation. At 8.30pm, patient had breathing difficulty and developed cardiac arrest. She was resuscitated and intubated by anesthesiologist. Started blood transfusion and was referred. She died on the way to the referral centre.*

Points to ponder:

A situation again where perimortem cesarean section could have been done at the same centre where she arrested. Instead she was just intubated, ventilated and shifted to another hospital.

Perimortem Cesarean Section (PMCS) (Resuscitative hysterotomy)

What is PMCS and how should it be timed and done?

Some of the guidelines for PMCS are as follows;

1. It is done at the place where she has arrested and resuscitation is being done. This is done when pregnancy is 24 weeks and beyond, after four minutes of cardiac arrest and completed within five minutes.
2. No consent is required.
3. All that you require is a pair of gloves, scalpel and scissors
4. No anesthesia is required
5. Vertical incision any length, from xiphoid to pubic symphysis depending on the uterine size and gestation
6. Cut right through all layers vertically. Open the uterus by a long vertical incision. Deliver the baby, clamp and cut umbilical cord and hand over the baby to the neonatologist for resuscitation
7. Do a mass closure of the uterus and abdomen
8. During the entire procedure, the resuscitative process like chest compression is continued without any interruption. (An Internal Cardiac massage can also be given if required).

When PMCS done is within 4- 5 minutes of cardiac arrest, it helps in the mother's resuscitation; first and foremost. It primarily improves her circulation and has the added benefit of salvaging the baby, with less neurological damage.

Selected Cases of technichal lapses

Example 1

Primi, married 6yrs, treated for infertility, (known case of pregnancy induced hypertension and pregestational diabetes on high dose of insulin) was induced at 39 weeks of gestation and later was taken up for cesarean section at 11.45 am for failed induction. Immediate postoperative period was uneventful. Then the next morning at 7.00 am, patient was found to have tachycardia - 150/min and

decreased urine output of just 30ml in toto, BP - 90/60. Then according to the notes at 11 am, she was given a fluid challenge of 1 pint normal saline and 1 ringer lactate, along with 20 mg inj.lasix. Still urine output was nil and patient was started on dopamine infusion and referred.

Patient reached the referral centre with a feeble pulse, BP- 70 mm systolic, severe pallor and was found to be jaundiced. Abdomen was distended with free fluid. Uterus 20 weeks and well contracted. USG in labour room showed free fluid in the peritoneal cavity including the hepatorenal pouch. Hb 3.9 gm, GRBS 357mg, urine acetone 3+, S.bilirubin 5.3 mg, SGOT/PT 129/48, S.Creatinine 1.6mg, platelets 53,000.

A relaparotomy was immediately done at the referral centre. On opening the abdomen, through the previous incision, there was a gush of dark, altered blood with a large hematoma beneath the rectus sheath, more on the right side. On opening the peritoneal cavity there was about 1 litre of dark altered blood and clots. Uterine wound was intact, but there was a large broad ligament hematoma on the right side, extending to lateral pelvic wall, with bleeding at the right corner of the uterine incision.

The broad ligament hematoma was evacuated, the right uterine and other bleeders caught. As the uterus was flabby, compression sutures were applied. Then bilateral internal iliac artery ligation was done. The rectus sheath hematoma was tackled by multiple hemostatic sutures and abdomen closed with a drain. Postoperatively, patient continued to deteriorate and was on both dopamine and nor-adrenaline supports and on the ventilator. Later she developed sepsis, MODS and expired after 3 days.

Points to ponder

1. A precious pregnancy after 6yrs of married life and with both hypertension and Gestational Diabetes Mellitus (GDM) should have been induced earlier and not after 39 weeks.
2. She underwent cesarean at 11.45 am and was found to have a urine output of only 30 ml next morning. She had severe tachycardia and hypotension. There seems to have a lack of proper postoperative monitoring. Post operatively, all patients should have an hourly pulse / BP / RR / urine output chart for the first 24 hours. Bleeding from the vagina and contraction of the uterus should also be watched.
3. When the patient had the above warning signs of tachycardia, pallor, hypotension and decreased urine output, a bedside ultrasound scan and test for fall in haemoglobin should have been done without delay to rule out intrabdominal bleeding.
4. At every cesarean section, we must take care to see that the incision does not go lateral to lateral margin of the rectus muscle where normally one encounters the inferior epigastric artery (which is a direct branch of the external iliac artery) , which if cut should be ligated and secured properly, separately. It is not enough to cauterize it.
5. The uterine wound closure after every cesarean should be as follows :
   a. Secure the angle first (the right angle) with proper mattress sutures,
   b. start suturing the incision from the left end, again taking care of the angle.
   c. If there is an angle bleeder, it should be caught separately and not just included in the suture line.

The rest of what happened in this patient is a sequel to sepsis and MODS which proved to be irreversible and terminal.

Example 2

20 year old primi, full term with no co-morbidities had cesarean section for CPD at 3.50 pm. After reaching the ward, she had severe hypotension. Gave

intravenous fluids, inotropes, started blood and transferred her to a tertiary care centre.

At the emergency department of the referral hospital, she had a cardiac arrest and was revived - intubated- ventilated and vasopressors given. Ultra sound scan showed hemoperitoneum with rectus sheath hematoma. Investigations showed a serial drop in hemoglobin with persistent hypotension and tachycardia. Blood and blood products were started and given as per massive transfusion protocol.

Exploratory laparotomy was done. There was massive hemoperitoneum with diffuse intra peritoneal bleed, including a rectus sheath hematoma. Same evacuated, intra-abdominal packing done, drain kept and closed. In the postoperative period, a transient improvement noted and patient was weaned off vasopressor supports. Then again hypotension, tachycardia and Hb fall with increase in drain and ongoing bleed suspected. CECT showed active intra-abdominal bleed again. Emergency interventional radiology angiogram done, followed by embolisation. Guarded prognosis explained to bystanders. Slowly patient worsened and died 10 days after cesarean. Autopsy - refused.

Points to ponder:

1. When patient's condition worsened postoperatively with hypotension, instead of treating with inotropes, blood and transferring patient to another hospital; she should have been investigated with an urgent scan and proceeded with a laparotomy immediately.
2. At laparotomy in the tertiary care centre, patient was found to have a massive hemoperitoneum with profuse intraperitoneal bleed and because they could not control the bleeding, they packed the abdomen. In this situation, a hysterectomy would have been a better option (even though she was a primi) with simultaneous treatment of DIC, instead of packing the abdomen.
3. Another point to be mentioned is, they say vasopressors were stopped three times and restarted. Probably stopping was done too early. She could have been given a stabilizing dose for a longer time and weaned off slowly, especially in a situation of such severe shock.

Example 3

36year old G3 P1 L1 A1; diabetic on insulin and gestational hypertension on alphadopa and nicardia, underwent emergency LSCS for failed induction at 40 weeks 2days of gestation. On 3rd postoperative day, she developed severe dyspnoea and hence, was referred to a higher centre. On examination, patient obese, heart rate 160/minute, echo showed dilated Right atrium (RA) Right Ventricle (RV), and severe Pulmonary Artery Hypertension (PAH). Managed with inj.heparin, digoxin and lasix. Ventilatory support initiated in view of fall in SPO2. Same day she developed severe bradycardia. Cardiopulmonary resuscitation (CPR) given but could not revive. Cause of death: Acute pulmonary embolism

Points to ponder

1. All guidelines advocate termination earlier in pregnancies complicated by hypertension and diabetes on insulin.
2. Obese, elderly patient with GDM, gestational hypertension, past date and emergency cesarean section. Here, thromboprophylaxis was indicated for more than one reason.
3. Early ambulation, plenty of oral fluids in the postoperative period to prevent dehydration plus thromboprophylaxis could have prevented a Deep vein thrombosis (DVT) and pulmonary embolism.
4. Elastic compression stockings can be worn by the patient during and after surgery.
5. The recommended dose of Low Molecular Weight Heparin (LMW) for an average built patient (50-90kg) would be 40 IU enoxaparin s/c daily for 3 days till the patient is fully

ambulant (start first dose12 hours after LSCS). This small dose of heparin does not increase the incidence of any postoperative bleed and can be safely given without any monitoring or fear. Obese women require higher doses of LMWH.

Example 4

G2 P1 L1, at 38weeks gestation was found to have BP 140/90. Induced with PGE1 25/µg. Oxytocin was started seven hours later. ARM was done at 3 cm, six hours after initiating oxytocin. Inj.drotaverin was given one hour after ARM. Cervix was fully dilated 15 minutes after inj drotaverin. At 2nd stage, she collapsed. Resuscitated by code blue and she was taken up for immediate cesarean. A still born baby was delivered with difficulty. Lower segment vertical tear from left angle was identified and sutured. After cesarean section (CS), urine was blood stained. In spite of resuscitative measures, patient expired 2 1/2 hours post LSCS. Cause of death : AFE –

Points to ponder when doing a cesarean at full dilatation

1. Don't forget to put a foley's catheter and leave it in situ in a 2nd stage emergency CS. Usually bladder will be pulled up. Hence, open the parietal peritoneum at a much higher level (upper 1/3rd) to prevent injury to bladder (which is normally drawn up and edematous).
2. Uterine incision should be at a higher level. Otherwise you may be incising the vagina and it will be a vaginal cesarean (where the anatomy is totally different.)
3. Care should be taken to deliver the deeply engaged head slowly, so as to prevent extension of the uterine incision which is possible because it is thinned out and friable. If there is a tear, suture it by interrupted stitches after exteriorising the uterus. Then, suture the CS suture line.
4. Active management of 3rd stage during CS. Follow the same protocol of active management as in a normal vaginal delivery, for all cesareans too. It is preferable to wait for spontaneous separation of placenta before removing it. No placental extraction should be attempted until the uterus is well contracted.
5. Chances for lower segment PPH when we use vaginal misoprostol.

A dangerous combination is when we use smooth muscle relaxants like drotaverine and epidosin along with vaginal misoprostol. KFOG has repeatedly adviced to restrain from using these smooth muscle relaxants due to the distinct association with AFE.

Tackling extension of uterine wound

1. Exteriorize the uterus
2. Control excessive bleeding from uterine wound with Allis or Green Armytage forceps, if available or with your thumb and index finger.
3. Extension of wound downwards is sutured with interrupted sutures 0 or No 1 Vicryl, starting from beyond the apex of the tear. Keep suturing until you reach the main wound and then stop. Before suturing, push down the bladder adequately, to prevent injury to the bladder.
4. Uterus is closed with continuous non-locking sutures. Any excess bleeding from wound edge is tackled with separate square or figure of 8 sutures.

Classification of Cesarean

Category 1

Emergency (crash) represents an immediate threat to the life of the mother or fetus. It aims

to deliver as soon as is safely possible, from the time of decision. That is < 30mts.

Indication for category I CS should be documented in the case sheet by the deciding obstetrician. Eg. Suspected uterine rupture, abruption, severe hemorrhage and shock, cord prolapse, FBS PH 7.2, pathological CTG

Category II

(Urgent CS) Represents maternal or fetal compromise that is not immediately life threatening. Deliver within 75 minutes from the time of decision.

Category III

(Scheduled CS or Expedited CS) represents the mother who needs early delivery but here is no maternal or fetal compromise. Eg: booked for elective CS, but came with PROM or in early labor

Category IV

(Elective CS) Represents the delivery date given to the mother

Modified Robson's classification

This is a useful way of auditing your delivery cases to give you an overview of monthly statistics and to pin down the category where you have the highest rate of cesarean sections

1. Nullipara, singleton cephalic, > 37weeks, spontaneous labour
2. Nullipara, singleton cephalic , > 37weeks
   2A - indicated induction
   2B- elective induction
   2C - Cesarean section before labour
3. Multipara, singleton cephalic, > 37weeks, Spontaneous labour
4. Multipara, singleton cephalic, > 37weeks
   4 A-indicated induction
   4 B- elective induction
   4 C-Cesarean section before labour
5. Previous cesarean section, singleton cephalic > 37weeks
   A. Spontaneous labour
   B. Induced labour
   C. Cesarean section before labour
6. All nulliparous breeches
   A. Spontaneous labour
   B. Induced labour
   C. Cesarean section before labour
7. All Multiparous breeches (including previous cesarean section)
   A Spontaneous labour
   B. Induced labour
   C. Cesarean section before labour
8. All multiple pregnancies (including previous cesarean section)
   A. Spontaneous labour
   B. Induced labour
   C. Cesarean section before labour
9. All abnormal lies (including previous cesarean section but excluding breech)
   A. Spontaneous labour
   B. Induced labour
   C. Cesarean section before labour
10. All singleton cephalic ≤36 weeks (including previous cesarean section)
    A. Spontaneous labour
    B. Induced labour
    C. Cesarean section before labour

If you can categorise your patients according to the revised Robson's criteria, we can certainly reduce our unnecessary interventions and cesarean sections.

A few tips on tackling "not so easy"cesarean

Antibiotic policy:

Prophylactic antibiotic like inj.cefazoline 1gm IV / if not available, Inj cefuroxime 1.5 gm IV within 60 min before skin incision, preferably in the operation theatre. This will be a good coverage so long as the case is clean, planned and straight forward.

For a woman who has been in prolonged labour or after a failed trial or after failed instrumentation, it is good to give good gram positive, gram negative and anaerobic coverage like a combination of Ampicillin, gentamycin and metrogyl or still higher as the case demands.

Anesthesia:-

In a patient who is hemodynamically unstable or when problems are anticipated, general anesthesia is a good choice. Also it helps in continued postoperative ventilation as and when the situation demands.

Abdominal incision

In all dire emergencies, for quick and easy access or when you expect or anticipate difficulties, a vertical abdominal incision helps. Its more so when the lower segment is shut off by adhesions of previous cesareans or when you are required to do classical sections as in a previous cesarean section with placenta praevia accreta or when the case is associated with other intra-abdominal pathology. In all the above situations a vertical abdominal incision would be the most preferred incision. If it's a Pfannensteil incision and if at any time you feel the incision is inadequate, the Maylards muscle cutting incision can be tried.

Tackling previous surgical adhesions

You are likely to encounter omental or bladder adhesions while opening the peritoneum . So to play it safe, open the peritoneum vertically in its upper third so as to avoid the bladder. Omental adhesions which may come in the way of surgery only need be removed while opening the abdomen, leaving the rest of the adhesions to be tackled before closure.

While searching for the U-V fold, many a time it may be missing. So carefully identify the upper limits of the bladder. An inflated Foley's bulb may come to your aid in this situation. Dissect the bladder by sharp dissection and gently push it down, If at any point you feel that the bladder adhesions cannot be released, then put the uterine incision just above that point and deliver the baby, without dissecting the bladder.

Uterine Incision

Identify the place where you have to make the uterine incision and see that it is cut little larger for easy extraction of the baby - this is because fibrosed scar tissue does not normally yield very easily when there is a difficult extraction. While putting the uterine incision in a patient with prolonged protracted or obstructed labour, remember to put the incision high on the lower segment or else you may enter the vagina inadvertently. So also, if and when the uterine incision is inadequate, extend it as a J or U to enable easy extraction rather than an inverted T.

Extraction of the baby

Always plan and take out the baby preferably in a flexed attitude. If the baby is lying in a transverse lie, do an External Cephalic Version (ECV) after opening the abdomen but before the uterine incision is put. If you have not been able to correct it, map out the baby – so you can access the feet and deliver the baby by breech extraction.

If the baby's head is high & floating, deliver the baby by gripping the feet and extracting as breech. Another way of delivery of a high floating head is by extraction aided by the outlet forceps. Identify the occiput of the baby. The baby's back normally leads you to it. Then keeping the head in the transverse position, first introduce the posterior

blade and then the anterior blade, so that the pelvic curve of the forceps is directed towards the occiput and the 2 blades are gripping its parietal bones and gently ease the fetal head out of the uterine wound

When the fetal head is jammed in the pelvis, a steep Trendelenburg position may aid in fetal head extraction. The best way is to put your hand deep in the pelvis , position it below the head and gently ease it out taking a little time. Deepening the anesthesia may also help in extraction of the impacted head in the pelvis.

If still not possible, another way is for an assistant to push the fetal head from below - just enough for you to grip the head and guide it out through the uterine incision. If the head is pushed too far and it goes above the pelvic brim, we may have to again struggle with a floating head and its associated difficulties.

Patwardhan's method of fetal extraction in a deeply engaged head - This is a method wherein the upper limbs, trunk and lower limbs are delivered and the last to come out would be the head

Active management of 3rd stage during CS

After the delivery of the fetus follow the active management of 3rd stage by oxytocics and uterine massage. It is preferable to wait for spontaneous separation of the placenta before removing it. No placental extraction should be attempted until the uterus is well contracted .This way, the bleeding can be reduced. Adequate oxytocics are given to make sure the uterus is well contracted once the baby is out.

Uterine wound closure

Once the placenta is out, the uterine wound is closed. But before that the obstetrician should palpate the uterine cavity to make sure that there is no placental or membrane bits or septum or submucous fibroid. Similarly it is advisable to identify the internal os so that one does not inadvertently stitch the upper edge of uterine wound to a bulging posterior wall of uterus. Preferable to close the uterine wound with Polyglactin 910 (Vicryl) and not Catgut. While closing the uterine wound, we must make sure it is properly approximated whether by a single or two layered closure. It is good to secure the proximal angle first before closure is attempted from the opposite end. It is advisable to take care of the angle in box stitches before the running stitches are taken to approximate the edges. Any spurters should be tackled by separate bites. If there is any extension of the uterine wound, then it is good to exteriorise the uterus and then suture them.

Eg - if there is an extension down – take interrupted sutures, starting from beyond the apex of the tear and keep suturing until you reach the main wound & then stop. The rest of the uterine wound closure is as described above, in the routine way.

Table 1: Number of cesareans which needed a relap

Year	Cesarean	Relaparotomy
2010	45	4
2011	36	7
2012	35	4
2013	43	7
2014	38	6
2015	36	2
2016	30	5
2017	50	8
2018	51	8
2019	33	9
Total	**398**	**60**

Rare situations

Bladder injury: If at any point you suspect bladder injury, always check it out by instilling dilute methylene blue per urethra. And if there is an injury to the bladder, do a repair at the end of surgery by a meticulous 2-3 layered water –tight closure with interrupted suture and follow it up with a continuous bladder drainage postoperatively for 7-10 days.

Bowel injury: But on the contrary, if there is a bowel injury and if it is anything other than a serosal aberration, always get a surgeon to repair it for you.

Disseminated intravascular Coagulation (DIC):

If a CS is to be done on a patient with DIC, go by a vertical skin incision. It is important we try to attain meticulous hemostasis before closure. Most importantly, close with an intra- abdominal drain (preferably size 28) and a parietal drain with a vacuum tip (Redi -vac) within the abdominal wall below the rectus sheath, so that no collection occurs causing problems later. So also if there is any intra-abdominal collection, it will come out through the drain.

Myomectomy at cesarean

This can be attempted and the bleeding during the procedure can be reduced by tying a tourniquet at the level of the isthmus, to occlude the uterine arteries. Meticulous hemostasis must be attained in this situations, as bleeding tends to be more when we remove a myoma from a pregnant uterus. If required, the uterine artery on that side can also be ligated.

Broad ligament hematoma

If you encounter a broad ligament hematoma, open its leaves, scoop out the clots, identify the bleeder and catch it .Always remember that however large the hematoma is, even if it is up to the splenic flexure, the bleeder will always be below the pelvic brim. If you cannot attain hemostasis, then ligate the int. iliac artery of that side- it normally helps!

Abdominal closure

It is like any other abdominal closure. But remember to look beneath the rectus sheath for any perforating vessels which may be bleeding and missed out while opening the abdomen .This can later produce rectus sheath hematomas in the postoperative period. The inferior epigastric artery normally does not get injured. But if, while opening, you have dissected laterally beyond the rectus muscle it could get injured .In this event, it should be identified and tied securely.

Postoperative period: Apart from the routine postoperative orders of IV fluids, analgesics and antibiotics, wherever indicated thrombo-prophylaxis is very important and can be life-saving.

Conclusions

Thus, we have tried to cover, ways of correcting proper timing of cesarean section, scenarios where in perimortem cesarean section could have made a difference and ways of tackling a not-so-easy cesarean section. Thus a cesarean section should not be treated lightly, and should be done taking all due precautions, both during the time of surgery and proper monitoring postoperatively, in order to reduce the morbidity and mortality associated with it.

CHAPTER

24

Obstetric care in the periphery
Role of Health workers in the periphery in reducing maternal death

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Editors' Note

Kerala health system is unique in several aspects. The most noteworthy is the structure of it. It is not like any other in the world, especially when we consider the obstetric services. About 70% of deliveries take place in the private sector, where the beneficiary pays the entire services, most of the time out of the pocket as there is very little insurance coverage. The remaining 30% of deliveries take place in the government run hospitals which range from community health centres to Medical colleges.

Under the private sector the range of delivery centres is huge – from single obstetrician nursing homes to top of the range multispecialty hospitals which are accredited by international bodies like Joint Commission International (JCI). Any patient can walk into any of the government or private hospitals and get treatment; of course in the private sector they have to pay for it.

The CRMD team was worried about a pattern of cases that end up in maternal deaths – a patient starts treatment in a small peripheral (private or government) and is then referred to higher centre when complications occur. She reaches the higher centre often late and in an irreversible stage. The paying capacity of the patient and family often decides where she

ends up. The CRMD committee felt that knowledge of the structure of the health system is essential to understand these issues. The authors have given an overview of the peripheral network for health care under the government.

The Director of Health Services is the head of this section of health care including public health. The staff like ASHA workers, Junior Public Health Nurses (JPHN), Health inspectors etc. come under the Director of health services. When it comes to curative health care, co-ordination between these peripheral health workers and the hospitals is often poor.

Lack of well co-ordinated ambulance service is a major problem for the peripheral health centres. The poor who are served by these health centres will not be able to afford the private ambulance service. The government has to chalk out plans for improving this.

Lack of trained manpower especially obstetricians and nurses is the second major problem faced by the peripheral centres.

The third problem is lack of blood transfusion facilities. To overcome this all community centres that have deliveries are allowed blood storage centres. However, often the required components in sufficient quantities may not be available.

Overcoming all these deficiencies is not going to be easy. In the immediate future what we can hope for is to train the peripheral health workers properly so that problems can be anticipated easily and acted on, before it deteriorates to a non- retrievable stage.

Once transfer to a higher centre becomes essential, it should be done after taking steps to stabilize her and prevent deterioration on the way. Such steps are described in the chapters dealing with the common problems like obstetric hemorrhage and hypertension.

V P Paily

Introduction

The excellent health indicators prevalent in Kerala are mainly due to the availability and accessibility to health care services as well as high literacy rate. Though there is a gross disparity in the facilities and manpower between rural and urban areas, things are improving. While analyzing the maternal deaths, we can see majority of deaths occurred in tertiary care centers which is not surprising as they are all referral centers, but on tracking the cases it will be seen that the initial event started at the primary care centers. And many times we have noticed that a few additions or modifications in the management or a few minutes saved would have resulted in a different outcome. To have all deliveries in tertiary care centers is not practical as well as will be increasing the load on the system. There should be a balanced and equal distribution of facilities and manpower between obstetric care services in periphery and the centre. Both government and private institutions play a key role in this. In a state where more than 95% deliveries are institutional; strengthening the base level will make a good impact on reducing mortality. Often when a mishap occurs, the deficiencies are highlighted resulting in blame game.

The chain of Health Care Workers (HCW) is as follows

ASHA – JPHN- LHI (Lady Health Inspector)- LHS (Lady Health Supervisor)– Medical Officer

Referral Chain of Institutions

Sub center-Block PHC(Primary Health Centre)-CHC (Community Health Centre) (till this point, only basic services are provided by MBBS doctors. Deliveries are not conducted)

Taluk Headquarter Hospitals (specialty cader, this is FRU (First referral unit) with blood storage facilities) District Hospital / General Hospital (second referral unit)

Medical College (Tertiary Care)

How the system works in Kerala

Government sector.

ASHA workers remain as the primary link between the local population and health care facilities. In fact this was one revolutionary step which helped to make the health services reach to the grass root level.

ASHA (Accredited Social Health Activist)

ASHA is a community health worker instituted by Goverment of India Ministry of health and family welfare as a part of National ruiral health mission (NRHM). Though started in 2005, it was fully implemented by 2012. It is now considered as the largest community health worker programme in the world enabling people's participation in health. The main aim is to strengthen the decentralized village and district level health planning and management.

ASHA workers are selected from the local community, age group between 24-45 yrs, with minimum educational qualification of SSLC, selected through interview and test by panchayath authorities in rural areas. In the Urban areas selection is by the Mayor and Superintendent of district hospital. One ASHA worker caters for 1000 population. Though it is a social voluntary work, they get remuneration for the services they provide.

Services

1. Antenatal care

- Tracking and registering all pregnant women preferably in the first trimester itself and entering all data like LMP (last menstrual period), EDD (Expected date of delivery), co morbidities etc. in a prescribed format which is reported to the JPHN of sub center.
- Creating awareness on antenatal problems, diet, nutrition, hygiene, sanitation, immunization and taking the pregnant ladies to

subcentre for receiving Toxoid vaccine, and vitamin supplements.

- Conduct antenatal classes, yoga, cookery show for antenatal mothers
- Accompany them to hospital for delivery services, sterilization and IUCD services.

2. **Neonatal care**

- Domiciliary care of babies especially preterm and IUGR babies and ensuring timely immunization

3. Deworming programme
4. Palliative care, house visit to elderly people
5. Mental health programme
6. Taking patients for cataract surgery
7. Services and data collection during epidemic and pandemic times

Though they are not allowed to prescribe medicines or give injections, they remain as the strongest link between the pregnant women and the healthcare workers. They receive periodic training and get updated. Especially during this pandemic period the importance and effectiveness of ASHA services have been highlighted.

Junior Public Health Nurses (JPHN)

They are in charge of a subcentre under PHC (Primary Health Centre) and cater to 5000 population. All the details of antenatal patients brought by ASHA workers are entered to the RCH portal by which they are given a unique ID number. This will help to render antenatal services as well as child immunization. This is called MCTS number (Mother & Child Tracking System number).

MCTS is a centralized web based application launched by the Ministry of Health & Family welfare in India in Dec 2009, to provide reliable data for effective decision making. It involves entry of huge volumes of data generated at the grass root level, which is usually at the sub centre. It is then compiled at different levels and transmitted to the next higher level.

Services

- Registration of antenatal patients in MCTS.
- Weekly once Antenatal care (ANC) clinic with help from ASHA worker. During the clinic check BP, weight and do abdominal palpation. Arrange antenatal classes, administer Toxoid vaccine, iron & calcium. Create awareness of danger signals and timely referral to delivery points.
- Provide antenatal book in which all details are entered.
- During PHC medical officer visit, organize antenatal and immunization camp once a month
- Keep all registers ready and updated.
- Premarital & post marital counseling.
- Anemia prophylaxis programme.
- Along with LHI, visit blocks and conduct home visits
- Spread awareness about government programmes for antenatal patients like Janani Sureksha Yojana (JSY) where antenatal care, delivery and sterilization services are free. In Government hospital after delivery, the pregnant women are given financial support for transportation.

Private setup

Kerala has rich network of private hospitals, especially maternity centers. Most of the centers at periphery will be small delivery units with the single obstetrician providing 24x7 services with anesthetist and pediatrician available only on call. Though it helps the local people, many times the system may not be able to cope with emergencies which can happen in obstetrics at any time.

Problems faced by healthcare workers in the periphery

1. Shortage of manpower- most of the delivery points in government and private sector may be working with a single gynecologist, one labor room staff, one or two nursing assistant at a time.
2. Lack of anesthesia services for emergencies/ transport facilities and blood and blood products.
3. Lack of reliable male bystanders when referral of patient is needed.
4. Monetary problem – Bystanders may not be able to afford the treatment at higher center. Hence they hesitate to give consent which results in wastage of time between referral and reaching the higher centre.
5. The increasing violence against healthcare workers and hospitals if anything goes wrong in spite of the best available treatment provided.

All these result in 2 scenarios.

1. At the slightest hint of difficulty, patients are referred to tertiary care center resulting in overload at the referral centre.
2. Patients are observed with the hope that things will become better, but not getting adequate time for a timely referral for the patient to reach the higher facility in a good shape if anything goes wrong

KEY SUGGESTIONS

The major killers are PPH, ECLAMPSIA, SEPSIS , AFE, SUICIDE, etc

PPH

- Preparedness in terms of trained manpower, availabilityof drugs and necessary instruments.
- Preprepared sterilized set of cervical inspection (3 long single blade speculums/retractors, 3 sponge holders , suture material) , uterine pack to be kept ready
- Emergency trolley with all lifesaving drugs, cannula, IV sets, etc which should be periodically checked and maintained. This helps to avoid unnecessary running around in case of an emergency.
- Instruments like forceps, vacuum, suction cannula, TVUAC, neonatal intubation set, suction apparatus, all in good working condition
- All drugs in the management of PPH to be kept in the fridge at the desired temperature to maintain potency.
- Flow charts on the drug and route of administration to be displayed in labor room for emergencyreference.
- ORRT team involving nurses and nursing assistants to help in immediate resuscitation
- Keep the communication to the bystander liberal so that when a calamity occurs they understand the gravity of the situation properly.
- Train staff periodically by frequent mock drills and teach them to apply TVUAC.
- Strictly follow the induction protocols, especially the dosage and frequency of prostaglandins (oral preferred over vaginal). Keep adequate time interval between pitocin and prostaglandins. Also avoid regular use of vasodilators in active labor.
- Call for help, either colleagues or consultants from nearby centers if needed. If planning referral, do it early according to the available facilities at the center.

Hypertensive diseases & Eclampsia

- Periodic checking of BP and never skip BP checking in AN check ups

- If BP is at borderline level, do frequent checking or admit and monitor as it may worsen very rapidly.
- Urine albumin checking in each visit as per KFOG protocol – once in first and second trimesters and all visits after 34 weeks.
- Teach the impending signs and encourage the woman to reach hospital if any of the signs appears.
- In the event of impending eclampsia or eclampsia, give MgSO4 in the full dosage, even if the patient is being referred. Half doses will not help in any way.
- In acute hypertensive crisis control of blood pressure is very important. IV labetalol in the right dose should be given before transferring.
- Beware of the possibility of deterioration in the postpartum period, hence continue monitoring.
- No role for diazepam in seizure episodes.

Sepsis

- Strict asepsis in all routine procedures to be maintained in labour room and operation theatre.
- Daily inspection of wound in cesarean patients to find out the early stage of infection.
- Early warning signs of sepsis like tachycardia, tachypnoe should not be ignored and step up antibiotics early than late. Follow sepsis bundle guidelines.
- Proper sterilization of instruments to be ensured and adequate sets of instruments to be kept ready after autoclaving depending on the number of deliveries. Do not boil and reuse the instruments.

Early Pregnancy Complications

It is really sad to notice mothers dying due to early pregnancy complications. ***Even if the patient is in shock, immediate management saves the patient than referral***. Always do an early scan to rule out ectopic pregnancy. Beware of the new entity scar pregnancy where an intrauterine sac will appear suspiciously low in the lowerpart of cavity. Ruptured ectopic should be quickly tackled with emergency laparotomy and shouldn't be waiting for laparoscopy.

Also if incomplete abortion is bleeding profusely quick evacuation of products is the answer along with stabilizing the patient.

Referral and Transport

The decision to refer the patient should be taken early rather than late. Most of the time the death happens on the way due to delay in transportation. Before transferring the patient all possible measures to arrest the bleeding or control hypertension should be done at the peripheral centre, like Extra IV lines, investigations, arranging donors and sending them with the patient, medical management of PPH, packs, condomtamponade, TVUAC application, giving mgso4, labetalol IV , transfer with NASG.

Inform the higher centre early by telephone and give an idea about the condition and provisional diagnosis so that they are prepared to tackle the case. A detailed reference letter with all given drugs with time and dose is essential. A nurse or doctor should accompany the patient to keep the IV lines running and if needed to give CPR on the way.

Arrange ambulance. A tie up should be there with local services and keep a fund ready for such emergencies so that precious time is saved.

Where to refer

Though the hierarchic system of transferring from FRU to district hospital to medical college looks good, always ensure the receiving centre has adequate manpower and facility to tackle the problem. In private set up having a tie up with the nearest tertiary care centre will help.

Incidence of Death on the way during tranportation

	Cases analysed by CRMD	Cases not analysed by CRMD
2010	Eclampsia -1 postpartum collapse –1	Heart disease -1 Pneumonia -1 unknown-1
2011	sickle cell -2 Traumatic PPH -1 Heart disease -1	Aspiration - 2, PPH – 1 Unknown 2 Respiratory disease -1
2012	PPH -Rupture uterus -1 PPH (pl.previa accreta) -1 Hypertensive disorders -2 Unknown -1 PPH following cesarean -1	Unknown -1 PPH -1, Chest pain -1 PE? DVT -1
2013	Heart disease -1 Hypertensive disorders. 1 Thyrotoxicosis -1 Traumatic PPH -1 AFE -1	Hypertensive disorder -1 Rheumatic heart disease -1 APH -1, PPH -1 Eclampsia -1 Unknown -2
2014	sepsis -1 Hypertensive disorder -3 Ectopic -2, Sickle -1	 PPH -3AFE -1 Unknown -3
2015	Anesthetic cause -1 Sepsis -1 Pul.embolism -1	Chest pain -1 Unknown -3 PPH -1, ARDS -1
2016	PPH -2 Cerebral venous thrombosis -1	 Unknown -1ARDS -1Ectopic ? 1
2017	Heart disease 1 PPH(delivery at home)-1 Traumatic PPH -1 Unknown (Early pregnancy) -1 Postpartum seizure at home -1 Atonic PPH -1 Unknown -1	Unknown -2 Pul.embolism -1
2018	PPH -1 Amniotic fluid embolism -1 Sickle cell -1 Unknown -1	Unknown -2 ? Pul.embolism -1 Eclampsia -1
2019	AFE -1 Unknown (PN) – 1 Pulmonary Embolism - 1	

DEATH AT HOME (Excluding suicides)		
	Cases analysed by CRMD	Cases not analysed by CRMD
2010/11	Unknown cause – 3 (2 postnatal, 1 Antenatal) Home delivery & PPH-1, Ca Breast -1	? Tuberculosis -1
2011/12	Nil	? CVT -1
2012/13	1. 24wks gestation, vomiting and collapsed (? aspiration) 2.11wks gestation – collapsed 3. Unknown -1	Eclampsia -2, home delivery &PPH -1, postpartum collapse -1, unknown -2
2013/14	Heart disease -1	PPH -1 Unknown -2 ? Pul. Embolism -1
2014/15	1 Antenatal, sudden collapse 2. Post Cesarean - 13th day ? PE	nil
2015/16	Nil	2
2016/17	Nil	
2017/18	Unknown -1	Unknown 1, PE. DVT -1
2018/19	ITP -1	nil

We can see a large number due to PPH, eclampsia, undiagnosed heart disease etc.

Conclusions

Asha workers play a key role in identifying the pregnant women and helping them to get proper care. Strengthening their services and using them to identify the mental health of the pregnant women can help a lot in reducing the rising rate of suicide in pregnancy.

Health care workers should be working as a team and should get updated to tackle an emergency. Good instruments in working condition, transport facilities and accessibility to blood bank services are crucial. Communication and frequent antenatal classes will help to relieve the anxiety of patients.

A proper history at the initial visit itself and keeping relevant information highlighted in a compact antenatal card will avoid missing important points.

Strict protocols on induction, strict practice of AMTSL, and careful monitoring of fourth stage will help to avoid PPH. If a complication is anticipated in the antenatal period like placenta accreta, refer the patient early. In unexpected calamity, do not lose control, do all first aid measures fast and do timely referral.

Periodic updating of staff and mockdrills should be conducted.

We do agree that all deaths are not avoidable, but we should be prepared to tackle an unexpected emergency by making use of the available facilities to the maximum.

A good rapport between the practitioners in the periphery and the higher institutions is always helpful.

CHAPTER

25

Blood and Blood Products

Ramesh Bhaskaran, Susheela Innah

(This Part of the chapter is reproduced from the previous edition written by Dr. Susheela Innah)

Blood has been viewed as something special. It has been created with magic qualities of healing properties. People believed blood determined the qualities of an individual and that such quality could be transferred in the blood.

Transfusion therapy in obstetrics affects the pregnant woman, the developing fetus and the neonate. Although various hematological diseases can predispose a pregnant woman to the need for transfusion, even a healthy pregnant woman at term can experience significant blood loss that also requires transfusion. Further various hematological disorders may require that transfusions be given to the developing fetus during pregnancy or to the neonates after delivery.

Blood Component Therapy

Blood component therapy is an integral part of the management of postpartum hemorrhage. The assessment as to when to begin blood product replacement is tailored to the clinical assessment, including the cause of blood loss, the base line hemoglobin and hematocrit, the patient's age, the amount of estimated blood loss, and the rapidity with which the blood loss will be controlled.

Blood and Blood components used in transfusion

A. Whole Blood

- Volume: 350 ml / 450 ml
- Proportion of anticoagulant (CPD-A1) – 14ml / 100ml Blood
- Hb approximately – 12 g/dl
- HCT – 35-45%
- No functional platelet
- No labile coagulation factors (V and XIII)
- Unit of issue : One donation referred as one 'unit' or 'pack'
- Storage : 2^0 C - 6^0 C is approved Blood bank refrigerator filter with temperature chart and alarm. Transfusion should be started within 30 minitues of removal from refrigerator.
- *Indications:*

  Red cell replacement in acute blood loss with hypovolemia

  Exchange transfusion

  Patient needing red cell transfer when red cell concentrates or suspension is not available

  Contraindication :

  Risk of volume overload in patients with

  (a). Chronic anemia

  (b). Incipient cardiac failure
- *Administration:*

  Must be ABO & Rh D compatible with the recipient

  Never add medication to a unit of blood

  Complete one unit of transfusion within 4 hours of commencement.

B. Red Cell Concentrates

('packed red cells', 'plasma-reduced blood')

- Description:

  150-200 ml red cells from which most of the plasma has been removed. Hemoglobin approximately 20 g/100 ml (not less than 45 g per unit). Hematocrit 55%-75%.
- Unit of issue: 1 donation
- Infection risk: Same as whole blood
- Storage: Same as whole blood
- **Indications:**

  Replacement of red cells in anemic patients.

  Use with crystalloid replacement fluids or colloid solution in acute blood loss.

  Administration:

  Same as whole blood. To improve transfusion flow, normal saline (50-100ml) may be added using a Y-pattern infusion .

C. Red Cell Suspension

Description:

150-200 ml red cells with minimal residual plasma to which +/-100ml normal saline, adenine, glucose, mannitol solution (SAG-M) or an equivalent red cell nutrient solution has been added. Hemoglobin approximately 15g /100 ml (not less than 45 g per unit). Hematocrit 50%-70%.

Unit of issue: 1 donation

Infection risk: Same as whole blood

Storage: Same as whole blood

Indications: Same as red cell concentrate

Contraindications:

Not advised for exchange transfusion of neonates. The additives solution may be replaced with plasma, 45% albumin or an isotonic crystalloid solution, such as normal saline.

Administration: Same as whole blood. Better flow rates are achieved than with red cell concentrate or whole blood

D. Leucocyte Depleted Red Cells

Description:

- A red cell suspension or concentrate containing $<5x10^6$ white cells per pack, prepared by filtration through a leukocyte-depleting filter.

- Hemoglobin concentration and Hematocrit depend on whether the product is whole blood, red cell concentrate or red cell suspension.
- Leukocyte depletion significantly reduces the risk of transmission of cytomegalovirus (CMV).

Unit of issue: 1 donation

Infection risk: Same as whole blood for all other transfusion –transmissible infections.

Storage: Same as whole blood

Indications:

Minimize white cell immunization in patients receiving repeated transfusions, but to achieve this, all blood components given to the patient must be leukocyte-depleted.

Reduces risk of CMV transmission in patients who have experienced two or more previous febrile reactions to red cell transfusion.

Note: **Will not prevent graft versus host disease.** For this purpose blood components should be irradiated where facilities are available (radiation dose: 25-30Gy).

E. Platelet Concentrates

(Prepared from whole blood donation)

Description: Single donor unit in a volume of 50-60 ml of plasma should contain:

- At least $5.5x10^9$ platelets/bag
- $<1.2x10^9$ red cells/bag
- $<0.12x10^9$ leucocytes/bag

Unit of issue: May be supplied as either,

- Single donor unit: platelet prepared from one donation.
- Pooled unit: platelets prepared from 4 to 6 donor units 'pooled' into one pack to contain an adult dose of at least $240x10^9$ platelets.

Infection risk:

- Same as whole blood, but a normal adult dose involves between 4 and 6 donor exposures.
- Bacterial contamination affects about 1% of pooled units.

- *Storage:*
- Up to 5 days at 20^0C to 24^0C (with agitation) unless collected in specialized platelet packs. **Do not store at 2^0C to 6^0C**
- Longer storage increases the risk of bacterial proliferation and septicemia in the recipient.

- *Indications:* Treatment of bleeding due to
- Thrombocytopenia
- Platelet function defects
- Prevention of bleeding due to thrombocytopenia, such as in bone marrow failure.

- *Contraindications:*

Not generally indicated for prophylaxis of bleeding in surgical patients, unless known to have significant pre-operative platelet deficiency.

Not indicated in:

- Idiopathic autoimmune thrombocytopenic purpura (ITP)
- Thrombotic thrombocytopenic purpura (TTP)
- Untreated disseminated intravascular coagulation (DIC)
- Thrombocytopenia associated with septicemia until treatment has commenced or in cases of hypersplenism.

- *Dosage:*
- 1 unit of platelet concentrate /10 kg body weight: in a 60 or 70 kg adult, 4-6 single donor units containing at least $240x10^9$ platelet should raise the platelet count by 20-40/mm^3.
- Increment will be less if there is:

Splenomegaly, Disseminated intravascular coagulation, Septicaemia.

- *Administration:*
- After pooling, platelet concentrate should be infused as soon as possible, generally with in 4 hours, because of the risk of bacterial proliferation. **Must not be refrigerated be-**

fore infusion as this reduces platelet function.

- 4-6 units of platelet concentrate (which may be supplied pooled) should be infused through a fresh standard blood administration set.
- Special platelet infusion sets are not required.
- Should be infused over a period of about 30 minutes.
- Do not give platelet concentrate prepared from RhD positive donors to an RhD negative female with child-bearing potential.
- Give platelet concentrates that are ABO compatible, whenever possible

- *Complications:*
- Febrile, non-hemolytic and allergic urticarial reactions are not uncommon, especially, in patients receiving multiple transfusions.

Platelets Transfusion in Pregnancy

Conditions associated with low platelet count in pregnancy include:-

1. Benign Thrombocytopenia of Pregnancy (BTP)
2. ITP and Pregnancy
3. Thrombcytopenia associated with hypertension in pregnancy
4. HELLP
5. Thrombotic Thrombocytopenic Purpura and Hemolytic Uremic syndrome
6. Alloimmune Thrombocytopenia

Management:-

1. In BTP platelet count is repeated in each trimester and neonatal platelet count is done. Usually patient does not require any transfusion.
2. In ITP and Pregnancy steroids are given if platelet count is less than 50,000/mm^3
3. In HELLP syndrome platelets should be available for transfusion if platelet count is low (20,000 - 50,000/mm^3)

F. Platelet Concentrates
(collected by plateletpheresis)

- *Description:*
- Volume 150-300 ml
- Platelet content 150-500 x 10^9, equivalent to 3-10 single donations
- Platelet content, volume of plasma and leukocyte contamination depends on the collection procedure
- *Unit of issue:* 1 pack containing platelet concentrates collected by a cell separator device from a single donor
- Infection risk: Same as whole blood
- *Storage:* Up to 72 hours at 20^0C to 24^0C (with agitation), unless collected in specialized platelets packs validated for longer storage periods; **do not store at 2^0C and 6^0C**
- *Indications:*
- Generally equivalent to the same dose of platelet concentrate prepared from whole blood.
- If a specially typed, compatible donor is required for the patient, several doses may be obtained from the selected donor.

G. Fresh Frozen Plasma

- *Description:*
- Pack containing the plasma separated from one whole blood donation within 6 hours of collection and then rapidly frozen to -25^0C or colder.
- Contains normal plasma levels of stable clotting factors, albumin and immunoglobulin.
- Factor VIII level at least 70% of normal fresh plasma level.

- *Unit of issue:*
- Usual volume of pack is 200-300 ml
- Smaller volume packs may be available for children
- *Infection risk:*
- If treated, same as whole blood
- Very low risk if treated with methylene blue / ultraviolet light inactivation (see virus 'inactivated' plasma)
- *Storage:*
- At -25^{0}C or colder for up to 1 year
- Before use, should be thawed in the blood bank in water which is between 30^{0}C to 37^{0}C. Higher temperature will destroy clotting factors and proteins. Once thawed, can be stored in refrigerator at +2^{0}C to +6 ^{0}C for upto 12 hours.
- *Indications:*

  Replacement of multiple coagulation factor deficiencies: e.g.
- Liver disease
- Warfarin (anticoagulant) over dose
- Depletion of coagulation factors in patients receiving large volume transfusions.

  Disseminated intravascular coagulation (DIC)

  Thrombotic thrombocytopenic purpura (TTP)
- *Precautions:*
- Acute allergic reactions are not uncommon, especially with rapid infusions.
- Severe life threatening anaphylactic reactions occasionally occur.
- Hypovolaemia alone is not an indication for use.
- *Dosage:* Initial dose of 15 ml/kg
- *Administration:*
- Must normally be ABO compatible to avoid risk of haemolysis in recipient.
- **Need not be Rh compatible.**
- No compatibility testing required.
- Infuse using a standard blood administration set as soon as possible. after thawing. Labile coagulation factors rapidly degrade; use with in 6 hours of thawing.

  Fresh Frozen Plasma is used for massive obstetric hemorrhage and for patients who have demonstrated a factor deficiency or developed DIC. The usual starting dose of FFP is two units. **AB plasma can be used for all blood groups**.

H. Cryoprecipitate

- *Description:*
- Prepared from fresh frozen plasma by collecting the precipitate formed during controlled thawing at +4^{0}C and resuspending it in 10-20ml plasma.Contains about half of the factor VIII and fibrinogen in the donated whole bloods: e.g. Factor VIII: 80-100iu/bag; fibrinogen: 150-300 mg/bag.
- *Unit of issue:* Usually supplied as a single donor bag or a bag of 6 or more single donor units that have been pooled.
- *Infection risk:* As for plasma, but a normal adult dose involves at least 6 donor exposures
- *Storage:* At – 25^0 C or colder for up to 1 year
- *Indications:*

  As an alternative to factor VIII concentrate in the treatment of inherited deficiencies of:
- von Willebrand Factor (von Willebrand's disease)
- Factor VIII (hemophilia A)
- Factor XIII

  As a source of fibrinogen in acquired coagulopathies: e.g. disseminated intravascular coagulation (DIC)
- *Administration:*
- If possible, use ABO compatible product.
- No compatibility testing required.

- After thawing, infuse as soon as possible through a standard blood administration set.
- Must be infused within 6 hours of thawing.

Massive Transfusion

Massive blood loss is arbitrarily defined as the loss of one blood volume within a 24-hour period although other, more convenient, definitions include 50% blood volume loss within 3 hours or a rate of loss of 150mL/mt. This degree of blood loss may be associated with significant coagulation abnormalities. Thrombocytopenia can occur reasonably quickly and usually results from dilution, but increased consumption of platelets may also occur. The use of plasma - reduced red cell concentrates can result in significant dilution of coagulation factors.

The management of ongoing bleeding requires both clinical and laboratory input. The inability of standard laboratory tests to keep pace with the clinical picture is well recognized; nonetheless, patients receiving massive transfusion should have routine test of haemostasis performed early in order to define previous abnormalities.

Whilst there is no clear evidence to support transfusion triggers, guidelines do exist in order to prevent the indiscriminate use of component therapy. The British committee for standards in hematology recommends the following:

- Maintain Hb >8 g/dl
- Keep platelets >75 x 10^9 /L – microvascular bleeding and general oozing from wounds or venepuncture sites are particularly likely when the platelet count falls bellow 50 x 10^9 /L.
- Maintain PT & APTT <1.5 x mean control – administrate FFP 12-15 ml/kg. Anticipate needs for replacement after 1-1.5 x blood volume replacement.
- Maintain fibrinogen >1.0 g/L – if not corrected by FFP, give two pooled pack of cryoprecipitate or fibrinogen concentrate.
- The need for on going haemostatic treatment should be guided by the patient's clinical response and results of repeated laboratory tests.

Recombinant F VIIa

In recent years, recombinant FVIIa (NovoSeven) has been used for patients with uncontrollable, life-threatening hemorrhage. This product was originally developed for use in hemophilia patients with inhibitors to FVIII or FIX. In the setting of massive blood loss, the evidence for rVIIa use is limited and anecdotal but is increasing. A recent systematic review concluded that the application of rVIIa in severe bleeding is promising and relatively safe with a 1-2% incidence of thrombotic complications. Due to its expense, its use is generally limited to 'rescue' therapy for massively transfused patients with persistent bleeding despite appropriate blood component transfusion, haemostatic and pharmacological measures and surgical intervention. A dosing schedule of 300µg/kg followed by further doses of 100µg/kg at 1 and 3 hours as required is suggested – as the half- life is relatively short, repeat dose may be needed to decrease bleeding significantly.

Before the infusion of Recombinant Factor VIIa the following blood parameters should be corrected:-

1. Platelet Count > $75x10^3$
2. Fibrinogen>100mg/dl
3. PT & APTT – normal or near normal.

The mainly listed indications for Factor VIIa are the following:-

1. Factor VIII or Factor IX inhibitors
2. Factor VII deficiency
3. Glanzmanns Thrombasthenia

The decision to use this product should generally be made in consultation with a hematologist/ transfusionist.

Disseminated Intravascular Coagulation

In disseminated intravascular coagulation (DIC), the coagulation and fibrinolytic systems are both activated, leading to deficiencies of the coagulation factors, fibrinogen and platelets.

Laboratory Findings

DIC is characterized by:

- Reduced coagulation factors(so all coagulation tests are prolonged)
- Reduced platelet count (Thrombocytopenia)
- Prolonged activated partial thromboplastin time (APTT)
- Prolonged prothrombin time (PT)
- Prolonged thrombin time: particularly helpful in establishing presence or absence of DIC
- Decreased fibrinogen concentration
- Breakdown of products of fibrinogen: fibrin degradation products (FDPs)
- Fragmented red cells on the blood film.

Management

Rapid treatment of removal of the underlying condition is imperative.

If DIC is suspected, do not delay treatment while waiting for the results of coagulation tests. Treat the cause and use blood products to help control hemorrhage.

Transfusion support should be given to help control bleeding until the underlying cause has been dealt with and to maintain an adequate platelet count and coagulation factor levels.

1. Monitor:
   - Activated partial thromboplastin time
   - Prothrombin time
   - Thrombin time
   - Platelet count
   - Fibrinogen.
2. Identify and treat or remove the cause of DIC.
3. Give supportive care:
   - Fluids
   - Vasopressor agents
   - Renal, cardiac or ventilatory assistance.

Transfusion

1. If the PT or APTT is prolonged and the patient is bleeding:
   - Replace red cell losses with PRBC <5days old or the fresh whole blood.
   - Give fresh frozen plasma as these contain labile coagulation factors: 1pack/ 15kg body weight (4-5packs in adults)
   - Repeat FFP according to the clinical response.
2. If fibrinogen is low or the APTT or thrombin time is prolonged, also give cryoprecipitate (To supply fibrinogen and factor VIII): (8-10 packs in adults).
3. If the platelet count is less than $50x10^9$/L and the patient is bleeding, also give platelet concentrates: 4-6 packs (adults).
4. The use of heparin is not recommended in bleeding patients with DIC.

Evidence based transfusion of components

Dr Ramesh Bhaskaran , Dr Suseela Innah

Introduction

In most centers, transfusion therapy in Massive Obstetric Hemorrhage (MOH), is still based on clinical assessment of blood loss, which is highly subjective[1], coupled with conventional laboratory test results, like Hb, Platelet counts and standard tests of coagulation, and though these are apt in resource limited settings, these tests have a limitation in not being based on the actual coagulation status of the patient.

'Time is of essence, and nowhere is this more true than in catastrophic obstetric bleeds!'

Restoring hemodynamic stability in women identified at risk for MOH is crucial as the rate of blood loss during MOH can rise exponentially while awaiting the test reports of standard laboratory coagulation assays.

Massive Transfusion Protocols (MTP) in obstetric hemorrhage currently has no consensus. Though the empirical use of components, like platelets, packed red cells, fresh frozen plasma in acceptable ratios[2], while awaiting lab reports, have proven to reduce mortality and ICU stays, such prevalent rampant usage of components are fraught with serious side effects like TRALI, circulatory and iron overload, immunomodulation etc. Such practices also prevent the rational use of precious resources and also deplete an already scarce commodity. It has been also found that, use of predefined ratios of components have not demonstrated their usefulness in the context of MOH.[3]

Limitations of prevalent laboratory tests of coagulation and hemostasis

Apart from the concerns of turnaround times of conventional lab tests like Hb, aPTT, PT, platelet counts and fibrinogen etc, these standard tests remain inadequate in guiding transfusion therapy in patients with obstetric bleeds, as these tests do not assess the comprehensive process of clot formation, stability and clot dissolution as it happens in vivo. This may lead to unwanted components being transfused or more seriously, being withheld. It has been found that tests like aPTT and PT are in fact not adequate to predict key changes in the maternal hemostatic profile during MOH.

So one must keep in mind that the coagulation status of the patient can change considerably while awaiting conventional lab reports, if using such tests for guiding transfusion therapy, as it can have a bearing on the effectiveness and outcomes of the transfused components.

This is where the possible use of *viscoelastic testing algorithms* can provide timely and vital laboratory support to guide management of MOH.

Role of Evidence Based Laboratory support in managing Massive Obstetric Haemorrhage

Despite the fact that over the years, transfusion therapy has evolved into a much safer interventional modality, opportunities remain to further enhance patient safety from both, the bedside clinical and laboratory perspectives, by ensuring rational and judicious use of blood components, by harnessing latest diagnostic and therapeutic technologic advancements.

Effective Patient blood management (PBM) has been found to aid in the transfusion decision making process and ultimately help reduce unwarranted transfusions, minimize healthcare costs and ensure the availability of precious blood components to those who really need them.

Rotational thromboelastography (ROTEM) (ROTEM®; TEM International, Munich, Germany) and thromboelastography (TEG) (TEG®; Haemonetics, Braintree, MA) are both point of care (POC) viscoelastic tests of hemostasis in whole blood, which allow measurement of global clot formation and dissolution in real time. ROTEM is a modern modification of the TEG technology originally described by Hertert in 1948[4]

They have been proven to negate the limitations of current standard lab tests of coagulation which are time consuming (45-60 minutes of turnaround times) and also generally do not give a true idea regarding the clot strength, stability and lysis times and hence cannot be considered as true markers for predicting developing coagulopathy in patients at a potential risk of massive hemorrhage.

Laboratory data based on these newer viscoelastic testing modalities, for coagulation defects, will help surgeons make more timely intraoperative decisions regarding appropriate and targeted transfusion decisions, rather than hoping for and "give all components to cover all defects" approach as well as in predicting potential impending bleeds.

Viscoelastic Testing (ROTEM) in Management of Obstetric Hemorrhage

Viscoelastic testing by ROTEM basically analyzes the patients' blood sample to provide information on the quality of clot formed. The analyzer collects data by imitating in vivo sluggish blood flow to derive measurements of the kinetics of each stage of clot initiation, strength, and lysis. A small sample of patient blood is placed into a cup, and a sensor rod is inserted into the blood sample. The sensor rod rotates freely till it is deterred by the clot formation process. The change in speed and pattern of change are measured by a computer and depicted as a graph.[5,6] In fact the main **difference between TEG and ROTEM** is the bit which rotates (**TEG** rotates the cup, and **ROTEM** rotates the pin). Irrespective of which bit is rotating, some impediment to the rotation develops as the blood clots.It may be noted that the values of analogous ROTEM and TEG parameters are not interchangeable but do provide similar data and interpretations with respect to global hemostasis testing. However, ROTEM as a system has more robust quality assurance checks, multiple channels, is more resistant to mechanical shocks and has fully automated pipetting to reduce errors when compared to TEG. Here we will discuss more about ROTEM.

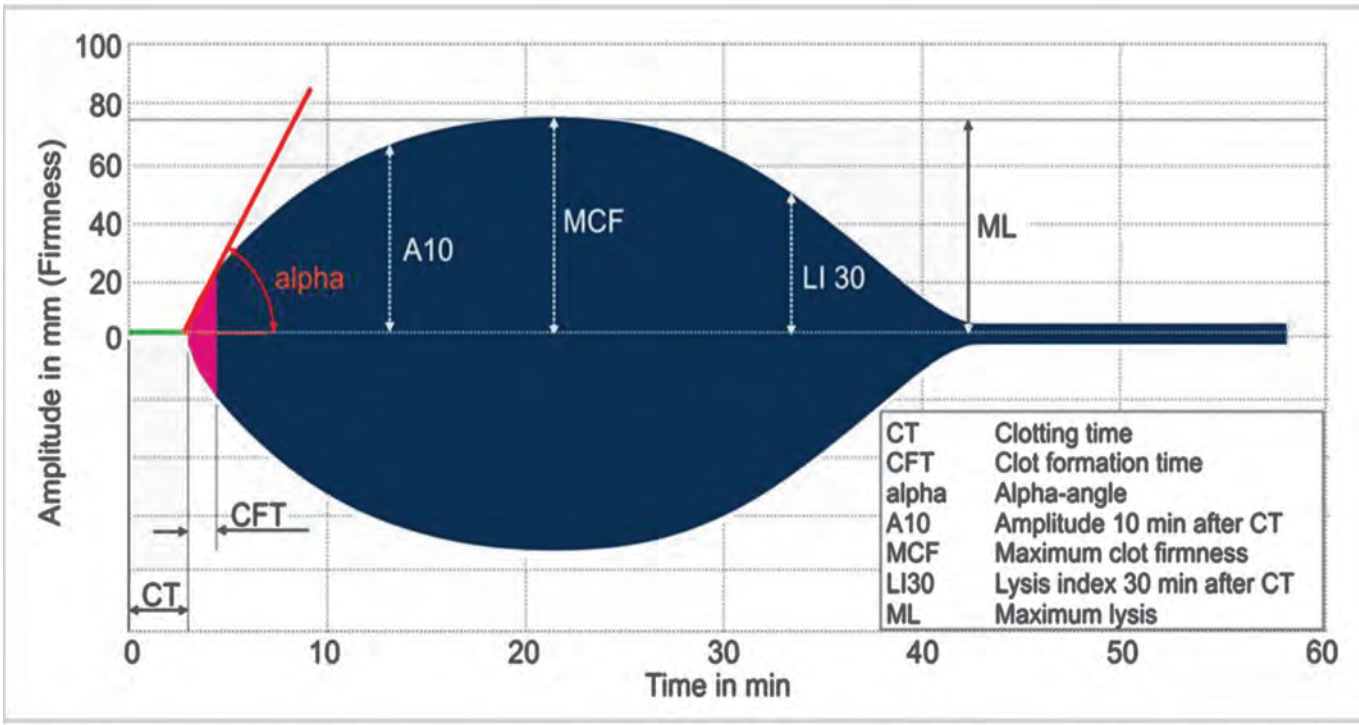
ROTEM provides a global assessment of hemostasis by using a whole blood sample to demonstrate how platelets, coagulation factors, RBCS, and other elements are working together to:

1.Initiate a clot

2.Determine clot strength

3.Investigate if there is any fibrinolysis.

Fig : 1 : Graphic representation of ROTEM parameters



The clotting time (CT, in seconds) describes the time from the start of measurement until the initiation of clot formation to amplitude of 2 mm.

The clot formation time (CFT, in seconds) describes the period from initiation of clotting until a clot firmness equivalent to a 20 mm amplitude is reached, relating to fibrin polymerization and clot stabilization.

The alpha angle (á, in degrees), which also describes clot kinetics, is given by the angle between the horizontal axis and tangential line to the TEMogram curve through the 2 mm amplitude point.

Clot amplitudes at 5–30 min (A5–A30, in millimeters) express the clot firmness at the respective time points after CT.

Maximum Lysis (ML, described in percent of MCF) demonstrates the maximum lysis detected during the analysis. The clot lysis indices at 30–60 min (LI30–LI60, in percent of MCF) express the residual clot firmness at the respective time points from CT, describing the progress of fibrinolysis.

Maximum clot firmness (MCF, in mm) measure of firmness and quality of the clot defined by the highest amplitude reached before the clot is dissolved, representing the maximal firmness that the clot achieves during the assay.

The ROTEM system also has multiple assays for analysis of various aspects of the coagulation cascade.

INTEM is similar to the APTT. This test uses phospholipid and ellagic acid as activators and provides information similar to that of the APTT. Intrinsic pathway is being tested.

EXTEM is similar to the PT. The test uses Tissue Factor as an activator and provides information similar to the PT- clot firmness based on platelet and fibrin contribution. Extrinsic pathway being tested.Deficiency of factors of the extrinsic pathway; indication for PCC administration.

HEPTEM excludes the effects of heparin HEPTEM uses lyophilised heparinase for neutralising heparin, and reports a result which uncovers any coagulopathy which might coexist alongside heparinisation.

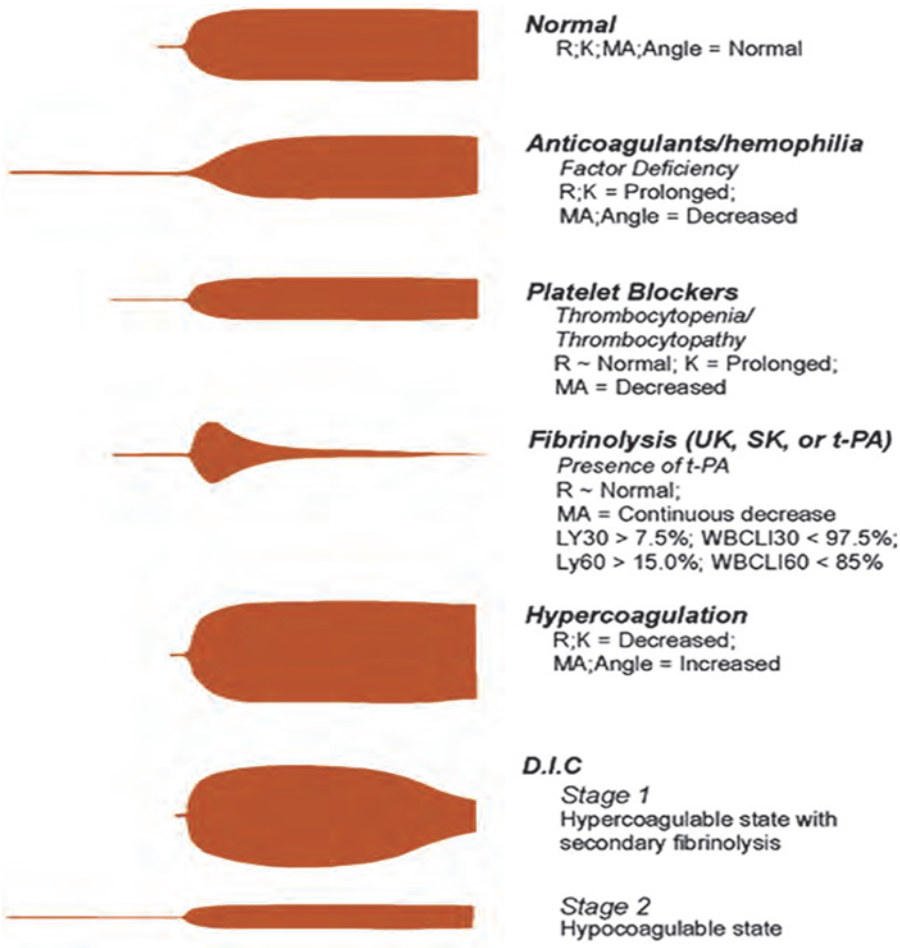
APTEM excludes fibrinolysis. This test uses aprotinin to inhibiting fibrinolytic proteins. It is otherwise identical to EXTEM. A shortened CT and a higher MCF in an APTEM test (compared to EXTEM) suggests that hyperfibrinolysis is taking place (i.e. the clot forms faster and stronger in the presence of fibrinolysis inhibitor such as aprotinin). In such a situation, one might reach for the tranexamic acid.

FIBTEM isolates fibrinogen function. By using a platelet inhibitor (cytochalasin D) this test blocks the platelet contribution to clot formation, leaving only the clotting proteins. Thus, one can observe the contribution of functional fibrinogen to clot formation. A FIBTEM MCF of less than 9mm suggests that there is insufficient fibrinogen level, and a MCF in excess of 25mm suggests that there is an excess of fibrinogen and perhaps some sort of procoagulable state.

ECATEM tests for direct thrombin inhibitors. This test uses Ecarin which is a prothrombin activator. In the presence of direct thrombin inhibitors, ECT will be prolonged; however with heparin or warfarin ECT will be normal.

Typically, INTEM EXTEM FIBTEM and APTEM will be performed, with HEPTEM and ECATEM being optional extras. The maximum clot elasticity (MCE), Maximum clot velocity (MAXV), Time to Maximum Velocity (MAXV-t), Platelet assays like ARATEM, TRAPTEM ADPTEM etc, and other additional parameters may be calculated by the ROTEM® software for further research applications.

Fig 2 Normal versus various coagulopathies



Advantages of ROTEM® over traditional coagulation assays

- Quicker turnaround times (10-15 mins)
- Whole blood as sample
- Can be a bedside test option
- Graphical & numerical result formats and displays.
- Reference ranges to rapid diagnosis of specific coagulopathies.
- Wide thermal range (22 to 42 !), to demonstrate the effects of acidosis, and hyperthermia or hypothermia on coagulation.
- Detects specific defects in coagulation, such as hypofibrinogenemia, hyperfibrinolysis, factor deficiency, and heparin effect.[7]

These advantages help in rapid identification of specific coagulopathies and help in guiding hemotherapy as per patient specific transfusion needs, resulting in a reduction in the overall transfusion requirements, a decrease in hemorrhage rates, and hence decrease in patient mortality.[8]

ROTEM results should be interpreted as a combination of sequences as mandated by the validated algorithms, and not according to their chronology of data output, to avoid potential misinterpretation of ROTEM results.

Quick roadmap to general interpretations on ROTEM

How Fast does the clot begin to form ?

The first question to address is how quickly a new clot begins to form and is represented by the clotting time (CT) 's in the EXTEM test and indicates the cumulative functionality of all the higher-level clotting factors within the coagulation cascade, leading up to the conversion of prothrombin to thrombin. Prolonged CTs can be treated with fresh frozen plasma (FFP) or prothrombin complex concentrate (PCC).

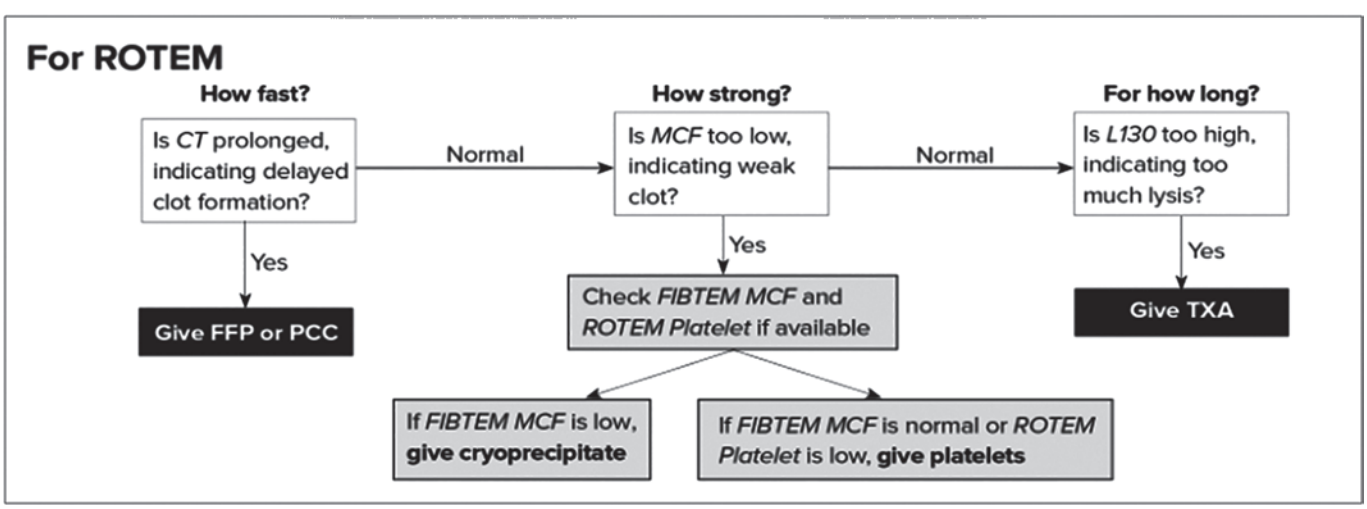
How strong is the new clot once it's formed?

Fibrin and platelets deficiency results in a pathologically weak clot. If Maximum clot formation (MCF) value is normal, there is no clot strength deficiency. If the clot is too weak overall, assess the FIBTEM MCF which measures the contribution of fibrin to clot strength.If the FIBTEM MCF in ROTEM is abnormal the fibrin component is deficient, and cryoprecipitate is indicated.Or if the FIBTEM MCF is normal, but the overall clot strength (MCF) is deficient, it may indicate a deficiency in platelet functionality and hence platelets would be indicated.

For how Long is the clot durable?

Is fibrinolysis normal as expected and the clot stable as long as it is needed or is there hyperfibrinolysis owing to hyperactive plasmin. Hyperfibrinolysis, is a treatable form of coagulopathy. To detect hyperfibrinolysis, examine the lysis index at 30 minutes (LI30) in ROTEM, and treatment with tranexamic acid (TXA) maybe indicated as per established protocols.

Fig: 3



Target values for ROTEM algorithms have been validated in many trials to assess whether the suggested interventions achieve hemostasis, reduction in transfusion requirements, and/or improvement in patient outcomes.[9,10,11]

Review of Emerging Data :
ROTEM in Obstetric Hemorrhage

Viscoelastic tests have a higher sensitivity as compared to standard lab tests like fibrinogen levels and the use of a whole blood sample makes detection of hypercoagulability in pregnancy related conditions like gestational diabetes, HELLP syndromes and pre eclampsia, a value added feature.[12,13,14]

The clinical utility of ROTEM in conditions such as antiphospholipid syndrome[15,16] is also documented as the pathological changes of coagulation parameters including fibrinolysis in recurrent pregnancy loss have been documented.[17]

From the data which has been forthcoming it is evident that TEG/ROTEM parameters confirm the hypercoagulable state of pregnancy in all its stages, even up to 6 weeks postpartum, wherein it has been found to correlate with the risk of venous thromboembolism (VTE).[18,19]

Though there are studies[20] to justify the use of viscoelastic test systems to guide blood product therapy in postpartum hemorrhage, there remains a gap in terms of having large scale randomized control trials addressing the utility of such tests for scenarios like risk stratification in hypercoagulable conditions needing prophylaxis like venous thromboembolism, and conditions like HELLP syndrome etc. Furthermore in terms of providing therapeutic guidance with respect to the use of tranaxemic acid and defining significant fibrinolysis, more studies are needed in obstetric patients, to further substantiate the use of viscoelastic testing.[21,22]

Conclusions

Blood is scarce and precious resource and mandates judicial and rational use. Incorporating recent diagnostic technical advances in clinical practice, especially where major blood loss is anticipated, can help reduce unwanted transfusions and associated complications.The use of viscoelastic testing looks promising and clinicians are encouraged to explore the possibility of adding to the emerging evidence of its utility in the management of hemostasis, by conducting further studies and trials and generating scientific data as to the utility and impact of viscoelastic testing on clinical outcomes.

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CHAPTER

26

Disseminated Intravascular Coagulation

B Presannakumari, R Sreekumari, Nandini

Editors' Note :

Disseminated intravascular coagulation (DIC) is a nightmare to obstetricians. Unfortunately it is associated with many serious obstetric complications. Often acting as a common pathway for a variety of conditions – Abruptio placenta, Amniotic fluid embolism, sepsis, prolonged fetal demise and severe PPH. To understand the pathogenesis of DIC, one has to understand the physiology of the cascade of coagulation factors and the pathway. In this chapter the authors have described the clinically relevant points in a concise manner and given tips for the management with clinical case scenarios.

What is often forgotten is that severe PPH can lead to shock, metabolic acidosis and DIC. These often happen in unanticipated situations in centres with poor facilities. The most common situations leading to DIC are abruptio placentae, PPH, and amniotic fluid embolism. Laboratory investigations may not be available. Once DIC has developed salvaging the situation is extremely difficult. Still, we have to try. While every attempt is made to replace blood and components, definitive steps to arrest the primary cause, whenever possible, should be undertaken simultaneously. This often requires completion of delivery or even hysterectomy. As the authors have emphasized a vertical abdominal incision should be used for laparotomy. Internal iliac artery ligation may not be an appropriate step once DIC has set in as it will open up retroperitoneal spaces leading to the possibility of further bleeding there.

V P Paily & V. Rajasekharan Nair

Outline

Key Points

1. DIC occurs following pregnancy complication like abruptio placenta, severe PPH, HELLP syndrome, amniotic fluid embolism, acute fatty liver of pregnancy, septic abortion.
2. Management of underlying problem is important in treating DIC.
3. Diagnosis of acute DIC made by clinical / laboratory finding - Thrombocytopenia, Prolonged PT, APTT, Fibrinogen.
4. DIC following PPH can be prevented by early management and prevention of PPH.
5. Massive transfusion protocol should be initiated, when there is massive hemorrhage.
6. Acute DIC should be anticipated in a pregnant woman with underlying condition mentioned and effort should be made to recognize and treat latent abnormality to prevent overt DIC.

Key Recommendations

1. Hemorrhage leading to shock should be prevented.
2. Sepsis should be identified and treated early.
3. HELLP syndrome should be terminated early, because endothelial damage can cause DIC
4. Prolonged hypotension even in absence of hemorrhage can lead to endothelial dysfunction and DIC.
5. In some situations we may have to perform simultaneous correction of coagulation failure and resort to hysterectomy.
6. A minimum of 6 PRBC, 6 FFP, 1 platelet unit (platelet apheresis) should be made available and given in the ratio of 1:1:1 to those who bleed profusely.

What is DIC?

There is no universally accepted definition for DIC. DIC is a systemic bleeding and clotting disorder seen in association with well-defined clinical situations and laboratory evidence of

- Procoagulant activation
- Fibrinolytic activation
- Inhibitor consumption
- Biochemical evidence of end organ damage or failure.

The International Society of Thrombosis and Hemostasis has defined DIC as an acquired syndrome characterized by the intravascular activation of coagulation with loss of localization arising from different causes. It is always secondary to an underlying disorder and is associated with a number of clinical conditions, generally involving activation of systemic inflammation.

Pathophysiology

In the human body, blood is maintained in a fluid state inside the vascular system by a finely tuned balance between coagulation and fibrinolysis. The activation of coagulation system is regulated by 3 main natural anticoagulant pathways.

1. Protein C, S, Z synthesis in liver,

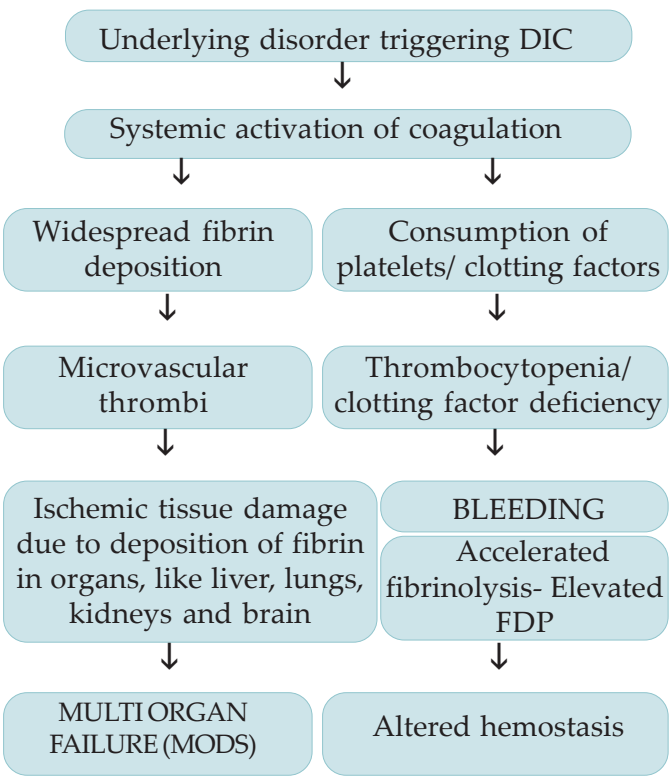
2. Antithrombin
3. Specific tissue factor inhibitor pathway, synthesized by normal trophoblast.

Whenever the coagulation system is activated, prothrombin will be converted to thrombin which converts fibrinogen to fibrin to form a fibrin clot resulting in hemostasis. The fibrinolytic system will be then activated and plasmin is released. Plasmin breaks down fibrinogen and fibrin to Fibrin Degradation Products (FDPs). When there is disseminated intravascular coagulation, fibrinolysis and coagulation are deregulated resulting in widespread bleeding.

Three main triggers:

1. Endothelial injury
2. Thromboplastin release
3. Phospholipid exposure

Processes in DIC



Thus, there is activation of both coagulation and fibrinolytic systems.

The hematologic derangements seen in DIC result from the following **four** simultaneously occurring mechanisms:

a) Thrombin generation and tissue factor activation

When there is an endothelial or tissue damage, exposure to tissue factor (TF) in the circulation occurs. TF activates coagulation via the extrinsic pathway involving factor VIIa. The TF-VIIa complex activates thrombin, which cleaves fibrinogen to fibrin and simultaneously causes platelet aggregation. The intrinsic (or contact) pathway may also be activated in DIC, though contributing more to hemodynamic instability and hypotension than to activation of clotting.

b) Impaired coagulation inhibitor systems

Once intravascular coagulation is triggered, compensatory mechanisms are overwhelmed or incapacitated. Various natural regulating pathways of coagulation activation may not function properly and this can further amplify thrombin generation and contribute to fibrin formation.

Plasma level of the most important inhibitor of thrombin, the antithrombin, is usually markedly reduced in patients with DIC. In addition to this, significant depression of the protein C and protein S [anticoagulant compensatory mechanisms] are seen. Increase in proinflammatory cytokines TNF-alpha and IL-1, can lead to exaggerated expression of tissue factor. This can generate uncontrolled coagulation response and eventually DIC.

c) Defective fibrinolysis

The intravascular fibrin produced by thrombin is normally eliminated via a process termed fibrinolysis. When the fibrinolytic system is shut off, maximal activation of coagulation happens. This is mainly caused by high circulating levels of plasminogen activator inhibitor type 1 (PAI-1). Impaired fibrin removal in sepsis can result in a

rapid increase in fibrinolytic activity, probably due to the release of plasminogen activators from endothelial cells. However, this is almost immediately followed by suppression of fibrinolytic activity due to a sustained increase in plasma levels of PAI-1. High PAI-1 levels precede DIC and predict poor outcomes. Phospholipid microparticles from active monocytes and platelet monocyte complexes increase thrombin generation. The increased thrombin activates the thrombin activable fibrinolysis inhibitor leading to decreased fibrinolysis and fibrin deposition in the microvasculature. Increased thrombin generation leads to depletion of coagulation factors, platelets and fibrinogen. Fibrin degradation products and D dimer increase in circulation will interfere with platelet function and uterine contractility. This can result in uncontrolled hemorrhage, microvascular thrombosis, damage to respiratory membranes and hemolysis due to injury to RBC membranes. All of these can lead to multi -organ failure.

Trophoblast, decidual cells, sub endothelium, fibroblast, monocytes, amniotic fluid all express tissue factor. Tissue factor is functionally inactive under normal condition. When there is endothelial disruption, placental trauma like abruption or fetoplacental necrosis as occurs in Intrauterine Fetal Demise(IUFD), tissue factor will become activated and the activated TF activates factor VII. This starts the coagulation cascade.

d) Inflammatory activation

Inflammatory and coagulation pathways interact in such a way that there is cross-communication between the two systems, whereby inflammation gives rise to activation of the clotting cascade and the resultant coagulation stimulates more vigorous inflammatory activity.

Learning from examples

Example 1

29-year-old second gravida with previous cesarean section was admitted in a tertiary care centre, at 35 weeks of gestation with complaints of abdominal pain, at 4PM. On admission - pulse rate 78/minute, BP 130/80 mm of mercury, uterus size 36 weeks and fetal heart sounds not heard. Ultrasound scan revealed fresh intrauterine death with no evidence of retroplacental clot or rupture uterus. Patient was kept under observation. After 3 hours she developed profuse bleeding per vaginum. Diagnosis of abruptio placentae was made and she was taken for cesarean section at 8.30 PM. Preoperative investigation showed - platelet count- 1.2 lakhs/cml, clotting time - 13 minutes, PT-19 seconds, and APTT 30 seconds. A still born female baby of 2.3kg was delivered. There was 1kg of retroplacental clot and fluid blood loss was about 1.2 litres. Uterus was couvelaire and atonic and hence subtotal hysterectomy with right salpingo-oophorectomy was done. Abdomen closed with drain in situ. She was transfused one unit fresh blood as per records. After 6 hours she was suspected to have internal bleeding and hence was taken for laparotomy. There was 500-750 ml of blood and 100-200 gm of clot in the peritoneal cavity. Bilateral internal iliac artery ligation was done. Clotting time was 15 minutes and platelet count was 72000/mm^3. Abdomen closed with four packs inside. After about six hours she developed cardiac arrest and was ventilated. She was transfused with 4-unit platelet and 1-unit FFP. The next day she developed high grade fever. CT scan showed brain edema. She went into coma and died on the eighth postoperative day.

Learning Points

1. Abruptio placentae should be diagnosed by history and clinical examination.
2. Total blood loss 1.2 litre plus 1 kg clot(3L) means massive obstetric hemorrhage which should be corrected with component therapy. As per records it is not done.

3. On second day when decided for relaparotomy, clotting time was 15 minutes and platelet count 72000/cml. Instead of relaparotomy and internal iliac ligation, coagulation defect should have been corrected. She went into cardiac arrest the same day. Death might have been due to hypoxic brain damage.
4. Immediate cesarean section on arrival to labor room and adequate correction of coagulation defect with component therapy.

Example 2

23-year-old second gravida with previous cesarean section was admitted at 28 weeks of gestation with decreased fetal movements. Ultrasound revealed intrauterine death. Labor was induced with PG E1 and augmented with oxytocin. It was a compound presentation with hands prolapsed into the vagina. Hand was pushed up under general anesthesia. After three days of induction she delivered a dead fetus. Following delivery, she developed severe PPH and hemoglobin dropped to 2.9 gram. Since PPH did not respond to oxytocin, hysterectomy was done. She was shifted to tertiary care centre in a mobile ICU. Reaching there she was transfused 8 units of packed cell and 4-units of FFP. Platelet count was 64,000. She was started on vancomycin and hydrocortisone. She died on 12th post-natal day due to hepato- renal failure.

Learning Points

1. Prolonged induction after manipulations would have contributed to sepsis and PPH. DIC due to sepsis might have led to hepatorenal failure.
2. Avoiding sepsis and prompt treatment of sepsis would have prevented death. Sepsis can lead to DIC and MODS.

Changes in coagulation factors in pregnancy:

Normal pregnancy is a hypercoagulable state.

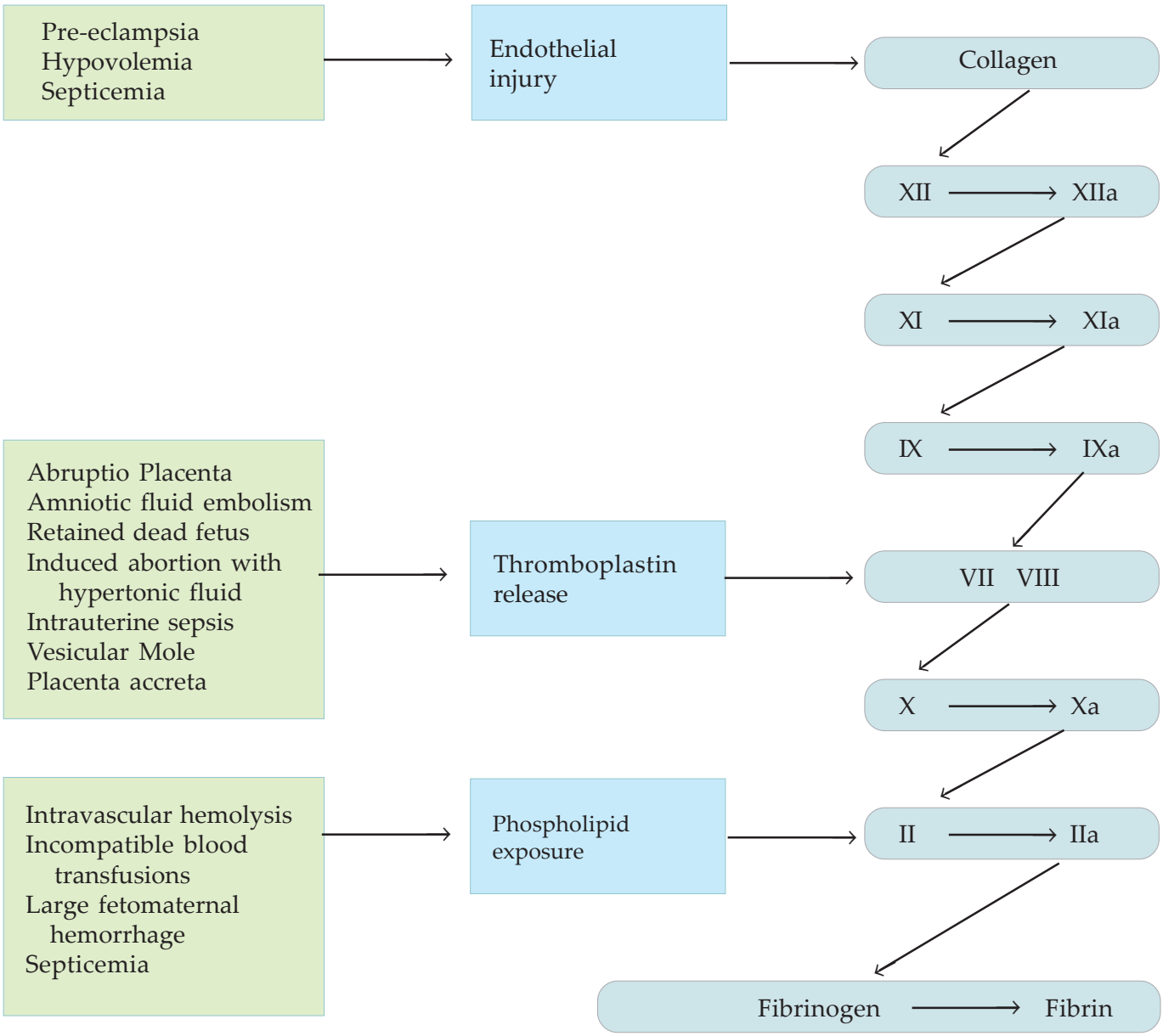
- There is an increase in all coagulation factors except factors XI and XIII.
- There is shortening of PT and APTT.
- Consumption of coagulation factors may elevate PT and APTT, but will still be within non-pregnant state
- Fibrinogen almost doubles, whereas the fibrinolytic system is depressed. Fibrinogen level < 200 mg% should be taken as abnormal.
- Similarly platelet count is low in pregnancy. Platelet count of >1.5lakhs/cmm is taken as normal.
- Thrombocytopenia can occur in the following conditions
  1. Gestational Thrombocytopenia
  2. HELLP Syndrome
  3. Sepsis

Important triggers of DIC in pregnancy:

- Sepsis and severe infection
- Hypovolemic shock and massive blood transfusion
- Obstetric complications -Amniotic fluid embolism; Abruptio placentae; Hemolysis, Elevated Liver enzymes and Low Platelets (HELLP) syndrome; Acute fatty liver of pregnancy and Eclampsia
- Retained dead fetus syndrome, retained products of conception
- Catastrophic antiphospholipid syndrome (rare)

The end result in all four mechanisms is generation of thrombin with increased fibrin deposition and platelet depletion. Platelets decrease due to consumption and aggregation. However, many pathogeneses can overlap. Systemic activation of coagulation can result in bleeding and multi-organ failure.

Pathogenesis in Different Situations



Spectrum of DIC in obstetrics

Table-1

SEVERITY	IN VITRO FINDINGS	OBSTETRIC CONDITIONS commonly associated
Stage 1- low grade Compensated	FD P ↑ Platelet ↓	Pre-eclampsia and related syndrome
Stage 2- uncompensated but no hemostatic failure	Platelet ↓ Fibrinogen ↓ Factor V ↓ Factor VIII ↓	Abruptio placenta and severe pre-eclampsia
Stage 3- Rampant with hemostatic failure	Platelet ↓↓ Fibrinogen ↓↓ FDPs ↑↑↑	Abruptio placenta Amniotic fluid embolism Eclampsia

Fibrin Degradation Products in Obstetric DIC:

- Impair fibrin monomer polymerization (i.e. prevent cross linking of fibrin and formation of new clots)
- Coat platelet membranes resulting in decreased platelet function.
- Impairs myometrial contractility- hence, worsens PPH and may be cardio toxic- lowers cardiac output and blood pressure and can decrease organ perfusion.

Clinical Presentation

DIC, being the effect of an underlying disease process, often patients present with the symptoms of the underlying condition. On physical examination patients with acute DIC often manifest as petechiae on the soft palate, trunk, and extremities and ecchymosis at venepuncture sites, along with blood loss from intravenous (IV) lines and catheters. In postoperative patients with DIC, bleeding can occur from surgical sites and drains.Bleeding from at least 3 unrelated sites is particularly suggestive of DIC. There can be life threatening hemorrhage. Severe hemorrhage leading to hypotension, tachycardia, and circulatory failure can occur. Respiratory system involvement can lead to ARDS. Gastrointestinal bleeding can cause hematemesis. This type of acute DIC is seen in amniotic fluid embolism and abruptio placentae. As many as 25% of patients present with renal failure. Patients with pulmonary involvement can present with dyspnea, hemoptysis, and cough. Comorbid liver disease, as well as rapid hemolytic bilirubin production may lead to jaundice. Neurologic changes (e.g. coma, obtunded mental status, and paresthesia) are also possible.

Management of DIC

DIC is commonly a consequence of delayed or inadequate resuscitation.

Diagnosis:

DIC is diagnosed, not by a single laboratory value but by a constellation of laboratory markers. The laboratory markers consistent with DIC are

1. Prolongation of PT and APTT due to underlying consumption of coagulation factors. Thrombin time is increased in 80 % of cases of DIC. APTT measures the time required for the intrinsic pathway and hence is not very useful.
2. A rapidly decreasing platelet count.
3. Serum fibrinogen- Fibrinogen levels double in pregnancy. Hence, all cases of DIC do not have low fibrinogen. 70% will have decreased fibrinogen. It can be used as a predictor of severity of PPH.
4. High levels of Fibrin degradation products including D –Dimer due to intense fibrinolytic activity stimulated by the presence of fibrin. FDP is elevated in 85-100% of patients with DIC. The level of FDP is increased in normal pregnancy also, when there is a trauma or recent surgery. Presence of venous thrombosis can also raise FDP. Hence, it is a nonspecific marker. It is also

implicated in the increased synthesis of inflammatory cytokines.

5. D-Dimer – This is an antigen formed as a result of fibrin degradation. It is increased in 90 % of cases of DIC. The level of D-Dimer is also increased in normal pregnancy, in trauma or recent surgery and in venous thromboembolism.
6. Peripheral smear shows fragmented RBCs called schistocytes, but it has been found to be neither sensitive nor specific for DIC.
7. Clot retraction test - it is a bedside test. It is a test for decreased fibrinogen.

Definitive diagnosis is by histological viewing of fibrin deposits. However, this is not feasible in obstetric emergency conditions. Clinical and laboratory parameters should be measured frequently, depending upon clinical scenario.

Treatment of Obstetric DIC

DIC can be avoided in most situations by a 'timely' resuscitation and management of underlying disease (e.g. abruption or preeclampsia.) DIC can be predicted in all previously mentioned high risk conditions except Amniotic fluid embolism. Therapy should be highly individualized

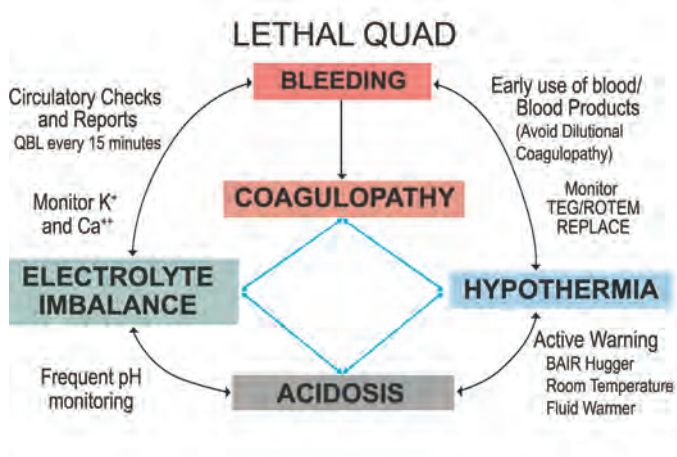
1. Treat the obstetric abnormality
2. Replace blood products
3. Treat acidosis, hypothermia and hypocalcaemia
4. Multidisciplinary approach - cardiopulmonary support including use of inotropic therapy, blood transfusion and assisted ventilation, if required.

1. **Treat the underlying cause -** Identifying the underlying cause is the cornerstone of management.
2. **Maintain oxygen perfusion.**
   Oxygen saturation is to be maintained above 94%. If needed mechanical ventilation should be started.
3. **Administration of blood and blood products.** Replacement of blood and blood products forms the cornerstone in management of *DIC*. Anesthetist and blood bank to be informed. It is important to involve a hematologist in the management.
4. **Women who are bleeding-** Arrest the hemorrhage at the earliest so that DIC can be prevented. In women who bleeds profusely after delivery attempts to arrest hemorrhage (this will be dealt in chapter on PPH) fails, we have to resort to obstetric hysterectomy with simultaneous correction of DIC with massive transfusion. It is important to insert a large bore drain before closing the abdomen in all situations where bleeding is anticipated.

Management of DIC

If the fibrinogen level is <200 mg% the patient should be given either cryoprecipitate or FFP to increase fibrinogen to 300 mg%. In actively bleeding women blood should be given rapidly. In some situations blood may have to be pushed. Hypocalcaemia and hypercalcaemia associated with massive transfusion have to be managed.

The following chart describes blood products.



BLOOD PRODUCTS

PRODUCT	REMARKS
PRBC	Improve O2 carrying capacity Transfusion based on physical examination, vital signs and ongoing loss
FFP	Contains all plasma proteins and clotting factors. Transfuse if microvascular bleeding from clotting factor deficiency
Cryopre-cipitate	Contains clotting factors and high concentration of fibrinogen.Use when fibrinogen <1g/l and volume status is a concern
Platelet concentrate	1 adult dose should increase platelets by 25,000-30,000 cmm. Use if there is microvascular bleeding and platelet count is < 50,000/cmm

The guiding principles in blood transfusion are:

- Volume resuscitation with PRBCs as soon as available.
- Ratio of 1:1:1 (PRBC: FFP: Platelet) may be beneficial.
- Maintain low normal systolic BP and prevent hypothermia and acidosis.
- Use PRBC < 14 days- when massive blood transfusion is indicated
- Cryoprecipitate- when fibrinogen levels are less than 80-100 microgm/dl
- FFP- when PT and APTT are > 1.5 times the control / when massive blood transfusion is indicated
- Platelet transfusion – when count < 50000/cml / when massive blood transfusion is indicated

Transfusion targets –

1. HB > or 7 gm%.
2. Platelet >50000
3. Fibrinogen> or 200 gm%.
4. PT/APTT<1.5 times control.

- BALANCE is the key and avoid large volumes of crystalloids
- Use O negative blood until ABO/Rh type are confirmed
- Early contact with blood bank

Massive transfusion protocol is required when:

1. The expected blood loss is one blood volume within first 24 hours (about 5 liters in a 70 kg patient)
2. The predicted loss is > 50 % of blood volume within 3-hour period
3. Ongoing loss is > 15 ml/kg/hour

***Monitoring*:**

i. ABG
ii. Ionized calcium
iii. S. Lactate
iv. S. Electrolytes
v. CBC
vi. PT/ INR
vii. S. fibrinogen

Check every 30-60 minutes depending on clinical situation.

Thromboelastometry

As thromboelastometry gives a rapid global assessment of hemostatic function. It is a useful test when there is massive hemorrhage. Even though normal range for pregnant women and postpartum period are available, these are not based on robust data. More research is needed before this test can be recommended. These tests may become useful to identify early alteration of coagulation system.

Termination of pregnancy.

If coagulation failure is due to abruptio placentae, correct coagulation abnormality and evacuate the uterus, since triggering factor should be eliminated. PRBC, FFP, Platelet and cryoprecipitate should be arranged if bleeding is not controlled. If the patient is persistently bleeding from wound site, FFP and cryoprecipitate should be given without waiting for results of PT, APTT or Platelet count. In a patient when DIC is anticipated, a vertical incision is preferred to prevent hematoma formation.

To counter the complications of massive transfusion:

- Ionized calcium to be kept > 1.13 mmol/L
- Urine output to be > 30 ml/ hr (0.5 ml / kg/ hr)
- Systolic B.P. at low normal for age
- Temperature > 35degree Celsius
- pH> 7.10

Adjuvant Therapy

- Antifibrinolytics (Tranexamic Acid 10mg/kg intravenous) maximum dose of 1 g can be given.
- Recombinant factor VII should be considered if patient does not respond (Dose 20-50 microgram/kg/dose intravenous(iv).
- Prohemostatic drugs like DDAVP 10 microgram/ sq. meter, intravenously (maximum dose is 20 micro gram.)

Most patients improve after delivery.

Conclusion

- DIC is a rare but serious entity in obstetrics with high morbidity and mortality.
- Condition is difficult to diagnose and we must have a high index of suspicion when dealing with pathologies known to cause DIC.
- Mild untreated cases can rapidly progress to fulminant hemostatic failure.
- Treatment of DIC is aimed at underlying cause and supportive therapy.
- Inadequate resuscitation is the most common cause of maternal death, hence the importance of early intervention.

DIC can be predicted, prevented and successfully treated in most situations, if the obstetrician is alert and the situation is tackled judiciously with the use of blood products, ventilator support when needed, proper monitoring and multidisciplinary input. In situations like severe PPH, decision for hysterectomy should be taken in time. PPH should be treated actively by methods discussed in the chapter on PPH so that DIC will not occur. When there is massive blood loss blood may have to be pushed. The obstetrician should be vigilant in diagnosing DIC at the earliest and starting treatment.

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CHAPTER

27

Fluid resuscitation in shock

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Background

Shock is a life-threatening condition of circulatory failure that most commonly presents with hypotension. It can also be heralded by other vital sign changes or the presence of elevated serum lactate levels. The effects of shock are initially reversible but can rapidly become irreversible, resulting in multi-organ failure (MOF) and death.(1,2)

The treatment of shock in a pregnant woman differs in two important respects from the treatment of shock in other adults.

1. Normal physiologic changes occur in most organ systems during pregnancy and this can interfere with the evaluation of shock.

2. The mother and the fetus are both vulnerable during pregnancy.

Therefore, obstetric critical care involves simultaneous assessment and management of the mother and fetus, who have differing physiologic profiles. But the general principles of management will remain the same.

Definition and classification

Shock is defined as a state of cellular and tissue hypoxia due to reduced oxygen delivery and/or increased oxygen consumption or inadequate oxygen utilization. This most commonly occurs when there is circulatory failure manifest as hypotension (ie, reduced tissue perfusion).

A diagnosis of shock is based upon a constellation of ***clinical, biochemical, and hemodynamic features.***

Clinical: Most patients have hypotension. Hypotension may be

- absolute (eg: systolic BP <90 mm Hg; mean arterial pressure <65 mm Hg),
- relative (eg, a drop in systolic blood pressure >40 mm Hg)
- orthostatic (>20 mm Hg fall in systolic pressure or >10 mm Hg fall in diastolic pressure with standing)
- profound (eg, vasopressor-dependent) with clinical signs of tissue hypoperfusion (eg, cold, clammy, mottled skin; oliguria [<0.5 mL/kg/hour]; altered mental status).

Biochemical: Hyperlactatemia (>1.5 mmol/L).

Hemodynamic indices:

Low cardiac output, systemic vascular resistance, and/or mixed venous oxyhemoglobin saturation are not diagnostic but help to classify shock.

Shock is classified into four main classes: [1,2]

- **Distributive** eg: septic shock, systemic inflammatory response syndrome, neurogenic shock, anaphylactic shock, toxic shock, end-stage liver disease, endocrine shock.
- **Cardiogenic** eg: myocardial infarction, atrial and ventricular arrhythmias, valve or ventricle septal rupture.
- **Hypovolemic** eg: hemorrhagic and non-hemorrhagic fluid losses.
- **Obstructive**. eg: pulmonary embolism, pulmonary hypertension, tension pneumothorax, constrictive pericarditis, restrictive cardiomyopathy.

Sometimes even after this triaging it remains as "**Undifferentiated shock"** which refers to the situation where shock is recognized, but the cause is unclear.

When feasible, a multidisciplinary, team-based approach is preferred because it allows the simultaneous evaluation and administration of therapy to patients with hypotension and shock.

Point-of-care ultrasonography (POCUS) is a new noninvasive modality which can be used for evaluation of shock.[3]

POC ultrasonography algorithms, including rapid ultrasound in shock (RUSH), focused cardiac ultrasound (FOCUS), or abdominal and cardiac evaluation with sonography in shock (ACES), are more frequently used as portable, **bedside** diagnostic tools in patients with undifferentiated shock and hypotension.

When available, POC ultrasonography is typically used in patients in whom an empiric diagnosis has not been achieved with clinical and laboratory evaluation or in those in whom definitive imaging is unsafe and as a complementary tool to examine fluid responsiveness.

Although POC ultrasonography is not definitively diagnostic, when performed by trained personnel as a time-sensitive diagnostic tool in critically ill patients with undifferentiated shock or hypotension, valuable information can be obtained that can be lifesaving.

Interrogating inferior vena cava in a collapsed patient is easy – A collapsing inferior vena cava (IVC) at the end of expiration suggests hypovolemia from hemorrhagic or non-hemorrhagic causes. A dilated IVC may support cardiac tamponade or PE.

Fluid resuscitation in shock:

Because shock can be present with varying degrees of hypotension the precise threshold that warrants hemodynamic support is unknown.

In general, those with suspected shock who are hypotensive and/or have clinical or laboratory evidence of hypoperfusion (eg, change in mental status, clammy skin, diminished urine output, elevated lactate) should receive hemodynamic support with intravenous fluids (IVFs), followed by vasopressors, should IVFs fail to restore adequate tissue perfusion; the exception is hypovolemic shock where more fluids is preferred.

While the optimal end-organ perfusion pressure is unclear, in general, maintain the mean arterial pressure greater than 65 to 70 mmHg, since higher targets (eg, >70 mmHg) do not appear to be associated with a mortality benefit and may be associated with increased risk of cardiac arrhythmias.

Intravenous(IV) fluids are first-line agents in the treatment of patients with undifferentiated hypotension and shock. Administer IV fluids in well-defined boluses (eg, 500 to 1000 mL) that can be repeated until blood pressure and tissue perfusion are acceptable, pulmonary edema or intraabdominal hypertension ensues, or fluid fails to augment perfusion.[4]

In general, for patients with severe volume depletion or hypovolemic shock not due to bleeding, crystalloids are typically preferred over colloid-containing solutions. Among the crystalloids, normal saline (ie, 0.9 percent saline) is the most commonly used solution for initial repletion since data have failed to show consistent superiority of buffered crystalloids when compared with saline, especially when volumes <2 L are being administered. However, several factors influence the choice between 0.9 percent saline and buffered crystalloids.[4a]

The total volume infused is determined by the etiology of shock. As an example, patients with obstructive shock from pulmonary embolism or cardiogenic shock from LV myocardial infarction usually require small volumes of IVFluids (500 to 1000 mL), while those with RV infarction or sepsis often need 2 to 5 L, and those with hemorrhagic shock frequently require volumes >3 to 5 L (often inclusive of blood products). ***The administration of diuretic therapy should be avoided in hypotensive patients with pulmonary edema until the need for hemodynamic support has been weaned.***

Type of fluid to be used for resuscitation

Crystalloid solutions

- Normal Saline (0.9%)
- Buffered saline also known as balanced or chloride-restrictive solutions e.g., lactated Ringer's,
- Plasma-Lyte,
- Bicarbonate buffered 0.45% saline.
- Hartmann's solution is the same as lactated Ringer's, although small differences in the sodium, chloride, and calcium concentrations may exist across commercial formulations.[5]

Choosing between 0.9 percent saline and buffered crystalloid

Normal saline (0.9 percent saline) is hyperchloremic relative to plasma, such that large volume resuscitation using 0.9 percent saline may be associated with the development of a hyperchloremic metabolic acidosis. This has led to suggestions that isotonic fluids with lower chloride concentration be used instead of 0.9 percent saline for large volume resuscitation; such fluids are termed buffered, balanced, or chloride-restrictive crystalloids and include fluids such as lactated Ringer's solution (or Hartmann's solution), 0.45 percent saline solution with 75 mmol/L of sodium bicarbonate, or Plasma-Lyte.

If the requirement of fluid appears to be > 2 litres for immediate resuscitation, consider buffered electrolyte solutions[6]

Colloid-containing solutions

- Albumin solutions,
- Hyperoncotic starch,
- Dextran,
- Gelatin.

Colloid-containing solutions are rarely used as first line resuscitative fluids for the management of hypovolemia and hypovolemic shock not due to bleeding.

However, some clinicians advocate the administration of colloid solutions, particularly albumin, in those with limited response to crystalloid solutions or those in whom hypoalbuminemia is thought to be contributing to shock, although data to support these indications are limited. Hyperoncotic starch should, in general, be avoided since its use is associated with an increased risk of kidney dysfunction and mortality.[7,8]

Hemorrhagic shock requires a special mention. The management of hemorrhagic shock requires immediate resuscitative measures, including administration of oxygen, placement of 2 intravenous lines, and replacement of loss with blood.

Till blood can be made available crystalloids are to be given. The problem of massive transfusion, historically defined as the replacement by transfusion of 10 units of red cells in 24 hours, requires a special approach and is beyond the scope of this chapter including selection of the appropriate amounts and types of blood components to be administered and requires consideration of a number of issues including volume status, tissue oxygenation, management of bleeding and coagulation abnormalities, as well as changes in ionized calcium, potassium, and acid-base balance.

Blood products

Packed red blood cells or blood substitutes.

However, extrapolating from patients with septic shock, most patients are treated with crystalloids (eg, Ringer's lactate or normal saline), and those with hemorrhagic shock should be preferentially treated with blood products

Initial rate of fluid replacement:

The rate of fluid repletion should be individualized depending upon the underlying etiology and rate of fluid loss, estimated total body deficit, underlying electrolyte abnormalities, and predicted future losses, which can be hard to predict if fluid loss continues from persistent bleeding or third space sequestration.

While there is no one ideal initial rate, many clinicians model the rate of fluid administration on rates similar to those recommended in patients with sepsis and septic shock, although data to support this strategy is lacking.

Monitoring the response to fluid resuscitation:

The idea of fluid resuscitation is to prevent irreversible shock and also to prevent over resuscitation and iatrogenic hypervolemia. Irreversible shock is associated with loss of vascular tone, a drop in systemic vascular resistance, pooling of blood in the capillaries and tissues, an impaired response to vasoactive medications, and multiorgan failure.

Clinical parameters including heart rate, blood pressure, urine output, skin turgor, mucus membrane integrity, and mental status should be continuously followed during fluid replacement to assess the efficacy of volume replacement. For most patients, the period of observation lasts for the

duration of fluid resuscitation (eg, 6 to 48 hours, longer for ongoing fluid loss).

While there are no recommended ideal measurable targets for patients with hypovolemia, many clinicians use parameters extrapolated from patients with sepsis and septic shock (eg, mean arterial pressure 65 to 70 mmHg, no greater than 70 mmHg, urine output >0.5 mL/kg/hour).

In comparison, rapid fluid resuscitation is not necessary in patients with mild to moderate hypovolemia. The rate of fluid administration must be greater than the rate of continued fluid losses, which is equal to the urine output plus estimated insensible losses (usually 30 to 50 mL/hour) plus any other fluid losses (e.g. gastrointestinal losses) that may be present.

One regimen that can be used to induce positive fluid balance in such patients is the administration of fluid at a rate that is 50 to 100 mL/hour greater than estimated fluid losses.

Maintenance fluid therapy

Fine tuning the dyselectrolytemia :

Once the immediate resuscitation to bring back the vitals to normal is done, the goal of replacement therapy is to correct existing abnormalities in volume status and/or serum electrolytes.[9]

There is no formula that can be used to accurately estimate the total fluid deficit. If pre- and post-deficit body weight is known, then weight loss provides a reasonable estimate of fluid losses. Weighing beds in ICUs are useful here. Clinical and laboratory parameters can also be used to assess the possible presence of volume depletion, including the blood pressure, jugular venous pressure, urine sodium concentration, urine output, and, if baseline values are available and bleeding has not occurred, the hematocrit.

These parameters should be followed to assess the efficacy of volume replacement. If, for example, the urine sodium concentration remains below 15 mEq/L (15 mmol/L), then the kidney is sensing persistent volume depletion and more fluid should be given.

Use of the urine sodium concentration does **not** apply to edematous patients with heart failure or cirrhosis in whom the urine sodium concentration is a marker of effective circulating volume depletion but not of the need for more fluid or more salt.

Assessing the size and effect of respiration on the IVC measured by an US examination is a useful modality to assess adequacy of hydration, and since it is noninvasive can be repeated.

The rate of correction of volume depletion depends upon its severity. With severe volume depletion or hypovolemic shock, at least 1 to 2 liters of isotonic fluids are generally given as rapidly as possible in an attempt to restore tissue perfusion. Fluid replacement is continued at a rapid rate until the clinical signs of hypovolemia improve (eg, low blood pressure, low urine output, and/or impaired mental status).

Hypernatremia and hyponatremia should usually be corrected slowly since overly rapid correction is potentially harmful.

Potassium replacement is indicated in patients with potassium depletion. This is typically manifested by hypokalemia but may occur in the setting of a normal or even increased serum potassium in patients with diabetic ketoacidosis or nonketotic hyperglycemia.

If potassium is added to isotonic saline or one-half isotonic saline, it limits the potential rate of infusion. In most cases, the desired rate of potassium replacement is no greater than 10 mEq per hour; in patients with life-threatening hypokalemia, the rate can be increased to 20 mEq per hour, although electrocardiographic monitoring is required. Thus,

if 40 mEq of potassium has been added to a liter of intravenous (IV) solution, the rate of infusion should generally be limited to 250 mL per hour, or 500 mL per hour with electrocardiographic monitoring if the patient has life-threatening hypokalemia.

The addition of sodium bicarbonate may be required in patients with metabolic acidosis if the acidemia is severe (arterial pH less than 7.2) or bicarbonate losses persist (as with severe diarrhoea). Here a more complex solution may be required. In this setting, sodium bicarbonate may be added, particularly if the acidemia is severe (arterial pH less than 7.15 to 7.2 or less than 7 in diabetic ketoacidosis) or bicarbonate losses persist (as with severe diarrhea).

A word about Dextrose saline :

In general, there is little evidence that adding or omitting dextrose from saline has any benefit or harm.

However, there are settings in which **dextrose** should or should not be used. Dextrose-containing solutions **should be used** in patients with hypoglycemia, alcohol intoxication or fasting ketoacidosis and should be given with insulin in patients with hyperkalemia and no hyperglycemia since insulin-mediated entry of potassium into cells will lower the serum potassium concentration

Dextrose-containing solutions **should not be used** in patients with uncontrolled diabetes mellitus or hypokalemia. With respect to hypokalemia, the administration of dextrose stimulates the release of insulin, which promotes potassium entry into cells with possible worsening of the hypokalemia.[9]

Key Summary Points:

- Shock is defined as a state of cellular and tissue hypoxia due to reduced oxygen delivery and/ or increased oxygen consumption or inadequate oxygen utilization. This most commonly occurs when there is circulatory failure manifest as hypotension (ie, reduced tissue perfusion).
- In a pregnant patient the most common cause of shock is hemorrhagic shock, followed by Septic, embolic (amniotic fluid / thrombo) and anaphylactic. But one should also consider the various causes of shock, distributive, cardiogenic, hypovolemic and obstructive since the management essentially will depend on the causation.
- The initial fluid resuscitation generally follows the guidelines used for septic shock and is essentially crystalloids, except probably in hemorrhagic shock where it is blood and blood products.
- The type of fluid and the speed of replacement depends on the clinical situation and close monitoring of the patient. A large volume replacement may have to be done in hypovolemic shock but in cardiogenic and obstructive shock one has to be cautious not to produce fluid overload

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CHAPTER

28

Antibiotics

C Nirmala, Sheela Shenoy, Reji Mohan

Editors' Note

The authors have presented a realistic approach to antibiotic use in our setting. Many practical tips are given. They warn against the false sense of security in using antiotics to prevent and treat infections and advise to follow aseptic technique. The table on antimicrobial spectrum of commonly used antibiotic will be useful for day to day practice.

V P Paily

Introduction and Rationale

Sepsis is a leading cause of direct maternal death in many countries, more so in the developing and middle income countries ; in UK as well it is a major cause of direct maternal mortality. While the absolute risk of death from maternal sepsis is low in the UK (2.0/100 000 maternities), a study using the UK Obstetric Surveillance System (UKOSS), which captures data from obstetrician-led maternity units, found that the magnitude of severe morbidity is 50 times greater.[1] Even in an era of modern antibiotics and advanced medical care, the global incidence of sepsis has increased dramatically.

Antibiotics are frequently used during pregnancy. Several studies have shown that 25–40% of pregnant women take antibiotics, mainly in the second trimester, while the incidence of antibiotic intake is around 5% in the first trimester. Antimicrobial resistance (AMR) is a serious global concern and incidence rate of AMR is gradually rising in many pathogens which threaten our ability to treat and cure common infections. Irrational use of antibiotics, unregulated over the counter sale of antibiotics and lack of guidance and awareness on antibiotic use are major drivers of AMR incidences. Lack of monitoring and inappropriate use of antimicrobials is a major contributor for the development of AMR and its spread.

Confidential Enquiry into maternal deaths, 2009–2012 MBBRACE United Kingdom (UK) study observed that approximately 25% women who died had sepsis.[2,3] A key message from the report, ***Think Sepsis***, advocates for key actions for diagnosis and management of sepsis at an early stage such as timely recognition, fast administration of intravenous antibiotics and quick involvement of experts. Sepsis remains around 10% of the causes of death according to CRMD Kerala in the last decade.

Historical

King Henry VIII, Jean-Jacques Rousseau, and Mary Shelley, author of *Frankenstein*, all lost their mothers to infections following childbirth, and literature abounds with tragic stories of maternal death, from *A Christmas Carol* to *Wuthering Heights*, *Far From the Madding Crowd*, *A Farewell to Arms*, *Revolutionary Road*, *Lolita*, and *Harry Potter*.

A Big Burden

More than 30,000 women and 400,000 newborns die each year from infections around the time of birth. Most of these deaths occur in low-income countries, and the situation will only worsen as the antibiotics available for treating infections become less effective, owing to the emergence of resistant microbes. Current estimates indicate that more than 20,000 newborns die each year from infections that do not respond to available drugs. Hospital based reports estimate 40% infections in newborns are resistant to standard treatment regimes.

In facility-based births, increase in the risk of hospital-acquired infections occurs after normal vaginal delivery if not accompanied by improvements in the quality of hygiene and infection-control measures. However, the evidence is unclear about the added effect of antibiotic prophylaxis on the prevention of postpartum infections after an uncomplicated vaginal birth. Administration of a drug to a pregnant woman presents a unique problem. Most drugs or chemical substances taken during pregnancy can cross the placenta to some extent throughout pregnancy, but the fetus is at highest risk during the first 3 months of gestation. Physiologic changes in pregnancy lead to an increase in glomerular filtration and enhanced elimination of antibiotics; dosage adjustments (increases) may be necessary to ensure an appropriate serum level of drug.

We hope that this chapter will serve as a practical guide for the practising obstetricians in

guiding the treatment and proper usage of antimicrobials. This document will benefit in prescribing and dispensing antimicrobials effectively thus improving the quality of patient care and bringing down the AMR burden in our speciality.

All recommended therapies are either evidence-based or as per universally accepted standards. These are general guidelines; treatment of individual patients may vary depending upon local conditions and experience. The antimicrobial susceptibility data given in this guideline are compiled from ICMR guidelines [4, 5] and other standard guidelines around the globe like RCOG, ACOG [6], WHO[7] and local protocols [8]. Antimicrobial resistance data is known to differ between different healthcare institutes and each healthcare institute must customize their respective guideline accordingly depending on the updated antibiogram of the institution considering the suggestions of this chapter.

Steps of rational antibiotic use:

Step 1: Making a clinical diagnosis

Step 2: Limiting empiric antibiotic therapy

Step 3: Know your bugs

Step 4: Choose the appropriate antibiotic

Step 5: De-escalation/modification

Step 6: Stop antibiotics in the following clinical situations like low grade fever, viral infections, skin infections etc

Step 7: Reduce the duration of therapy

Step 8: Optimize PK-PD parameters

Antimicrobial stewardship is a pressing need of today and is the only proven strategy to prevent human antimicrobial over use and abuse which is one of the main reason of antimicrobial resistance. Rational use of antibiotics needs to be taught at all levels in the medical school curriculum.

Infection prevention and control

Aseptic technique is a key component of all invasive medical procedures. Hygiene and infection-control measures (hand-washing and disinfection, single use of gloves, and cleaning and sterilisation of equipment) are the basis for prevention of infection around the time of childbirth for women with uncomplicated vaginal births.

Antibiotic prophylaxis regimens

1. **Routine per vaginal examination and induction of labour**

   No antibiotics recommended[3]

2. **Artificial rupture of membranes in active phase of labour if labour occurs within 6 hours**

   No antibiotics recommended

3. **Artificial rupture of membranes in active phase of labour if labour tends to prolong beyond 6 hours**

   Inj.Cefazolin 500mg IV Q 6th hourly

4. **Clean episiotomy with minor tear**

   No antibiotics /oral ampicillin 500mg Q 6 hourly. Inj.Ampicillin 2 gm IV initial dose followed by 1gm IV 4-6 hourly till delivery for GBS prophylaxis. If allergic, vancomycin 1 gm IV 12 hourly till delivery.

5. **Deep episiotomy, multiple vaginal lacerations, complete perineal tear**

   Inj.cefazolin 500mg Q6th hourly and Inj.metrogyl 500mg Q 8th hourly for 3-5 days or Single dose IV cefuroxime 1.5 gm plus metronidazole 500 mg or IV amoxicillin-clavulanic acid 1.2gm or clindamycin 600 mg IV (if penicillin allergic).

6. **Uncomplicated cesarean section prophylaxis**

Inj. cefazolin 2gm IV or Inj. cefuroxime 1.5 gm 30 minutes before procedure. If allergic to cefazolin, give a single dose of IV clindamycin 600-900mg + gentamicin 80 mg. If cesarean lasts more than 3 hours or blood loss more than 1500ml, one more dose at 6 hours is advised

7. **LSCS with fever more than 100 degree or evidence of infection**

Add Inj.amikacin 500 mg Q 12 hourly IV and Inj.Metrogyl 500mg Q 8 hourly IV for 5 days

In case of suspected sepsis or if poor response clinically after 48 hours, get the culture and sensitivity report and change to appropriate antibiotic or upgrade to 3rd or 4th generation cephalosporin parenteral antibiotic or to piperacillin tazobactum combination 4.5 gm Q8th hourly or 12 hourly IV Do consider an expert opinion.

If patients have received antibiotics elsewhere or have septic shock or are intubated, consider optimum and appropriate antibiotics like imipenem and vancomycin, or teicoplanin to cover MRSA. It is important to consider and cover C. sordelli and C. perfringens. Amikacin may be included among the initial antibiotics to treat puerperal sepsis in India.

8. **Premature rupture of membranes more than 6 hours and term**

Inj.Cefazoline 1gm Q 8 h the after test dose. If allergic T.Erythromycin 500mg Q 6th hourly.

9. **Preterm premature rupture of membranes**

Erythromycin 250mg qid x 10days

Or azichromycin+ Inj.ampicillin 2gm IV 6thhrly for 48 hours followed by amoxicillin 500mg orally q6hrlyx 5 days

Or injcefazolin 1gm iv 8thhrly x 48hrs followed by cephalexin 500mg q6h x 5 days

Or inj clindamycin 900mg iv q8h x48hrs + gentamycin 2.5mg/kg two doses 24 hrs apart followed by tab clindamycin 300mg tid x 5 days

10. **Manual removal of placenta**

Inj.Cefazolin 2 gm stat and Inj.Metrogyl 500mg Q 8 hourly IV for 3 days

11. **Elective cerclage**

No antibiotics recommended

12. **Emergency cerclage**

Inj. Cefazolin 1gm half an hour before procedure IV or Inj. Ampicillin 2 g IV single dose to reduce the risk of infection due to exposed membranes in the vagina.

13. **Abortions:**

Women undergoing an induced abortion (surgical or medical) must receive antibiotics effective against Chlamydia trachomatis and anaerobes. There is no need of antibiotics following curettage for a missed or incomplete abortion. Regimens: doxycycline 100 mg oral twice daily for 7 days, starting on the day of abortion, plus metronidazole 800 mg oral at the time of abortion or azithromycin 1 g oral plus metronidazole 800 mg oral at the time of abortion

14. **Infective endocarditis (IE) prophylaxis in pregnancy**

Prophylaxis should be considered for patients at highest risk for IE:

(1) Patients with any prosthetic valve, including a transcatheter valve, or those in whom any prosthetic material was used for cardiac valve repair.

(2) Patients with a previous episode of IE.

(3) Patients with congenital heart disease (CHD):

(a) Any type of cyanotic CHD.

(b)Any type of CHD repaired with a prosthetic material, whether placed surgically or by percutaneous techniques, up to 6 months after the procedure or lifelong if

residual shunt or valvular regurgitation remains.

Antibiotic prophylaxis is not recommended in other forms of valvular or CHD.

Recommended prophylaxis for high-risk dental procedures in high-risk patients includes amoxicillin or ampicillin 50 mg/kg orally or i.v. or clindamycin 20 mg/kg orally 30-60 minutes before the procedure.

15.Asymptomatic bacteriuria

Treat for 7 days with an antibiotic according to the culture and sensitivity results. Repeat urine culture at a minimum in each trimester once asymptomatic bacteriuria is diagnosed and treated in pregnancy

16 Cystitis in pregnancy

Empirical therapy:

First line is oral nitrofurantoin 100mg bd x7 days (avoid in term patients or if delivery is imminent, due to risk of hemolysis in newborn and in patients with creatinine clearance <45ml/mt).

Second line Amoxicillin 500mg tds for 7days or Cefalexin 500mg BD for 7 days (NICE). Treatment should be guided by culture results. If the patient experiences recurrent Urinary tract infections (UTI) she should be investigated to exclude causes such as obstruction.

17 Pyelonephritis in pregnancy

If pyelonephritis is suspected then admission is required, blood and urine cultures sent and iv antibiotics commenced. Inj Cephalexin 1-1.5gm IV three times daily or four times daily is the first choice. (NICE).

Re-evaluate after 48hrs with culture and sensitivity report. Table 1 shows the anti-microbial spectrum of antimicrobial antibiotics

Table 1 Antimicrobial spectrum of antimicrobial antibiotics

AMA	Organism sensitive	Organism resistant
Ampicillin	Gram positive organisms Strept.pneumoniae, Strept.pyogenes, some types of Staph.aureus and some Enterococci Gram negative organisms Neiss.meningitidis, some strain of H.influenzae and enterobacteriaceae, Actinomyces sp.	MRSA, MSSA
Cefazolin	MSSA, Aerobic gram+ (staph.aureus, epidermidis, Strep.pyogenes, Strept. pneumoniae), aerobic gram neg if not ESBL or CRE (Ecoli, H influenza, Kleb. pneumoniae, N gonorrheae)	MRSA Enterococci anaerobes
Cefuroxime	Aerobic gram + Pneumococci, Strept.pyogenes, Staphaureus Aerobic gram neg in not ESBL or CRE (Ecoli, H.influenzae, Kleb.pneumoniae, Neiss.gonorrheae)	MRSA Enterococci anaerobes

Cefotetan	Like 2nd generation Additional anaerobes:bacteroides	
Metronidazole/ tinidazole	Broad array of gut anaerobes, protozoa and microaerophilic bacteria	ropionibacterium and lactobacillus sp.
Piperacillin with tazobactam	MSSA, Coagulase neg Staph aureus if methicillin sensitive, Strept pneumonia, H. Influenza, Neiss. gonorrheae, Enterobacteraceae, E coli, Pseudomonas aeruginosa	MRSA
Clindamycin	Staphylococci, Strept. Viridians, Strept pyogenes, Strept pneumonia ANAEROBES	H.influenzae, enterococci, Nmeningitides, aerobic gram neg bacilli
Vancomycin	MRSA	

ESBL-extended-spectrum beta-lactamases, CRE-carbapenem-resistant Enterobacteriaceae
MSSAMethicillin-sensitive Staphylococcus aureus, MRSA-Methicillin-resistant Staphylococcus aureus

Caveat of benefits versus harms

Compared with placebo, antibiotics for PPROM reduced the risk of chorioamnionitis in the mother. Antibiotics also reduced the risk of neonatal infections, including pneumonia, and cerebral abnormality, and were associated with a shorter stay in neonatal intensive care. On the other hand, antibiotics did not appear to have an impact on other infant mortality or severe morbidity or on longer-term outcomes. Overall, there are desirable short-term benefits for the mother and preterm infants without evidence of harm on short- or long-term effects

Despite the very low quality evidence to support comparative effectiveness of one antibiotic over another to treat maternal infections, the current guideline conditionally recommends specific classes of antibiotics for the management of chorioamnionitis (ampicillin and gentamicin) and postpartum endometritis (clindamycin and gentamycin), Conclusion is based partly on efficacy but also availability and cost. Almost all the studies were conducted in high-income countries and possible differences in microbiological aetiology in low-income settings could influence antibiotic effectiveness. The panel acknowledged that other simple, effective, and locally available antibiotics could be used as an alternative, recognising the importance of clinical experience and local knowledge of antimicrobial resistance

In 2015, the World Health Assembly, the World Health Organization's decision-making body, adopted a global action plan to address antimicrobial resistance. The plan establishes a framework for raising awareness of the problem, collecting more data, developing new drugs and diagnostic tools, encouraging practices to reduce infections, optimizing antibiotic usage, and investing in countries' health-care and sanitation capacities.The most important step is to stop the spread of infection, so that antibiotics donot have to be used in the first place. All health-care facilities, at a minimum, must have clean running water and sanitation services, and health-care professionals must follow good hygienic practices such as hand

washing. Facilities should also implement policies to discharge mothers and newborns sooner rather than later, in order to reduce the potential for exposure to infectious microbes, and to educate mothers on the importance of breastfeeding in strengthening newborns' immune systems. Finally, when antibiotics are used, health-care providers should confirm that they are truly needed and prescribe responsible doses. Saving the lives of mothers and infants will require us to address the problem of access as well as excess. Simply put, those who need lifesaving antibiotics must get them, and those who do not must not.

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PART 5
MISCELLANEOUS

CHAPTER

29

Teenage Pregnancy

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Editors' Note

There are significant numbers of deaths in the teen ages. However, among this 83% are in the age group of 18 -19. Most of these 18 -19year olds are married. The devastating effects of pregnancies occur in the 17% below the age of 18. As pointed out by the authors they face the double burden of growth and reproduction. In addition they are the victims of sexual exploitation. Only a multipronged approach involving parents, teachers, social activists and law enforcing agencies in addition to the girls themselves will help to find out a solution to this vexing problem. These young girls need very tender handling by the health workers.

V P Paily

Outline

- Key summary points
- Causative factors of Teen pregnancy
- Impact of teenage pregnancy
- Prevention
- Key recommendations
- Conclusions

World health organization defines Teenage Pregnancy as "any pregnancy in a girl who is 10-19 years of age, considering the early menarche. Typically teenage begins by 13 years and any pregnancy irrespective of the outcome, occurring in this age group should be taken into counting."

Key Summary Points

1. Among 1076 maternal deaths analysed during the period 2010-2020, 55 deaths (5.1%) were in the teenage group.
2. 83% of Teens were in the age group 18 yrs to 19 years.
3. 86.6% of the girls were married.
4. Highest death rate was from Malappuram district (32.7%).
5. Teenage marriages could reflect socio-cultural norms, especially because of large clusters in few specified areas.
6. Single most common cause of maternal death among teens was suicide which contributed to 23.6% of the total. Hypertensive disease was responsible for 14.5% of deaths. Sepsis including septic abortion contributed 10.9% and PPH 7.2%. Other causes include respiratory and viral infections (pneumonia and H1N1), heart disease, and others. In 16.3% cases underlying cause could not be identified.

Table 1. Incidence of Teenage maternal mortality during the period 2010-2020

Year	2010/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Total maternal deaths	113	85	101	112	117	106	80	138	122	102
Teen age pregnancies	4	6	6	7	6	3	8	9	2	4

Table 2
District wise distribution of teenage deaths

Districts	Number
Thiruvananthapuram	7
Kollam	4
Pathanamthitta	1
Alleppy	nil
Kottayam	2
Idukki	nil
Ernakulam	3
Thrissur	5
Malappuram	18
Palakkad	6
Kozhikode	2
Wayanad	3
Kannur	3
Kasaragod	1

Table 3. Age wise distribution

Age below 18yrs	18 to 19 yrs
6	49

Table 4. Causes of maternal death in teenage pregnancy

Causes of maternal death	Number (%)
Suicide	13 (23.6%)
Hypertensive disorders	8(14.5%)
Respiratory and viral diseases	7 (12.7%)
Sepsis	6 (10.9%)
Postpartum hemorrhage	4 (7.2%)
Heart disease	4
Neurological conditions	4
Others	9
Total	55

Causative factors of Teen pregnancy

Teen births can occur in cohabiting couple, after marriage or it may be illegal. Teen marriages are seen in both low and high income families especially where single parent thinks of the safety aspect, or when a suitable boy is found. Low education and influence of horoscope add to the increased number, besides the 'run away' weddings.

However, these are only reasons for early marriage. Pregnancy occurs in these teens due to lack of awareness regarding methods of delaying a pregnancy, egged on by the family / social desire for "good news" and an absolute ignorance about the risks involved.

In unmarried girls incest and rape causes teen pregnancy in so called secure homes and these are in relatively younger (<17)girls with late reporting. Internet abuse leading to forced sexual relations often under peer pressure is a new cause of teen unmarried pregnancy. 'Love traps', happens in families with domestic violence, homeless or care homes, are all risks for teen pregnancy.

The impact of teenage pregnancy

They represent a high risk group in reproductive terms because of the double burden of reproduction and growth. The World Health Organization estimates that the risk of death following pregnancy is twice as high for women aged 15-19 than for those aged 20-24. Teenagers have greater risk of poor nutrition, delayed pregnancy diagnosis, and delayed access to prenatal care.

Late reporting and diagnosis:

The menstrual cycle of an adolescent is often irregular and may give a false reassurance that pregnancy need not be considered. This may cause a delay in the diagnosis of pregnancy and seeking

prenatal care. Teens often feel they are not at risk for pregnancy, regardless of unprotected intercourse. Denial often plays a role in the patient's late presentation for medical care and diagnosis of pregnancy. One death reported was due to hyperemesis gravidarum treated as just vomiting.

Inadequate nutrition:

Poor eating habits are common in adolescence. In addition teenage mothers often have no antenatal checkup or have late antenatal care. So they may be deprived of needed calories, protein, essential nutrients and vitamins including folic acid, iron and calcium. They are more prone for low weight gain and anemia.

Antenatal complications:

Incidence of PROM, preterm labour, prolonged labour and chorioamnionitis due to genital infections is also reported to be high in teenage pregnancy.

Incidence of preeclampsia and eclampsia is increased by three fold in teenage pregnancy. This could be due to the growing reproductive system, especially the uterine structures and vasculature. Lack of early and regular blood pressure check and no medication or irregular medication increases the risk of hypertension. Lack of detailed evaluation of hypertension increase the complications like eclampsia, HELLP syndrome, cerebral hemorrhage and acute kidney injury in the antepartum, intrapartum and postpartum period. 14.5% of deaths were due to Hypertensive disease of pregnancy mainly eclampsia, and abruption.

Infections:

Incomplete immunization schedule in infancy, childhood and pregnancy along with the fact of pregnancy being an immune compromised state make them susceptible to infections and sepsis. Lack of adequate vitamin rich nutrition and delay in seeking treatment also lead to infections. One death each is attributed to myocarditis and retropharyngeal abscess. There were two deaths due to H1N1 infection and 3 deaths due to pneumonia.

Underlying medical disorders

Teenagers with co-morbidities have suboptimal care of their medical problem which can get aggravated leading to adverse fetomaternal outcome. The suboptimal care often may be because the medical condition is hidden from spouse and his family, hence from treating obstetrician. They tend to miss medication for fear of adverse effects on fetus or lack of awareness of the seriousness of the medical condition. This is evident from the causes of deaths such as congestive cardiac failure secondary to infective endocarditis; myocarditis, renal disease, polyneuropathy, Sjogren's syndrome, Protein C deficiency with chronic pulmonary embolism, epilepsy and congenital heart disease.

Medical Termination of Pregnancy (MTP)

Unmarried teenage pregnancy is prone for unsafe and septic abortions leading to maternal death. Unwed mothers are socially isolated, have less supportive home environments and are more prone to mental health problems. Social consequences for unmarried pregnant adolescents may include stigma, more abuse, rejection or violence by partners, parents and peers.Teenage pregnancy leads to school dropout, jeopardizing future jobs and economic prospects.

Parturition

The development of pelvic birth canal is slower than that of the early teenage spurt of long bones. As a result, cephalopelvic disproportion (CPD) is a common problem encountered during labour as the pelvic architecture is not yet completely formed and mature enough for delivery. Inadequate pelvis and increased chances of operative delivery and cesarean section are reported. 14.06% had undergone cesarean delivery.

Postpartum

Failure of lactation and feeding problems are common. One death was due to post cesarean HUS(Hemolytic Uremic Syndrome) and that pregnancy was complicated by preeclampsia and 7.2% of deaths were due to PPH. They are prone for puerperal endometritis and two deaths were due to post cesarean sepsis. One death each was due to postpartum meningo encephalitis and Cerebrovascular thrombosis.

Mental health

Adolescence is a period of emotional instability. Depression is one of the leading illness and disability seen among adolescents. Suicide is the second leading cause of death in adolescents according to WHO. Teenage mothers have to adjust to the responsibilities and demands of parenting, often in the context of economic and social disadvantage. Such stresses may contribute to a range of mental health problems that can adversely affect the functioning and parenting behavior of adolescent mothers and it also increase the risk of behavioral problems in their offspring too.

Adolescent mothers experience significantly higher rates of depression, both prenatally and postpartum, than adult mothers and their nonpregnant peers. Depression symptoms among young mothers are also more likely to persist well after the birth of their child .Few studies suggest that adolescent mothers may be at elevated risk for suicidal ideation and the rates ranging from 11% to 30%. Inadequate breast milk or feeding problems of the newborn may further increase the stress. 23.6% of deaths were due to suicide.

Contraception

Repeated pregnancy at short intervals due to nonuse of contraception is also common and it is a matter of concern, as it presents further health risks for both the mother and the child.

Complications in newborn and childhood

- Lower birth weights, stillbirths, birth asphyxia, respiratory distress syndrome and birth trauma lead to increased infant mortality
- Increased number of hospital admission in early childhood because of less supportive home environments especially if illegal. Poorer long term cognitive development is seen in the offspring.
- Female child of teenage mother is at a higher risk of becoming pregnant themselves as teenagers and the cycle repeats.

Prevention

1. Empower teenagers to avoid pregnancy.

Such an approach should include prevention of child marriage, coercion and sexual violence through law enforcement.

- *According to the Prohibition of Child Marriage Act 2006, any girl married below 18 years of age and any boy married before 21 years, is considered a "child marriage" which is a cognizable offence.*
- *Any pregnancy or delivery before completed age of 18 has to be given police intimation in the prescribed format by the concerned obstetrician.*
- *The Protection of Children from Sexual Offences Act(POCSO Act) 2012 was established to protect the children against offences like sexual abuse, sexual harassment and pornography. It was formed to provide a child-friendly system for trial underneath which the perpetrators could be punished. If anybody request for abortion or come for delivery below 18 completed years, it has to be intimated to the police.*

2 Education regarding sexual and reproductive health.

A systematic policy framework for teaching about sex and sexuality within schools should be implemented as part of curriculum. Adolescent classes should aim at provision of age appropriate comprehensive sexuality education. Provide information about contraception including emergency contraception and sexual health issues. Scripts can be used when talking to teens about sexual health issues

Most have emotional and cognitive maturity to accept these discussions. But children should feel secure when they confide these matters and one should assure them that confidentialitywill be observed in this matter.

Children should be made aware that in the teenage sexual relationship there is a risk of pregnancy and that it can occur even if they have not experienced their first menstrual bleeding. After menarche, they should develop a habit of keeping a menstrual calendar, be aware that missing a period could be pregnancy if they had engaged in sexual relation.

At college level, adolescent classes should continue, make it a point to discuss about the signs and symptoms of pregnancy. The program should address the importance of immunization schedule and its relevance in future pregnancy.

Such health education program should remind that adolescent girls with medical co morbidities before becoming pregnant should assess the medical condition and tailor the treatment to what is appropriate for pregnancy and that they should continue the medications in pregnancy also and that they need close monitoring during pregnancy

3. Prevention of mortality

Information about legal abortion service also be provided. Where permitted by law, adolescents who opt to terminate their pregnancies should have access to safe abortion and continuing contraception.

If pregnant teenagers choose to continue pregnancy to term, exemplary care should be provided in the antepartum, intrapartum and postpartum period. Special antenatal classes to be taken for this age group focusing on danger signals pregnancy complications, labour, postpartum care andstress on the need and availability of contraceptive methods.

4. Mental health support

Building life skills in children and adolescents and providing them with psychosocial support in schools and other community settings can help promote good mental health. Programs that help to strengthen the ties between adolescents and their families should be thought of and implemented. During pregnancy, ensure appropriate psychological or psychiatric evaluation and provision of support if needed. Special support is needed for breastfeeding.

Teenagers' choices to become sexually active and whether to use contraception, are influenced by many factors like knowledge, attitudes and beliefs, future expectations, substance use at the individual level, family structure, parent–child communication, socioeconomic status at the familial level, peer influences, sexual health education at school, health services at the community level as well as norms and values concerning teenage pregnancy

Among all the readily modifiable factors, main factor that can bring a drastic change is individual's knowledge about sexual health. Promoting safe sex and having access to contraception for these individuals is the practical solution to prevent teenage pregnancy. Knowledge regarding the social pressures and tactics of coercion for sex, their rights for safety, providing a safe setting for discussion of

problems as well as knowledge of contraception with 'where and whom' to approach for it should be provided.

Key recommendations

1. Avoid teenage marriage and pregnancy by enforcing law.
2. Prevention of sexual violence, and coercion also should be ensured by law.
3. Report POCSO and Child abortions and delivery to the concerned authority.
4. Focused, age appropriate sex education classes from the perimenarcheal age till college years are very important.
5. Contraceptive knowledge and awareness of availability of services for teenagers should be provided during adolescent classes.
6. Teenage pregnancy registration and reporting by ASHA workers should be made mandatory.
7. Provide safe abortion services as permitted by law.
8. Special antenatal classes for teenagers is needed, with specialised help in accepting the conditions.
9. Antenatal care with evaluation of the existing co-morbidities and early detection and management of the new onset complications.
10. Mental health evaluation and support should be provided by AMMA MANASU and psychologist and psychiatrist as and when needed.
11. Continuing care during the breast feeding period with neonatal care.
12. Importance of spacing in subsequent pregnancies also should be highlighted.

Conclusions

Teenage pregnancy is a very high risk event, because teenage girls are physically and psychologically immature for reproduction. If pooled together underlying medical disorders and infections are the important causes of death. Medical complications of pregnancy especially hypertensive disorders of pregnancy and sepsis are also important contributing factors. Suicide is the single most identified causative factor

CHAPTER

30

Accidents as a cause of maternal death and Tips for safe travel in pregnancy

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Editors' Note :

It is important for obstetricians to keep a tag on accidents, suicides and homicides. At present accidents are not included in the calculation of MMR, but it is possible that the status might change in the future just as it happened with suicides. There is some justification to do so because the outcome of accidents is influenced by pregnancy.

The distinction between suicides and homicides is extremely difficult on occasions. Many social activists feel that many homicides get labelled as suicides. Again it is necessary that we watch the number of suicides.

Travel during pregnancy is often unavoidable; often it is intercontinental. In Kerala setting, pregnant women traveling on two or three wheelers is very common. The safety tips given by the authors are very relevant.

V P Paily

Accidents are considered a coincidental cause of maternal death (WHO 2012). Deaths due to road traffic accidents(RTA), train or air travel accidents, deaths due to fire or electric shock and snake bite are included in this category. According to EMMBRACE 2019 report from U.K , 13% of deaths in reproductive age group is due to either RTA or fire amounting to 2.5/ 1 lakh. Out of this 97% is due to RTA. But fortunately they do not contribute a major share to maternal mortality (0.69/ 1 lakh). Since it is a coincidental cause, it is not included in confidential review, missing data is a major problem and many a time obstetricians might even be unaware of such an incident.

Our Data

Table 1 Maternal Deaths due to accidents(CRMD Kerala 2010-2020)

Year	RTA	drowning	burns	Train accident	Snake bite	Electric shock	Total
2010/11	1		1				2
11/12	2		3				5
12/13	2	1	5	2			10
13/14	9	2	1	1	1		14
14/15	2		1	1			4
15/16	4	1				2	7
16/17	3						3
17/18	2	1	3		1		7
18/19	3	1	2				6
19/20	2						2

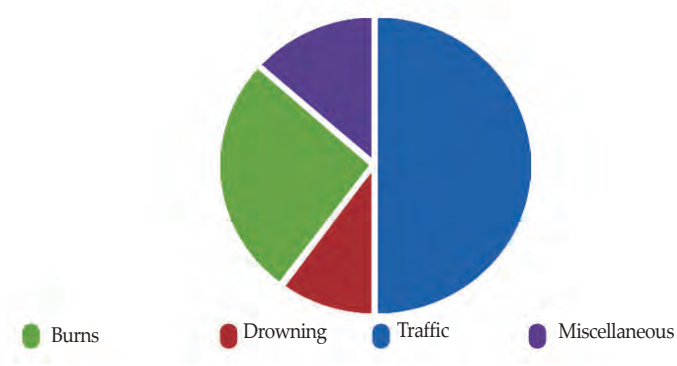
According to the data available, there were 60 deaths due to various accidents out of a total of 1624 maternal deaths (including accidents) during the period 2010 to 2020, which amounts to 3.6%. Accidents are not included in calculating MMR. However it is necessary for us to know the maternal deaths in this category to plan preventive steps for the future. Road traffic accidents and burns due to fire were the major accidents forming 50% and 25% of the total accidents respectively.

Global literature review reveals many cases of homicide during pregnancy. There were 9 cases of homicide during this 10 year period 2010-2020, analysed by CRMD Kerala.

Table 2 Maternal deaths due to Homicides

Year	2010/ 11	11/ 12	12/ 13	13/ 14	14/ 15	15/ 16	16/ 17	17/ 18	18/ 19	19/ 20
Homicides				3		3			1	2

Maternal deaths due to accidents



Key recommendations

- While resuscitating pregnant women who have met with accidents, relieving pressure on IVC by a 15 degree left lateral tilt from 20 weeks onwards is of utmost importance. This can be obtained by a wedge or even with the resuscitator's knee.
- Modified CPR with hand higher on sternum to be adopted.
- Art of intraosseous access should be learned
- If not able to resuscitate in 4 minutes, perimortem cesarean (Resuscitative Hysterotomy) section to be done.
- FAST (Focussed Assessment with Sonography for Trauma) scans should be used in emergency settings.

- Multidisciplinary team involvement is the corner stone in management.
- Improve facilities for timely transfer of pregnant accident victims to tertiary and critical care centres.

Overview and tips for travel

- Any travel lasting 4hours or more is considered as long distance travel and increases the chance of thomboembolism. Stay hydrated with plenty of fluids(water and noncarbonated drinks). Try to move around or at least keep flexing and extending lower limbs every half hour. Compression stockings and heparin can also be used as per advice.
- It is mandatory to use seatbelts while travelling. While using seatbelt,the cross strap should be between the breasts and lapstrap across pelvis under the distended abdomen.
- Use of safety helmet while on a two wheeler is mandatory. Avoid unnecessary travel during pregnancy.
- Blunt trauma due to falls and assaults can lead to serious intra-abdominal injuries. Bowel injuries are less frequent due to protective effects of a large uterus. Diaphragmatic, liver, spleen and kidney damage may occur. Sometimes the spectra of amniotic fluid embolism follow even after mild trauma. Abruption is usually concealed and uterine rupture especially in a previously scarred uterus is not uncommon. Hence it is essential to monitor these women atleast for 6 hours even if the vital signs are stable at presentation.
- In cases of suspected spinal injury use spinal board and wedge should be kept below the board.
- Patients with mental health issues, and on antiepileptics should be given special care during antenatal visits. Family members also should be counselled. They should avoid driving or travelling alone or going near waterbodies.
- In case of burns, as the involved body surface area (BSA) increases, in addition to maternal mortality and morbidity, fetal complications like cerebral palsy also increases. When more than 60% of BSA is involved, there is more than 50% mortality for new born.

To calculate Body Surface Area (BSA) **rule of 9** can be used. Head and neck forms 9% of BSA, each upper limb 9%, anterior torso 18%, posterior trunk 18%, each lower limb 18% and genitalia 1%.

Main points to be kept in mind while treating a case of burns are:

- Aggressive fluid resuscitation
- Supplemental oxygen and low threshold for ventilation
- Early termination of pregnancy if > 34 wks
- Watch for sepsis, Venous thromboembolism, smoke inhalation pnuemonitis

Conclusions

Even though accidents form a small portion of maternal deaths and are considered co incidental, every obstetrician should be well versed in resuscitating such patients. Updating EMOCALS training, forming ORRT (obstetric rapid response team), recourse to timely perimortem cesarean section are essential prerequisites. Timely resuscitation might be able to save many lives.

CHAPTER

31

Maternal Near Miss (MNM) Review

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Editors' Note

Maternal Near Miss Review (audit) is a relatively new concept but getting rapidly accepted as equal to or better than death audit in improving maternity care and preventing maternal death. We have converted the near miss audit to a confidential near miss audit by concealing the identity of the cases during discussion. This makes the process very similar to Confidential Review of Maternal Deaths (CRMD). However, the anonymity cannot be maintained when the discussion take place at the district level (see the chapter on MDNMSR). In spite of this limitation the concept of near miss audit is the way forward to avoid maternal deaths and bring down the Maternal Mortality Ratio (MMR).

V P Paily

Introduction

Maternal mortality remains an ongoing concern even though significant improvement has occurred in recent years as shown by a declining Maternal Mortality Ratio[1]. To reduce MMR further, we should plan strategies based on the real circumstances that lead to maternal death. An alternative approach can be to audit near miss cases. For each maternal death that occurs, there are several other women who go through serious life-threatening situations and survive (nearmisses).

Who is a Maternal Near Miss (MNM)?

A woman who survives life threatening conditions during pregnancy, abortion, and childbirth or within 42 days of pregnancy termination, irrespective of receiving emergency medical/ surgical interventions, is called Maternal Near Miss.[2]

What is the significance of MNM

Women who develop severe acute complications during pregnancy are often seen to share many of the pathological and circumstantial factors which were experienced by those who lost their lives during birth. Hence review and analysis of the conditions that lead to these "Near Miss" cases can provide valuable information. This will help in implementing strategies to prevent maternal deaths.

Why should we audit /analyse Maternal Near Miss (MNM)

As the complications during pregnancy and child birth often occur unexpectedly, timely access to emergency care is often the deciding factor in saving the lives. Awareness and early identification of high-risk factors, recognition of early warning signs, protocol in place for prompt and timely intervention will help us improve both maternal and perinatal outcomes. Essential infrastructure, resources and equipment are also crucial in defining the outcome.

Advantages of evaluating Near miss cases

- As the number of near miss cases are significantly more than maternal deaths, a larger number of cases are available for a reliable analysis.
- Interviewing these women who survived the complications may be less threatening to the health care providers. The details of the sequence of events and other contributory factors may be more forthcoming.
- Associated factors that helped the woman survive can be analysed.
- These reviews enable us to advantageously modify and implement strategies and have protocols in place which will help to reduce the severity of such complications and prevent maternal deaths.

How to diagnose MNM

Inclusion Criteria:

Critically ill pregnant, labouring, post-partum and post-abortal women admitted to notified health institutions. Criteria for identifying and notifying the MNM case: minimum three from each category must be met with:

1) Clinical findings (either symptoms or signs)
2) Investigations
3) Interventions

Or any single criteria which signifies cardio respiratory collapse (indicated by a heart symbol)

Categories of MNM :

Three broad categories

1) Pregnancy specific obstetric and medical disorders.
2) Pre-existing disorders aggravated during pregnancy.
3) Accidental / Incidental disorders in pregnancy.

Table 1. Categories of MNM

PREGNANCY SPECIFIC OBSTETRIC AND MEDICAL DISORDERS	PREEXISTING DISORDERS AGGRAVATED DURING PREGNANCY	INCIDENTAL AND ACCIDENTAL CAUSES IN PREGNANCY
Haemorrhage	Anaemia	Accident / assault /surgical problems
Sepsis	Respiratory Dysfunction	Anaphylaxis
Hypertension	Cardiac Dysfunction	Infection
Postpartum Collapse	Hepatic Dysfunction	Embolism and Infarction
Liver dysfunction	Endocrinal Disorders: Diabetic ketoacidosis, Thyroid crisis	
Cardiac dysfunction	Neurological Dysfunction	
	Renal Dysfunction / Failure	

Source : Maternal Near Miss Review Operational Guidelines - December – 2014, Maternal Health Division, Ministry of Health and Family welfare,Government of India

When did we begin?

A technical working group of obstetricians, midwives, epidemiologists and public health-care professionals was established by the WHO in 2002 to develop a standard definition and uniform identification criteria for maternal near-miss cases.[3] Maternal Near Miss reviews are now being conducted in several countries. In the United Kingdom, the MBRRACE report evaluates the reasons for maternal morbidity and ways to reduce them[4].

In India, the Maternal Health Division, Ministry of Health and Family Welfare, Government of India,in 2014 published the "Operational Guidelines for Maternal Near Miss Review"[2] to be implemented by all states in the country. The main aim being to be able to analyse the performance of the health care system, identify the gaps and implement appropriate corrective measures.

Near Miss Review in Kerala experience :

In 2017, KFOG initiated a pilot study of maternal Near Miss cases in five Government Medical Colleges in Kerala, namely Thiruvananthapuram, Kottayam, Alapuzha, Thrissur and Kozhikode. Operational Guidelines 2014 by Government of India was followed and the recommended steps of review process were adopted. As an additional measure each of the near miss cases identified were anonymised and were then independently assessed by a senior obstetrician of the state from a different institution, to reduce the chance of possible bias at the institutional level. Along with the Near miss data, these suggestions put forward were also compiled. The findings were discussed in the quarterly state level meeting held along with the CRMD meetings.

What next

After 2 years of this pilot project District level MDNMSR (Maternal Death and Near Miss Surveillance and Response) teams were constituted in all the districts of the state involving the District level RCH officers, obstetricians from government and private sector. All delivery points identified and a monthly report of MNM cases is being reported. A monthly district level review meeting is being conducted where the salient points of near miss cases are discussed.

Table 2.

Findings of the MNM Review 2017 – 2018

MNM Category	Number of cases	Percentage
Category 1 *Pregnancy specific obstetric and medical disorders*	324	88.7
Category 2 *Pre-existing disorders aggravated during pregnancy*	24	6.6
Category 3 *Accidental / Incidental disorders in pregnancy.*	17	4.7
Total number of MNM cases –	**365**	

Table 3.Category 1 - *Pregnancy specific obstetric and medical disorders* -324

Adverse event	Number of cases	Percentage (%)
Haemorrhage	213	65.7
Sepsis	53	16.4
Hypertensive complications	42	13
Cardiac dysfunction	9	2. 8
Obstetric collapse	4	1.2
Liver disease	2	0.6
Hyperemesis	1	0.3

Table 4. Category 2 *Pre-existing disorders aggravated during pregnancy- 24 cases*

Adverse event	Number of cases	Percentage (%)
Neurological	**8**	**33.3**
Cardiac disorder	**7**	**29.2**
Respiratory disease	**5**	**20.8**
Hematological	**2**	**8.3**
Pulm TB	**1**	**4.2**
MCTD (Sjogrens)	**1**	**4.2**

Table 5.
Category 3 *Accidental / Incidental disorders in pregnancy.- 17*

Adverse event	Number of cases	Percentage (%)
Dengue fever	**3**	**17.6**
H1N1	**3**	**17.6**
Appendicitis	**2**	**11.8**
Anaphylaxis	**2**	**11.8**
Accident	**2**	**11.8**
Leukemia	**1**	**5.9**
Hepatitis E	**1**	**5.9**
Herpes simplex	**1**	**5.9**
Nephritis	**1**	**5.9**
Acute pancreatitis	**1**	**5.9**

Of the 213 cases due to hemorrhagic complication, 76 (35.68%) were due to Placenta previa accreta which is a cause for concern, stressing the importance of reducing the number of primary cesarean

The MNM data closely goes parallel with the maternal death statistics, where the most common causes remain hemorrhage, followed by hypertension and sepsis

The significant contributory factors to near miss noted during these review meetings included

- Poor antenatal care
- Failure or delay in recognizing a potentially life-threatening condition
- Delay in referral and other social factors.
- Lack of adherence to standard protocols
- Limitation of resources.
- Poor documentation of events that occurred

But it has to be remembered that these women were saved most often because of prompt and timely interventions, like early referral, excellent

multidisciplinary team management thus avoiding a potential catastrophe.

Lessons learned:

1. Placenta accreta contributed to maximum number of hemorrhagic causes and this often lead to obstetric hysterectomy. The use of aortic clamp was found to significantly reduce morbidity and transfusion requirement. This underlines the need to reduce the primary cesarean section rate.
2. Sepsis was the second major contributor. Infection prevention and control by following strict aseptic protocols and judicious use of antibiotics may improve the outcome
3. Hypertensive conditions were comparatively less among the near miss cases reviewed. Adequate use of antihypertensive and timely Magnesium sulphate in most of the cases may have been the reasons for this. Delay in detecting raised blood pressure, delay in initiating antihypertensive and failure to check for urinary proteinuria contributed to most of these hypertensive near miss situations.
4. Induction protocols must be strictly adhered to in institutional delivery
5. Early involvement of a multidisciplinary team at the tertiary care centres had a huge positive impact on patient outcome.

Evaluation and review of near miss cases should help us to identify causes of near miss, lacunae in the response of the health system to emergencies, gaps in the health care organisation and corrective measures needed. This also will provide us with a regular feedback and essential measures needed to achieve our goals

Case Scenarios

Case scenario -1

A 27 year old primigravida underwent cesarean section (LSCS) for oligohydramnios and IUGR at 38 weeks of gestation at a peripheral centre. Developed bleeding from cesarean section wound site six hours later. She was given 2units of PRBC and was referred to tertiary care centre. Features of hemorrhagic shock on admission, uterus contracted. Emergency laparotomy was done. There was generalised oozing from all layers, broad ligament hematoma and 700 ml blood in peritoneal cavity. Right salpingoovariotomty, bilateral uterine artery ligation and Hayman sutures applied. Transfused 9 units (u) PRBC, 15 units FFP and 15 u platelet concentrate. She developed acute kidney injury requiring hemodialysis two days postoperatively. Had wound infection and resuturing was done on Post Operative Day (POD) 36. She was discharged on day 65.

Learning points:

1. Proper hemostasis to be ensured at primary surgery.
2. Close monitoring in the immediate post operative period is absolutely essential to pick up hemorrhagic shock.
3. Early diagnosis and prompt intervention at the primary care centre may have prevented the DIC, AKI.
4. Appropriate and timely management at the tertiary centre saved the patient

Case scenario - 2

G4P2L2A1, previous 2 LSCS with Central placenta previa diagnosed at 30 weeks was admitted at 37 weeks of gestation. MRI done was negative for placenta accreta. Midline vertical incision, classical cesarean

section done, perop placenta increta.There was severe oozing from bladder placenta interphase which was controlled with multiple sutures. Massive intraoperative blood transfusion- 5u PRBC, 6u FFP, 2u PRP 2u whole blood. Neartotal hysterectomy was done. Postoperative recovery was good. She was discharged on 10th postoperative day. Hospital stay 22 days.

Learning points:

1. Vertical midline incision put in spite of MRI report negative for accreta made Classical cesarean section possible.
2. Aortic / common iliac clamp may be used to control bleeding and avoid need for massive transfusion.

Case scenario-3

43 year old, elderly primi, married for 25yrs, conceived after infertility treatment , TCTA-fetoreduction to DCDA twins at 22wks. Referred to tertiary centre at 26wks 5 days with chronic hypertension, superimposed preeclampsia, acute hypertensive crisis, and pulmonary oedema. PGDM on Insulin, hypothyroidism on thyroxine. Admitted to ICU, put on NIV, antihypertensives and NTG drip. ABG showed combined respiratory and metabolic acidosis. Magsulf infusion started. ECHO showed stage 2 diastolic dysfunction. As urine output was decreasing and renal function tests (RFT) worsened an emergency LSCS was done. Patient improved and weaned off ventilator. Both babies expired and patient was discharged on day 21.

Learning points:

1. All women should have optimal prepregnant treatment of comorbidities and endorgan evaluation before initiating treatment for infertility.
2. Multidisciplinary care and timely termination of pregnancy helped this patient to survive.
3. Persistence with continuation of conservative management at all costs may adversely affect the maternal outcome too.

Case scenario -4

39 yr old, G3P2L2, twin pregnancy, gestation 33 weeks 6days, was admitted with vomiting and leaking per vagina since 3 days. GDM on insulin both fetus IUD. Labour was induced with mifepristone and misoprostol and she expelled both fetuses. Postnatally she had thrombocytopenia. RFT, LFT were altered. MODS considered. Multidisciplinary care given. Antibiotics stepped up, patient improved and was discharged on day 13

Learning points:

1. Watch for early warning signs of sepsis. MEOWS (modified early obstetric warning score) chart is a useful screening tool.
2. Aggressive management of sepsis

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PART 6
FOLLOW UP ACTIONS

CHAPTER

32

EMOCALS

(Emergency Obstetric Care and Life Support)

Neetha George, Sujamol Jacob,
Jyoti Ramesh Chandran

Introduction

This venture of KFOG was proposed in the year 2010 and came into effect from May 2011 onwards as an offshoot of the lessons learnt from CRMD. It was noticed that many of the maternal deaths were preventable if only appropriate emergency steps were taken at the start of the problems that lead to maternal deaths. This applied to most of the obstetric causes of maternal deaths like hemorrhage and hypertension. The emergency steps were not taken because of lack of awareness and skill in emergency obstetric care, lack of training in life support, lack of equipment and lack of personnel at the centres where the emergencies start. By the time the patient reaches the referral centre, it would be too late resulting in a near miss or maternal death. So KFOG took up the initiative to train nurses and doctors all over the state from 2011 onwards and hence EmOCaLS - D (for doctors) and EmOCaLS - N (for nurses) came into effect.

The chief coordinator of the programme is Dr. V P Paily who is also the state coordinator of CRMD. Under his leadership EmOCaLS joined hands with the NRHM (National Rural Health Mission) and Kerala Health Services (KHS) to train doctors and nurses all over the state. The chairpersons Dr.Bindu Menon (2011-2018) Dr.Neetha George (2019 till date) and 4 zonal coordinators-Dr.Lakshmiammal, Dr.Sathi MS,

Dr.Jyothi Chandran, Dr. Ajith S. have coordinated the programmes to train almost 70% of obstetricians and about 40 % of our labour room staff. The senior obstetricians of KFOG are the regular trainers along with the critical care and anesthetic dedicated personnel have helped us to deliver training programmes in each district. So also, Health Secretaries, DPM, RCH officers and District coordinators helped a lot to coordinate each meeting .

EMOCALS D (For doctors)

A. Training the Trainers

The idea of these sessions were to obtain a set of 150 trainers who will be recertified every 3 years and they have to train the doctors and nurses who will need recertification every 5 years. Passmark of 70% in the post-test was made mandatory for certification.

B. Training Doctors

From December 2011 onwards many training sessions were conducted in groups of 40 doctors and nurses all over the state. The main training centres were at Thrissur,Thiruvananthapuram, Kottayam, Calicut and Kannur. These centres were equipped with two regional coordinators, essential mannequins, trolley bags, shelves etc. In the 2 day course, one day was designated for the high risk obstetric emergencies and the 2nd day for the critical care team to teach the advanced life support.

EMOCALS D Training sessions conducted

In 2011 itself, two sessions to train the trainers were conducted (56 trainers were trained) .

From December 2011, training of the doctor delegates was started on a regional basis, distributed to all the districts. Thus there were 22 training sessions through which 745 doctors were trained.

EMOCALS N (For nurses)

Dr.Deepthy M and Dr. Betsy were the coordinators. KFOG was aware of the need for empowering nurses and nursing assistants in tackling emergencies as they are the ones available at the scene when emergency strikes. So senior and middle level nursing faculty from nursing colleges were trained with obstetric and life support procedures.

There were two sessions of training the trainers followed by several sessions to train the labour room nurses of government and private hospitals.

By 2016-17, EmOCals joined hands with Quality Standards in Obstetric Care and continued training the doctors and nurses (See the chapter on Quality Standards in Obstetric Care).

Later, the emphasis was further shifted to the ORRT (Obstetric Rapid Response Team). See chapter on ORRT.

Recommendations

1. There were changing trends in the causes of maternal deaths and therefore in addition to skilled training to tackle PPH, hypertension, sepsis and thromboembolism, we had to look at rarer causes. Antenatal classes and a search for underlying pathologies are important in MMR reduction. We promoted tests to detect proteinuria, auscultation of heart for murmurs, education of warning signs, proper timing and method of induction of labour, maintaining a modified labour register, active management of 3rd and 4th stage of labour etc. The topics covered in EmOCaLS stressed on the essential points

which will alter our approach to pregnancy and labour with aim of decreasing MMR to 30 by 2020.

2. As avoidable deaths continue to prevail as seen in the CRMD, the obstetrician must undergo periodic regular updation of obstetric emergency management and life support skills. They should educate their nurses also and upgrade their labour room to manage any emergency- TVUAC, crash cart or emergency trolley, early first aid measures by the personnel on the spot, early resort to referral or multidisciplinary approach, HDU/ICU care, access to equipped ambulance and blood bank services etc

3. There should be regular auditing of near miss and maternal deaths. Attending MDNMSR meetings and a tie up with emergency medicine or nearby tertiary care centre will help.

4. Proper antibiotic policy, early detection of sepsis and monitoring by hospital infection control committee is needed. MEOWS chart should be used in all obstetric high risk patients.

5. In certain geographical locations especially in Palakkad, Kasaragod etc. availability of blood and blood products were a problem. So every delivery point should at least have a blood storage facility. Round the clock availability of anesthesiologist is ideal. This will also help to reduce unnecessary cesarean section rates. Also sickling crisis and anemia should be corrected at the earliest.

6. Adolescent pregnancy, increasing suicides and abnormal mental health are an emerging problem. Programmes like Ammamanasu etc are trying to reach out to these issues.

7. Early referral with a referral form and accompanying doctor with equipped ambulance is needed when our hospital is not having the proper facility to tackle a critical situation

8. Every obstetrician should be trained in EmOCaLS and ORRT and recertify themselves periodically

9. KFOG Protocol books, ORRT manual, charts of management of emergencies like PPH, eclampsia, shoulder dystocia, anaphylactic shock, neonatal resuscitation etc should be provided in labour room.

10. ***Above all-Time is life in obstetrics and every obstetric patient is potentially high risk and any mishap to either mother or baby is a potential source of litigation. Therefore our skill, documentation and communication to patient right from conception to puerperium is of utmost importance.***

Curriculum of Emocals

Interactive lectures, videos and work stations	
Active management of 3rd stage & 4th stage	Multiple pregnancy-intrapartum management
Conservative mgmt. of PPH	Cord prolapse
Surgical mgmt. of PPH	Labour analgesia
Surgical steps of Cesarean Section	Near miss review, MDNMSR, RRT
Placenta accreta spectrum,	Rupture uterus
Acute Hypertension, HELLP, Eclampsia, Eclampsia Box	Acute collapse in labour
Stroke in pregnancy	Vasopressors, inotropes,
Labour register	Fluids in shock management
Early pregnancy emergencies Cesarean Section How to decrease CS rates Robson Classification Difficult Cesarean Section management Labour Induction protocol	DKA
Sepsis and Antibiotic policy	PTL, PPROM
Pulmonary Embolism and Thromboprophylaxis CTG	Peripartum cardiomyopathy Blood and blood components Massive transfusion protocol
Work Stations	**Work Stations**
Breech, ECV, shoulder dystocia	Electrolyte balance
PPH Surgical management (except TVUAC, CI CLAMP)	Basics of ECG & defibrillation
Instrumental delivery, digital rotation	Airway management
Emergency cerclage, PPH Box	ABG Basics
EASI, TVUAC, CI CLAMP	Cardiac arrest in pregnancy Neonatal resuscitation

CHAPTER

33

Quality Standards in Obstetric Care

Neetha George, Jyoti Chandran, Vasanthi Jayaraj, A P Geetha, Sujamol Jacob, S. Sreelatha, V. Rajasekharan Nair, V. P. Paily

Editors' Note

This project developed as a joint venture of the Government of Kerala, the NICE International and the Kerala Federation of Obstetrics and Gynecology (KFOG) is a typical example of how international collaborations can help in improving local practices. The NICE(I) team gave KFOG due credit for the hard work we had been doing, and helped to approach the problems in a systematic way acceptable to the international scientific community. It was a learning experience for all of us involved in the project and gave a boost to the work we had been doing. There was scope and need to expand the work to other aspects of maternity care and other branches of medicine. For reasons beyond our control the collaboration had to be stopped. However we should continue with the work and address other aspects of maternity care in the systematic way shown by this project.

V P Paily

Introduction

The government of Kerala in 2012 made quality care improvement one of its key health priorities. To achieve this goal, the Quality standards initiative was developed to implement quality measures to help institutions and professionals improve their practice and deliver better care for their patients. Quality standards that are derived from evidence based clinical guidelines and that are agreed by relevant stakeholders provide powerful levers to drive and measure quality improvement in health care institutions.

The quality standard in obstetric care is the product of a multi-stakeholder partnership between the Government of Kerala, the National Rural Health Mission, the Kerala Federation of Obstetricians and Gynaecologists (KFOG), the Departments of Health Services and Medical education and the National Institute for Health & Clinical Care Excellence (NICE) International, with support from the UK, Department for International Development (DFID), Multi Country Partnership grant (HPS) and the Joint Learning network (JLN).

The NICE team who visited Kerala several times had discussions with the KFOG on the basis of the first two reports of Confidential Review of Maternal Deaths (CRMD) and found that two leading causes- hemorrhage and hypertension should be addressed to bring down Maternal Mortality Ratio (MMR) of Kerala. A team was formed to work on the project. It was guided by Sir Rajeev Sadanandan, Secretary Health, government of Kerala and was supported by officials of the Directorate of Health Services and Director of Medical Education. The director of Health Services and Director of Medical Education joined in all discussions where policy matters were decided. Dr. Sandeep, Deputy Director coordinated the meetings. Ms Francoise Cluzeau represented NICE International. Dr. V P Paily assumed the post of State Coordinator on behalf of KFOG. Dr. V. Rajasekharan Nair acted as Liaison Officer. Dr. C. Nirmala, Dr. S. Sreelatha and Dr. Sajimol Jacob represented SAT hospital. Dr. Vasanthy Jayaraj, Dr. A P Geetha, Dr. Lakshmi Ammal, Dr. Bindu Menon and Dr. Neetha George with the help of many other active members of KFOG coordinated the activities.

After several rounds of discussions between the representatives of NICE(I) and KFOG, it was decided to specify simple and doable steps to address the problems of hemorrhage and hypertension, the two major contributors of maternal death in Kerala as identified by CRMD.

The Quality Standards identified to prevent PPH deaths

1. Practice active management of third stage of labour (AMTSL) in every delivery.
2. Fourth stage management - observe every woman after delivery for 2 hours in the labour room.
3. Give blood transfusion to everyone who develop Blood Pressure (BP) fall in spite of intravenous fluids.
4. Observe in Intensive Care Unit (ICU)/High Dependency Unit (HDU), everyone who received blood transfusion.
5. Insist on ultrasound scan at 32 weeks for every woman pregnant after previous cesarean to identify potential cases of placenta previa accreta.

Quality Standards to prevent deaths due to hypertension

1. Increase the pickup of preeclampsia cases by insisting on blood pressure check during every

visit and urine examination for protein in every antenatal woman once in 1st and 2nd trimesters and during all visits after 34 weeks.

2. Start antihypertensive therapy for every pregnant patient with BP>140/90
3. Start parenteral antihypertensive for every woman with BP>160/100
4. In every woman with high BP, check blood for liver enzymes and platelets and if identified to have HELLP, consider expedited delivery.
5. Use $MgSO_4$ as first line anticonvulsant in the standard dose for every case of eclampsia and impending eclampsia.

It was decided to pilot these steps in eight delivery points in the State. They were selected to represent the different types of hospitals under the government and private sector

The Pilot hospitals were

1. Women and Children (W&C) Hospital, Thycaud, Thiruvananthapuram
2. Sri AvitamThirunal (SAT) Hospital, Thiruvananthapuram Medical College
3. Community Health Centre (CHC), Kanyakulangara,Thiruvananthapuram
4. Thaluk Head Quarters Hospital (THQ), Chirayinkeezhu, Thiruvananthapuram
5. General Hospital, Ernakulam
6. Government Hospital, Perurkada, Thiruvananthapuram
7. Sri Uthradom Thirunal (SUT) Hospital, Thiruvananthapuram
8. Mother Hospital, Thrissur

The staff of these hospitals were given a prelaunch training.

National Rural Health Mission (NRHM) funded the project for training, baseline data collection, and provision of equipments.

Eventhough the emphasis was on preventing deaths due to hemorrhage and hypertension, the training given included:

1. Antenatal care including antenatal classes.
2. Induction of labour, current practice and its problems, recommendations for change.
3. Conduct of labour
4. Managing hemorrhage in labour as per the five quality standards
5. Managing hypertensive disorders
6. Amniotic Fluid Embolism
7. Sepsis and antibiotic use.
8. Thromboembolism
9. Heart disease
10. Cesarean delivery
11. Data entry in the revised Parturition Register

Demonstrations :

1. Acute collapse and resuscitation in the adult.
2. Newborn resuscitation
3. Steps to arrest bleeding
4. Instrumental deliveries.

Fig 1 : Signing of MOU

Training was given to doctors, nurses and nursing assistants. Labour register was modified to include all data to be collected. Monthly meetings chaired by the Health Secretary and attended by, Director of Health Services (DHS), Director of Medical Education (DME) and representatives from pilot hospitals were conducted.

The project caught the attention of the media. The Minister, Dept. of Health of the British Government along with the officials of NICE International visited the State and signed an MOU (memorandum of understanding) with our then Chief Minister Sri Oommen Chandy in the presence of Sri. Sunil Kumar, Health Minister of Kerala at that time.

The change in obstetric practice as a result of the focussed training was felt at SAT hospital which was the receiving centre of cases referred from the peripheral hospitals in the district. Number of patients referred for severe PPH and eclampsia rapidly declined. Referral protocols were followed when the patients were referred.

After about four months of the pilot project, there was call to roll out the Quality Standards to other major delivery points in the State under the government. In December 2013 the following hospitals were selected for phase 2.

1. Victoria Hospital, Kollam
2. District hospital, Palakkad
3. Tribal Speciality Hospital, Attapady
4. Women and Children Hospital, Kottaparambu, Kozhikode
5. District Hospital, Mananthavady, Wayanad
6. District hospital, Manjeri

KFOG team visited the selected hospitals and gave training to all labour room staff including obstetricians, nurses and nursing assistants.

By 2015, it was felt that the Quality Standards should be developed for managing other major contributors to maternal deaths. KFOG worked out such standards for the following conditions – Sepsis, Amniotic fluid embolism, Heart disease, Thrombo embolism, and Suicide. They are briefly presented here.

SEPSIS - 8 POINTS

1. **Every obstetric vaginal examination is done using a presterilised dedicated vaginal examination sets.**

   Contents of vaginal examination set :

   The compact set should contain a small bowl, cotton balls or gauze pieces and one artery forceps. Gloves may be included before sterilization or sterile gloves added later. Antiseptic solution is to be added.

2. **Every vaginal delivery is conducted with a dedicated autoclaved delivery set.**

Contents of delivery set

a. Large baby tray

b. Placental tray

c. Instruments – scissors – 2(one for episiotomy and one for cord cutting), cord clamp -2, needle holder - 1, thumb forceps - 1, sponge holder - 1.

d. Sterile gown - 1, sheets or towels for draping - 2, sterile towel for baby - 2.

e. Sterile absorbant mat - 2, 1 with pouch for liquor and the other for blood.

f. Gauze, cotton balls, mops and 1 tailed tampon.

g. The following items may be added - Sterile gloves, syringes, needles, suture material and antiseptic solution.

3. Delivery room has clean running water with appropriate taps.
4. Labour room has written down protocol for waste segregation and disposal.
5. Every labour room has a written down antibiotic policy displayed and followed.

6. Case records of women who had complicated deliveries or cesarean section will have chart for **Modified Early Warning Signs** and the staff trained to act at the appropriate trigger points.
7. For every woman who is pregnant, in labour or postpartum and is suspected to have severe sepsis or septic shock, the appropriate care bundles are initiated.
8. Once severe sepsis is identified, appropriate specialists are involved in the care or the patient is transferred to a centre with facilities to look after the problem. Transfer should be after administering necessary first aid and in an ACLS ambulance.

Other Measures emphasized

- Cleanliness is first requirement.
- Avoid misuse of antibiotics
- Unrecognised rupture of membranes can lead to serious consequences, so look for it.
- Postoperatively – inspect and palpate the wound. In the obese, explore wound with mosquito forceps if induration present.
- Handrub to sanitize hands between patients.
- Autoclaving with indicator tape is a must

Amniotic Fluid Embolism- 5 points

1) Evidence of agreed guidelines or protocols in the hospital for the appropriate management of AFE.
2) Display charts highlighting high risk factors for occurrence of AFE.
3) Display of flow charts based on the agreed guidelines or protocols in the labour Room.
4) Availability of the necessary drugs and equipment for emergency resuscitation at the place of delivery .
5) Presence of at least one staff, trained in basic life support/EmOCaLs

Emphasize also

- AFE Not totally preventable or predictable.
- Association with hyperstimulation observed – so avoid hyperstimulation.
- Avoid drugs like epidosin in established labour.
- First aid - chest compression and airway.
- Consider perimortem Cesarean Session if no return of spontaneous circulation (ROSC) in 4mts.

Heart Disease

- Auscultate chest at the first antenatal visit itself for murmurs
- Take history of any cardiac problem in childhood - exclude contraindications for pregnancy
- ECHO and cardiology consultation each trimester in those recognised to have cardiac problems
- Avoid fluid overload - delivery only in tertiary care centre
- Remember cardiomyopathy noticed after patient has gone into shock, may be due to anoxic damage to myocardium rather than peripartum cardiomyopathy.

Thromboembolism

- Use low molecular heparin more liberally especially after cesarean delivery.
- Early ambulation, adequate fluid intake especially after delivery or cesarean section.
- Discourage the practice of "complete bed rest" for flimsy reasons like history of previous abortion.
- Discourage complete bed rest after cervical cerclage.

Suicide

- During antenatal period, give chance for patients to have direct communication with the obstetrician with privacy maintained.
- Drop box for feedback forms may be kept in outpatient (OP) area.

- Suicide more commonly due to social and family factors like dowry and alcohol abuse.

The KFOG teams were monitoring the impact of Quality Standards Project in different parts of the State.

There were monthly meetings of all the stake holders at Thiruvananthapuram presided by the Principal Secretary Health to assess the progress of the project and thrash out any issues that came up. Modifica-tions were required in some of the recommended steps for tackling the leading causes of maternal deaths.

Modifications suggested in Quality Standards after the ongoing reviews:

Postpartum hemorrhage

In addition to emphasizing the five points initially promoted, the following steps were emphasized:

- The need for immediately arresting the bleeding if PPH develops, was highlighted.
- The use of Transvaginal uterine artery clamp developed by V P Paily and the suction cannula developed by Samartha Ram and promoted by Samartha Ram as well as Vasudeva Panicker was emphasized.
- The need for avoiding surgical complication that lead to maternal death, like reactionary and secondary hemorrhage after cesarean delivery was highlighted. Modifications of surgical techniques were promoted in the training sessions.

Hypertension

A modification in the approach to medical treatment of hypertension became essential because of the non-availability of Alpha Methyl Dopa (AMD). The widespread practice of using oral labetalol as first line antihypertensive was discouraged as it can lead to fetal growth restriction. Calcium channel blockers were promoted as first line. However, for acute control of severe hypertension intravenous administration of labetalol was promoted and the threshold to start intravenous labetalol was raised to 160/110.

The following programmes were held in 2015

September 9 - GMC Vandanam, Alleppy

September 16 - WCH Alleppey

October 28 - W&C Kottathara, GMC Kottayam, District Hospital Thrissur

October29 - Mannarkkad

November 11 - GMC Thrissur

By 2016, it was felt that rather than focussing on the selected delivery points under the government, training should be expanded to involve the staff of the private sector delivery points as well. This was essential as about 70% deliveries take place in private hospitals. Similarly, all categories of staff, obstetricians, nurses and nursing assistants have to be trained. Smt. Shailaja Teacher, the honourable Health Minister of Kerala inaugurated this new approach of training on 15th December 2016 at Thiruvananthapuram.

Subsequently training sessions were held in different parts of Kerala.

In the following two years training in Quality Standards in obstetric care was extended to all districts with support from National Rural Health Mission.

In 2018, Sri Pinarayi Vijayan Hon Chief Minister of Kerala, publicly announced the government's commitment to achieve an MMR of 30 by 2020 and 20 by 2030. KFOG took up this challenge along with the government and worked for it.

CHAPTER

34

ORRT
(Obstetric Rapid Response Team)

Raji Raj, Afshana Sidhik, Joshy Joseph.N, Soumya Ramakrishnan, Jaicob Varghese, Sachin George, Julius George.

Editors' Note

ORRT is a relatively new concept that KFOG has been promoting passionately. The Kerala government endorsed it. The basic principle is to have trained manpower for resuscitating acutely collapsed patient. Obstetric emergencies occur without warning even in women progressing normally. Presence of person trained in resuscitation of acutely collapsed patient can make all the difference between life and death. We recommend that every delivery point should have such a team.

V P Paily

Many a time obstetric emergencies occur unanticipated. The purpose of having a rapid response team is to ensure that in addition to usual staff there will be trained personnel to provide extra help.

The whole concept of ORRT came following an acute obstetric emergency that occurred at a tertiary care centre where a whole team of trained nurses and doctors revived a patient who almost succumbed to amniotic fluid embolism. The success in that situation was due to a system to call for help and the presence of trained man power who could initiate resuscitation promptly.

Obstetric Rapid Response Team includes obstetricians, anaesthetists and nurses. But the *key players* of the team are the nurses who will be available 24x7. Once the idea of ORRT was approved by KFOG, the Goverment of Kerala and the National health mission supported it. Govt of Kerala issued an order - G O Rt No1205/2019/ H&FW dated 20/05/2019 stating that every delivery point in the private and public sector should have an obstetric rapid response team.

In each district there will be nodal training centres entrusted with conducting training sessions. Nodal centres will be tertiary care centres (both private and govt). Every delivery point should send their team to attend the one day training session. The team from each delivery point should comprise of obstetricians, anesthetists and nurses.

After attending training sessions at the nodal training centre, the trained members can set up a rapid response team in their own hospital. At least one member of the team should be available in the hospital at any given time of day or night. Each member is supposed to carry a pouch (which will be supplied by KFOG during training session, one per hospital) which should contain a pocket mask, pocket pulse oximeter and essentials for securing venous access. The hospital has to make necessary arrangements to procure the contents of the pouch. During training session a pocket manual (hand book) will also be provided to each hospital.

Fig 1. ORRT pouch and hand book

Hospital should have a mechanism to alert the team member in case of an emergency like a public address system announcing code blue/purple or a phone with speed dialing, or can devote an emergency code 1 for maternal collapse and code 10 for crash cesarean.

Training sessions will be scenario based and hands on exposure will be given in the work stations.

Training sessions

There are mainly three scenarios and the management is based on the systematic approach including :

AIRWAY, BREATHING, CIRCULATION & DEFINITIVE THERAPY(ABCD)

CASE SCENARIOS WITH WORKSTATIONS

Scenario 1.

Patient developing PPH going for hypovolemic shock

Aim of discussing this scenario is -

1. To provide skills on getting venous access quickly.
2. To demonstrate the other methods to access the vascular system eg:
    - venous cut down
    - Intraosseous route
3. To provide training in methods to arrest bleeding
    - Applying TVUAC (Transvaginal uterine artery clamp)
    - Suction Cannula (Samartha Ram's or Panicker's)×
    - Condom Tamponade
    - Bakri balloon

Scenario 2.

Patient at 34 weeks gestation presenting with severe hypertension and eclampisa, followed by loss of consciousness .

This scenario focuses on differentiating between respiratory arrest and cardiac arrest.

1. Training will be provided on the use of different types of airways (oro pharyngeal or nasopharyngeal airway (NPA), LMA etc).
2. Hands on training on proper method of giving ventilation through AMBU bag.
3. Management of severe hypertension with intravenous agents (IV labetalol & magnesium suphate) and eclampsia management will be emphasised.

Scenario 3.

Cardiac arrest occurring following amniotic fluid embolism

Focuses on

1. Providing quality Cardio Pulmonary Resuscitation (CPR)
2. How to use AED (Automated External defibrillator)
3. Brief discussion on perimortem cesarean section.

SPECIAL SCENARIOS

Workstations for hands on training in newborn resuscitation, and shoulder dystocia are also incorporated.

Till now we have conducted one training session in each district with few districts having had more than one. About 1256 delegates (doctors and nurses) have been trained.

Conclusions

Establishing an obstetric rapid response team in every delivery point will facilitate effective management of obstetric emergencies and there by contribute to reduction in maternal near miss and mortality.

Obstetrician should keep learning the skills for resuscitating a patient in acute collapse , as some of the emergencies occur without warning and help from other specialists may not be available on the spot.

CHAPTER

35

MDNMSR
(Maternal Death and Near Miss Surveillance and Response)

Lekshmi Ammal, V.P Paily

Editors' Note

This tongue twister "MDNMSR" is a unique project developed in Kerala. It was born out of the realization that the gulf between centralised official machinery and policy makers on one side and the grass root health care workers in the periphery on the otherside has to be bridged for speeding implementation of the projects. Along with this MDNMSR acted as an occasion to bring together the private and government maternity care providers. The whole project was enthusiastically taken up at the district level and was perceived as a very useful and rewarding exercise. Even after the Covid started, many districts are continuing the meetings virtually.

MDNMSR evolved beyond our expectations. It has become a forum for academic exchange where the peripheral practitioners could interact with senior colleagues and thrash out clinical problems. For the government machinery it gave direct contact with the private health workers. Many district teams converted the get together as an opportunity for continuing medical education CME).

The idea of MDNMSR was conceived with emphasis on "Surveillance and Response". This forum for exchange of ideas was welcomed by all and can be projected as a model for other specialties.

V P Paily

Introduction

Maternal Mortality Ratio (MMR) is defined as the number of maternal deaths per one lakh live births. It is a sensitive index of the standard of health care of a community, State or Nation. That is why WHO and all national bodies strive to achieve low MMR. Along with the maternal deaths the mothers who suffered severe acute morbidity (Near misses) should also be considered. Pregnancy related morbidity and mortality has a huge impact on the society, lives of women and their newborn babies.

The causation of maternal mortality is multifactorial and activities aiming at reduction of maternal mortality require an insight into the various causative factors and demands collective efforts at various levels. The same applies to maternal near misses also. Hence it is customary to conduct maternal deaths and near miss audits of various kinds to ponder over the causation of the death and near miss.

Background

In late 1990s WHO started to use the words surveillance and response instead of audit, regarding maternal death. There were two reasons for this. Surveillance refers to a close observation of the circumstances of the death rather than looking at numbers. It was also realised that any form of audit or surveillance is meaningless unless we take remedial action as a follow up. So, maternal death audit started to be presented as Maternal Death Surveillance and Response (MDSR).

Another change in public health policy happened in early 2000, when audit of Maternal Near misses was recognised as equally important to reduce MMR. Government of India came out with the directive that maternal near miss audit should be conducted, and suggested that as a first step the medical colleges should start near miss audit. Kerala Federation of Obstetrics and Gynecology (KFOG) took up this recommendation and started near miss audit in the five medical colleges as a pilot project (See the chapter on Near miss audit by Resmi, Ajith Reena and Rajasekharan Nair in this book).

Eventhough, after every meeting of the Confidential Review of Maternal Deaths (CRMD) committee, the learning points were published in the KFOG journal and through social media, its reach to the peripheral practitioners was limited. So we thought that it is essential to decentralise the maternal death audit as well as the near miss audit to the district level. The idea was to have the district authorities under the chairmanship of the district collector to sit with representatives of the delivery centres once every month and review the deaths and near misses of the district and recommend the necessary changes in the management that would improve the maternity care. The district RCH (Reproductive and Child Health) officer was designated as the convenor. This was the background to formation of Maternal Death and Near Miss Surveillance and Response (MDNMSR) teams.

According to WHO, Primary goal of MDSR is ***to eliminate preventable maternal deaths***[1]

Other overall objectives are

1. To provide information about maternal deaths that can effectively guide actions to eliminate preventable mortality.
2. To count every maternal death.
3. Develop an effective framework to assess the magnitude of maternal mortality and its causation.
4. Develop remedial protocols and action plans.
5. Assess the effectiveness of preventive measures.

We reasoned that when the review is done at the district level, with the involvement of the peripheral obstetricians, there will be more commitment from all levels of health workers to improve maternity care.

The Prevailing System of maternal death audit in Kerala

The Department of Health, government of Kerala had been doing maternal death audit since 1997. These audits take place at the district level and the data are compiled by the Directorate of Health services at the state level. This process is still going on.

KFOG's involvement in maternal death audit

The obstetricians and gynaecologists of Kerala have organized themselves under their professional body, the KFOG. As early as 2003-2004 KFOG took the initiative to analyse the maternal deaths in Kerala joining hands with the government of Kerala. This Confidential Review of Maternal Deaths (CRMD) has come a long way in analysing the maternal deaths, reviewing the preventable causes of maternal deaths, arriving at remedial measures and implementing them through protocol developments, modifications in infrastructure, improvement in facilities and instituting various training programmes. Awareness is created among members through publications, conferences and CMEs.

In 2017, maternal near miss cases analysis was also taken up as a pilot project in the government medical college hospitals all over Kerala. In 2018, we thought of decentralizing these audits to the district level and thus MDNMSR was born.

Levels of Organisation of MDNMSR Activities of Kerala

Organized at the state as well as district levels

The State MDNMSR team

The state team is constituted by the captains, vice captains, RCH officers of all districts, president and secretary of KFOG and is coordinated by the State MDNMSR coordinator. The state team generally designs and executes major plans of action for the district teams.

The district MDNMSR team

The district team is under the District Collector. RCH officer is the convenor. KFOG is represented by one MDNMSR district captain and three vice captains.

District captain is responsible for coordinating the activities of the district. The vice captains are assigned one of the following specific duties

1. Maternal mortality cases
2. Near miss cases
3. Maintaining the minutes of the programme

All delivery points including the medical colleges come under the district team. All practicing gynecologists of the district are members of the MDNMSR Team. The Superintendents of the various delivery points also attend the monthly meetings to create awareness and facilitate administrative involvement.

The responsibilities of the District Team

1 Ensure reporting of

(a) Maternal deaths from all delivery points, both private and government including tertiary care centers

(b) Maternal deaths occurring at home or that occurring in transit

(c) Maternal deaths of migrant population

2 Ensuring analysis of deaths

a. Facility based audit by the district administration

b. Internal audit of deaths occurring at medical college hospitals.

In Kerala, report of maternal deaths is also given to the chairperson of state CRMD and the duly filled audit forms and anonymised case

sheets are sent to state CRMD chairperson for further proceedings of review process.

3 Near miss cases are reported from the referring centre or tertiary care centre to the MDNMSR vice-captain, who forwards the case sheets either directly or through the RCH officer to the State coordinator of near miss audit. Near miss cases from government medical college hospitals are sent directly to the state coordinator.

Monthly MDNMSR District meetings

Conduct of the meeting

RCH Officer convenes the meeting and it is presided over by the District Collector or an officer assigned by the District Collector. The superintendents of all delivery points also attend the meeting, representing the administrative machinery. Representing each delivery point, one gynecologist attends. The day of the monthly meeting is fixed for each district.

Agenda of the Meetings

The RCH Officer presents the statistics for the month, related to the total number of deliveries, percentage of vaginal deliveries and cesarean sections, relative percentage of deliveries in the private and government sector and the maternal mortality statistics with causes of death as assigned.

The detailed discussions on the mortality cases are purposefully avoided as a policy matter for fear of breach of anonymity. Instead, the summary of the maternal deaths once analysed by the CRMD committee is made available to the district team as 'Snippets'. They are discussed in the district meetings as a part of awareness and continuing medical education.

The **near miss cases** for the month are presented either by the concerned hospital or by the vice-captain. Senior members of the profession who attend these meetings without fail analyze the cases and emphasize on the management strategies that would have made a difference in the outcome.

The near miss case sheets are then sent to the concerned state authority.

Advantage

In short these MDNMSR meetings sensitise the obstetricians on the gravity and causation of maternal deaths and about the changes to be made in the protocols they follow.

- It is an ideal meeting point between the referring and referral units.
- offers a common platform for practicing obstetricians of the private and public sector for the exchange of ideas and experiences.
- It is a platform where the care provider's difficulties and needs can be projected directly to the administration and solutions sought out.
- The collector discusses the probable administrative remedial measures with the programme managers and superintendents which is conveyed promptly to the concerned authorities.

The purpose of the MDNMSR Meetings

1 These meetings help the efficient and prompt reporting of the maternal deaths. Since anonymity is maintained and discussions boost their confidence, the meetings by themselves are considered as continuing medical education.

2 Since superintendent of all delivery points, programme officers and the RCH officers are also present for the meeting, it acts as an effective

way of communicating the administrative and infrastructural lacunae and gaps existing in the system, and initiating discussions towards remedial measures

3 The direct involvement of policy makers are also ensured since the meeting is conducted in the presence of the collector or an officer equivalent in rank.

4 Representatives of the Public health nurses and ASHA workers are to attend the meeting. This helps to communicate the changes in policies of patient care directly to the field staff and helps in improving bonding between the field staff and hospital staff.

Ultimately MDNMSR aim to enhance accountability of maternal deaths and improve maternal mortality statistics.

The MDNMSR committees at the district level are regularly conducting meetings since January 2019. It is perceived as an academic meeting to gain and share knowledge. The meetings were achieving appreciable momentum and acceptance till the COVID19 pandemic toppled all the efforts and the meetings had come to a standstill. But now with the help of technology, MDNMSR meetings are getting revived.

The real limiting factor in maternal mortality is the under reporting of maternal deaths.

MDNMSR activities are aimed at solving this by starting from the grass root level. MDNMSR activities enhance the communication among the health workers and the communication with the health administration and policy makers.

With MDNMSR activities KFOG and Kerala hope to achieve our dream of bringing down the MMR in Kerala to 30 by the year 2020 and 20 by the year 2030.

MDNMSR is a continuous cycle of identification, notification and review of maternal deaths followed by actions to improve quality of care and prevent future deaths.

References

1 https://www.who.int/maternal_child_adolescent/documents/maternal_death_surveillance/en

2 https://nhm.gov.in/images/pdf/programmes/maternal-health/guidelines/Guideline_for_MDSR.pdf

3 *Beyond the Numbers: Reviewing maternal deaths and complications to make pregnancy safer*. Geneva, World Health Organization, 2004.

4 Why Mothers Die,Kerala ,chapter 2, 2004-2005

PART 7

ANNEXURE

Maternal Near Miss Review Operational Guidelines

CRITERIA FOR IDENTIFICATION OF MNM CASES

(Adapted from Govt Of India Operational Guidelines 2014)

For diagnosis of Near Miss, the patient should meet Minimum 3 criteria: one each from 1) clinical findings (either symptoms or signs), 2) investigations & 3) interventions done

Or

Any single criteria which signifies cardio respiratory collapse as indicated with heart (❤) symbol

Category 1 : PREGNANCY SPECIFIC OBSTETRIC AND MEDICAL DISORDERS

Category		Criteria : One from each of the 3 / Single criteria indicated by heart symbol ❤			
Adverse Event	Disorders/Conditions or Complications	Clinical findings		Results of Investigations	Interventions
		Symptoms	Signs		
HAEMORRHAGE	Spontaneous • Abortion Termination of Pregnancy (Safe/Unsafe) • Ectopic Pregnancy • Gestational Trophoblastic Disease • Antepartum hemorrhage - Placenta previa - Placental abruption • Scar dehiscence • Rupture uterus • Surgical injury during labour, Caesarean Section/ Forceps or Vacuum delivery • Third Stage complications, e.g. Inversion of uterus, retained placenta, Cervical tear, others • Post partum haemorrhage - Atonic - Traumatic • Amniotic Fluid Embolism	Any Bleeding from or into the genital tract leading to • Air Hunger • Syncopal attacks	• Altered conscious state • Tachycardia >120/min Low volume pulse • Bradycardia <40/min • Tachypnea >40/min • Bradypnoea < 6 /min • Blood pressure - Systolic < 90 mmHg - Diastolic < 60 mmHg • Absent peripheral reflexes • Oliguria with output < 30ml/hour	• Acute fall Hb < 5 gm % or 30 % fall in haematocrit (fall in hemoglobin so as to affect oxygen saturation) • ❤ Fall in oxygen saturation below 90 % • ❤ PaO2 : FiO2<200 • ❤ PaCO2>50mm Hg • ❤ Platelet < 20,000 (Acute Decline in platelet count more significant) • ❤ Clot observation time > 7 min. or any other test done which proves deranged coagulation profile • Serum creatinine >3.5mg/dL • ECG – Ischemic changes, ST inversion, elevation	• ❤ ICU admission requiring resuscitative (CAB) or cardio respiratory support • ❤ Blood & blood products transfusion (more than 90 ml/kg body weight/ >5 units of blood) • ❤ Use of cardiotonics/ vasopressors (Mephentine/ Dobutamine/Dopamine etc) • ❤ Circulatory collapse requiring Emergency Surgery for controlling blood loss such as urgent Evacuation, Laparotomy with or without Hysterectomy, Internal Iliac Ligation or any Suturing of tears with a background of hemorrhage • Dialysis- peritoneal/hemodialysis (renal replacement therapy)

PaO2 : Partial pressure of oxygen in the blood, FiO2: Fraction of inspired oxygen, PaCO2: Partial Pressure of carbon dioxide in the blood.

SEPSIS	• Septic Abortions → Termination of pregnancy / Spontaneous • Prelabour rupture of membranes Term/Preterm • Puerperal sepsis • Post surgical procedures (E.g. Cesarean section, laparotomy, evacuation, manual removal of placenta , others)	• High grade fever • Abdominal pain • Distension of abdomen • Vaginal foul smelling discharge • Decreased urinary output • Altered consciousness • Difficulty in breathing	• Delirium/altered conscious state • Persistent rise in Temp >39.2oC, not responding to routine treatment • Hypothermia temp < 37° C • Pulse rate > 120/min • Thready, low volume pulse • Tachypnoea> 20/min • Rebound tenderness of abdomen, guarding, rigidity • Clinical evidence of septic focus in body, Pus discharge from wound, cervix or vagina	• Leucocytosis (>15,000/cu mm) • Microbial culture positive for organisms • Ultrasound shows intra uterine/ pelvic/ abdominal collection • Imaging modality showing bladder/ bowel /uterine injuries e.g.. air under diaphragm	• ❤ ICU admission for resuscitative procedure like (CAB) or cardiorespiratory support • Shifting to intravenous fourth generation Antibiotics like(Sulbactum + Cefoperazone combinations, Imepenum etc) • ❤ Blood component transfusion (upto 90 ml /kg body weight/ >5 units of blood) • ❤ Use of cardiotonics/ vaso pressors (Mephentine/ Dobutamine/ Dopamine etc) • ❤ Surgical procedure done (Evacuation, Laparotomy for Drainage of pus,Repair of Bladder, Bowel and /or Hysterectomy) • Dialysis – peritoneal /hemodialysis (renal replacement therapy)
HYPERTENSION	• Hypertensive disorders of pregnancy (Pregnancyinduced hypertension, Preec-lampsia, Eclampsia, HELLP Syndrome)	• Convulsions • Diminution/ Blurring of vision • Severe epigastric pain • Severe headache non responsive to pain killers • Difficulty in breathing • Palpitations	• Altered conscious state • BP >160/110mm Hg • Deep Jaundice • Oliguria / anuria / haematuria • ❤ Coma • Coagulation failure • ❤ Pulmonary edema • ❤ Evidence of circulatory collapse	• Proteinuria > 1 gm/dl • S. Creatinine >3.5 mg / dL • Elevated S Bilirubin (> 6 mg/dL) • ALT, AST(>100 IU/L) • Thrombocytopenia <50,000 • Haemolysis on peripheral smear • ❤ Clot observation time > 7 min. or any other test done which shows deranged coagulation profile • Hypertensive retinopathy > GRADE II • Abnormal ECG (ST inversion, elevation/ arrhythmias) • ❤ Cerebral hemorrhage on CT scan	• ❤ ICU admission for resuscitative procedure like (CAB) or cardiorespiratory support • ❤ Non responder to Magnesium sulphate • ❤ Mechanical Ventilation • Blood & blood products transfusion (more than 90 ml/kg body weight/ >5 units of blood) • ❤ Use of cardiotonics/ vaso pressors (Mephentine/ Dobutamine/ Dopamine etc) • ❤ Status eclapticus

POSTPARTUM COLLAPSE	• Amniotic Fluid Embolism • Uterine Inversion	• Acute collapse of patient after delivery	• Pusle not recordable • BP not recordable • Cardiorespiratory arrest	• Acute fall Hb < 5 gm % (fall in hemoglobin so as to affect oxygen saturation) • ❤ Fall in oxygen saturation below 90 % • ❤ PaO2 : FiO2<200 • ❤ PaCO2>50mm Hg • ❤ Platelet < 20,000 (Acute Decline in platelet count more significant) • ❤ Clot observation time > 7 min. or any other test done which proves deranged coagulation profile • ECG – Ischemic changes, ST inversion, •	• ❤ ICU admission requiring resuscitative (CAB) or cardio respiratory support • ❤ Blood & blood products transfusion (more than 90 ml/ kg body weight/ >5 units of blood) • ❤ Use of cardiotonics/ vaso pressors (Mephentine/Dobutamine/ Dopamine etc) • ❤ Circulatory collapse requiring Emergency Surgery for controlling blood loss such as urgent Evacuation, Laparotomy with or without Hysterectomy , Internal Iliac Ligation or any Suturing of tears with a background of hemorrhage
LIVER DYSFUNCTION / FAILURE	• Acute fatty liver of pregnancy • Acute Fulminant hepatic failure	• Convulsions • Altered behavior • Bleeding from various sites (nose, gums, IV access ports, varices)	• Unconsciousness • Deep jaundice • Hepatic flaps, tremors • Abnormal bleeding sites - Hematuria, hematemesis, hemoptysis, bleeding gums etc.	• Elevated Serum Bilirubin (>6mg/dL) • Abnormal liver enzymes ALT,AST (>100 IU/ L) • Abnormal ECG • Coagulation profile deranged • USG showing showing changes of Acute fatty liver ❤ Fibroscan showing changes of acute fatty liver	• ❤ ICU admission for • ICU admission for resuscitation and cardio-respiratory support • ❤ Resuscitation • ❤ Mechanical ventilation • ❤ Blood and component transfusion (more than 90 ml/kg body weight/>5 units of blood

CARDIAC DYSFUNCTION / FAILURE	• Cardiomyopathy (antepartum, postpartum)	• Breathlessness specially at night • Palpitations • Chest pain • Orthopnoea	• Tachycardia pulse > 120 bpm • Dyspnoea • Organic Murmurs • Cardiomegaly • Signs of CCF/LVF	• Abnormal ECG • Abnormal echocardiography • X ray chest (with shielding of abdomen) showing Gross Cardiomegaly • ❤ Acid Base values PH <7.35 or >7.45 PCO2 >50 or <30 mmHg PO2 arterial < 80 mmHg	• ❤ ICU admission for resuscitative procedure like (CAB) or cardiorespiratory support • ❤ Ventilatory support • Digitalisation • Use of cardiotonics
Category 2 : PREEXISTING DISORDERS AGGRAVATED DURING PREGNANCY					
Anaemia	• Iron /Folic Acid Deficiency • Sickle cell Disease • Thalassemia • Aplastic Anemia	• Dyspnea • Palpitations • Syncope Attack • ❤ Altered conscious state • Features of Sickle cell crisis such as bone pains, joint pains, acute abdominal pain etc • Swelling over body	• Severe Pallor • Jaundice • Tachycardia- pulse rate >120/ min • Tachypnea>20/min • Tender, inflamed joints • Sternal tenderness • Splenomegaly • Anasarca • Ascites • ❤ Signs of congestive cardiac failure • Bleeding Tendencies	• Hemoglobin below 5 gm/dl • Hemoglobin status not able to maintain O2 saturation of 90% • Platelet < 20,000 • ❤ Clot observation time > 7 min. or any other test done which proves deranged coagulation profile • Elevated S Bilirubin (> 6 mg /dL)	• ❤ ICU admission for resuscitative procedure like (CAB) or cardiorespiratory support • ❤ Blood /component transfusion (Upto 90 ml /kg/ >5 units of blood) • ❤ Use of cardiotonics/ vaso pressors (Mephenteramine/ Dobutamine/Dopamine etc)
Respiratory Dysfunctions	• Asthma • Tuberculosis • Pneumonia	• Breathlessness /Air hunger • High/Low grade fever • Chronic weight loss	• Tachycardia- pulse rate >120/min • Tachypnea - >20/min • Orthopnea • Abnormal Chest signs (Rhonchi, Creps, Absent breath sounds) • Signs of Cardiorespiratory failure • Cyanosis, flaps	• Various lesions on chest X ray (with shielding of abdomen) specific to disease • ❤ Abnormal Acid Base values PH <7.35 or >7.45 PCO2 >50 or <30 mmHg PO2 arterial < 80 mmHg PO2 venous <40 mmHg	• ❤ ICU admission for resuscitation and Cardiorespiratory Support, and or Endotracheal Intubation

Cardiac Dysfunctions	• Rheumatic Heart Disease • Congenital Heart Disease • Cardiomyopathies • Aortic Aneurysm • Collagen Disorders	• Breathlessness/Air hunger • Orthopnea • Palpitations • Paroxysmal nocturnal dyspnea • Chest pain	• Tachycardia - pulse rate >120/min • Bradycardia > 40/min • Irregular pulse • Tachypnea > 40/min • Bradypnoea < 6/min • Organic murmurs • Cardiomegaly • Tender hepatomegaly • Signs of CCF/LVF Pitting edema, raised JVP, basal creps etc.	• Abnormal ECG • Abnormal Echocardiography • Abnormal Acid Base values PH <7.35 or >7.45 mmHg PCO2 >50 or <30 mmHg PO2 arterial < 80 mmHg PO2 venous <40 mmHg	• ❤ ICU admission for resuscitative procedure like (CAB) or cardiorespiratory support • ❤ Ventilator support, • ❤ Digitalization • ❤ Use of cardiotonics
Hepatic Dysfunction	• Cirrhosis of liver • Portal hypertension • Acute liver failure	• Yellowness of urine / eyes/other body parts • Convulsions • Altered behavior • Bleeding from various sites (nose, gums, IV access ports, varices)	• Deep Jaundice • ❤ Hepatic flaps/ tremors • Abnormal bleeding sites - Hematuria, hematemesis, hemoptysis, bleeding gums etc. • Abnormal bleeding from nose, gums, I/V sites, varices • Hepatomegaly Ascites	• Elevated Serum Bilirubin (>6 mg /dL) • Abnormal liver enzymes ALT,AST (> 100 IU / L) • Abnormal ECG • ❤ Clot observation time > 7 min. or any other test done which roves deranged coagulation profile • Imaging modalities showing hepatomegaly ,splenomegaly and any other abnormalities	• ❤ ICU admission for resuscitative procedure like (CAB) or cardiorespiratory support • ❤ Mechanical Ventilation • ❤ Blood and component transfusion
ENDOCRINAL DISORDERS Diabetic Ketoacidosis	• Gestational diabetes mellitus • Diabetes mellitus	• Altered conscious state • Breathlessness / Air Hunger • Palpitations • Convulsions • Bladder/Bowel dysfunction	• ❤ Features of circulatory collapse • Neurological deficit like muscular weakness, paresis/ plegia • ❤ Altered consciousness • ❤ Coma	• Ketoacidosis pH < 7.35 RBS > 200 g/dL • Abnormal ECG • Electrolyte imbalance (Sr Na < 129 K <3.2 - >5.5	• ❤ ICU admission for resuscitative procedure like (CAB) or cardiorespiratory support • ❤ Mechanical Ventilation • Resuscitative Procedures • Management of Keto acidosis (Insulin or
Thyroid Crisis	• Thyrotoxicosis • Thyroid storm • Pheochromocytoma	• Palpitations • Convulsions • Bladder/Bowel dysfunction	• Altered consciousness • Coma • Tachycardia pulse > 120 bpm	• S. T4 .elevated (>200 IU) • Low TSH (< 0.2 IU) • Ischemic changes on ECG • Elevated Vinyl mandilic acid	• ❤ ICU admission for resuscitative procedure like (CAB) or cardiorespiratory support • ❤ Mechanical Ventilation • Resuscitative Procedures

Neurological Dysfunction	• Epilepsy • Cortical vein thrombosis	• Syncopal attacks • Convulsions • Unconscious state	• Altered conscious state and coma • Abnormal reflexes (hyper or absent) • Paresis/plegia • Cardiorespiratory failure	• Abnormal EEG • Abnormal acid –base status • ❤ CT/MRI head showing abnormalities	• ❤ ICU admission for resuscitative procedure like (CAB) or cardiorespiratory support • Shifting to intravenous Antibiotics fourth generation • ❤ Mechanical ventilation • Heparanisation
Renal Dysfunction / Failure	• Medico renal disease e.g chronic/ acute renal failure • Renal artery stenosis • Transplant complications • Collagen Disorders	• Reduced / absent urine • Edema all over body • Breathlessness (due to volume overload) • Unconscious state	• Oliguria - < 400 ml urine output in 24 hours not responding to fluid therapy and diuretics • Anuria • ❤ Coma	• USG showing renal abnormalities • Doppler USG showing stenotic renal artery • Deranged KFT	• ❤ ICU admission for resuscitative procedure like (CAB) or cardiorespiratory support • Need for dialysis peritoneal/ hemodialysis
Category 3 : INCIDENTAL AND ACCIDENTAL CAUSES IN PREGNANCY					
Accident/ assault/surgical problems	• Trip or fall • Vehicular accident • Violence • Blunt trauma abdomen • Assault • Burns • Poisoning • Cancers • Acute surgical condition • Suicide attempt • Snake bite • Other	• History of trauma or accident, suicide attempt • Syncope • Pain (abdominal or pertaining to specific site) • Blurred vision • Bleeding • ❤ Convulsions • ❤ Altered behavior	• Altered conscious state • Tachycardia > 120/ min, low volume pulse • Bradycardia <60/min • Tachypnea >20/min • Blood pressure Systolic < 90 mmHg Diastolic < 60 mmHg • Tenderness, rigidity and guarding of anterior abdominal wall with/without distension • ❤ Cardiorespiratory failure • Evidence of trauma / burns	• Acute fall Hb < 5 gm (fall in hemoglobin so as to affect oxygen saturation) • Fall in oxygen saturation below 90 % • ❤ PaO2 : FiO2<200 • ❤ PaCO2>50mm Hg • Platelet < 20,000 acute decline in platelet count more significant • ❤ Clot observation time > 7 min. or any other test done which proves deranged coagulation profile • USG showing trauma to vital organs • Imaging modality showing Injury to bladder, bowel, liver, spleen • CT/MRI showing injury	• ❤ ICU admission for resuscitative procedure like (CAB) or cardiorespiratory support • ❤ Blood &blood products transfusion (more 90 ml/ kg body weight/ >5 units of blood) • ❤ Use of cardiotonics/vaso pressors (Mephentine/ Dobutamine/Dopamine etc) • ❤ Surgical procedures done (laparotomy for intraperitoneal haemorrhage, repair of bladder, bowel, spleen, liver, kidney, burr hole for head injury

Anaphylaxis	• Anesthetic drugs • Antibiotics • Antimalarial • Iron preparations • Anticonvulsants • Blood transfusions • Other reactions	• History of taking the drug • Breathlessness • Air Hunger • Syncope • Not passing urine	• ❤ Altered conscious state • Tachycardia > 120/min thready, low volume pulse • Bradycardia <60/min • Tachypnea >20/min • Blood pressure - Systolic < 90 mmHg - Diastolic < 60 mmHg • Oliguria/Anuria	• Fall in oxygen saturation below 90 % on room air • ❤ PaO2 : FiO2<200 ❤ PaCO2 > 50mm Hg • Proteinuria > 1 gm/dl • S. Creatinine >3.5 mg /dL • Elevated S Bilirubin (6 mg/ dL) ALT, AST(>100 IU/L) • Thrombocytopenia <20,000 • Haemolysis on peripheral smear • Clot observation time > 7 min. or any other test done which proves deranged coagulation profile • ECG	• ❤ ICU admission for resuscitative procedure like (CAB) or cardiorespiratory support • ❤ Blood & blood products transfusion (more 90 ml/kg body weight/ >5 units of blood) • ❤ Use of cardiotonics/ vaso pressors (Mephentine/ Dobutamine/ Dopamine etc • ❤ Use of Adrenaline Renal dialysis- peritoneal/ hemodialysis (Renal Replacement Therapy)
Infections	• Malaria • Dengue • H1N1 viral Disease • Lower respiratory tract infections • ARDS • Meningitis • Encephalitis • Infective hepatitis (A,B,C,E) • HIV/AIDS • Scrub typhus • Nephritis • Other	• High grade fever (with/ without chills and rigor) • Yellowness of urine • Altered behavior • Breathlessness • Abdominal pain • Abdominal Distension • Unconscious state • Convulsions	• Altered conscious state • Persistent rise in Temp >39.2 °C, not responding to routine treatment • Hypothermia temp, 37 °C • Pulse rate > 120/min • Tachypnea> 20/min • Chest signs (Creps, crackles, rhonchi, decreased or absent air entry) • Neck rigidity • Coma • Bleeding from various sites	• Leukocytosis (>15,000/ cu mm) • Toxic granules on peripheral smear • Low platelets(<50,000) • Microbial culture positive for organisms • Dengue , malarial parasite positive on ELISA/ peripheral smear • H1N1 ELISA positive • Spinal fluid positive for infection • Elevated serum bilirubin (>6 mg) • Abnormal liver enzymes (> 100 IU) • Abnormal ECG • Abnormal EEG • Clot observation time > 7 min. or any other test done which proves deranged coagulation profile • Positive Hepatitis markers • HIV ELISA positive	• ICU admission for resuscitative procedure like (CAB) or cardiorespiratory support • Shifting to intravenous Antibiotics of fourth generation (Sulbactum+ Cefoperazone combinations, Imepenum) • ❤ Blood component transfusion (upto 90 ml /kg body weight/ >5 units of blood) • ❤ Use of cardiotonics/ vaso pressors (Mephentine/ Dobutamine/Dopamine etc) • Injectable antimalarials • Use of drugs to relieve cerebral odema (Mannitol) • Antiretroviral

Embolism and infarction	• Pulmonary embolism • Cerebral Embolism (Stroke) • Cardiac Embolism (Myocardial Infarction)	• Breathlessness • Air Hunger • Collapse • Acute Chest Pain • Syncope	• Tachypnea - >20/min • BP: 1) Systolics <90 mhg. 2) Disytollics < 60 mhg. • Weak Pulse • Abnormal chest signs (Ronchi, Crepts, Effusion) • Sweating, cold and clammy skin	• Various lesions on chest X ray pertaining to disease • Abnormal ECG • CT/MRI showing Lesion	• ICU admission for resuscitative procedure like (CAB) or cardiorespiratory support • Blood component transfusion (upto 90 ml/kg body weight/ >5 units of blood) • Use of cardiotonics/ vaso pressors (Mephentine/ Dobutamine/ Dopamine etc • Antocoagulant therapy • Drugs to reduce cerebral odema (Mannitol)

MATERNAL NEAR MISS REVIEW REGISTER
TO BE FILLED AT NOTIFIED INSTITUTIONS/DISTRICT

NAME OF THE FACILITY:

DISTRICT:

Year: Month:

Sr. No	Name	Husband's / Partner's name	Age	Address with mobile no.	MCTS No.	Date & Time of Admission	Admitted with no Disorder	Admitted with Disorder* 1/2/3	Admitted as Near Miss	Interventions done #			Date of Discharge	Remarks	Signature of the Doctor Incharge with designation and date	
										1	2	3			Name and Designation	Signature with date

*1 - Pregnancy specific obstetric and medical disorder/s 2 - Preexisting disorders aggravated in pregnancy 3- Accidental/ incidental disorder/s

 # Interventions should be written broadly under following details –

- ICU admission
- Cardiopulmonary resuscitation
- Mechanical ventilation
- Use of cardiotonics as vasopressins, dopamine or dubotamine
- Digitalization in cardiapulmonary collapse
- Massive blood /blood product transfusions
- Intravenous higher antibiotics
- Renal or peritonial dialysis

This register to be printed at A3 size for actual size.

- Blood coagulation disorder leading to heparanization and anticoagulants
- Management of ketoacidosis
- Management of status epilepticus
- Surgical procedures as laparotomy , hysterectomy, b lynch suture, stepwise

vascular ligation including internal iliac ligation, repair of bowel, bladder,

Repair of vault, cervical tears and drainage of haematoma etc

- Any

ANNEXURE III

Modified Early Obstetric Warning System (MEOWS) for early detection of sepsis

OBSTETRICS EARLY WARNING CHART

Patient Label

Date																	
Time																	
Respiration	≥ 30																
	21-30																
	12-20																
	< 12																
Saturation	> 94%																
	< 94%																
Temperature	≥104° F																
	103° F																
	102° F																
	101° F																
	100° F																
	99° F																
	98° F																
	97° F																
	≤ 96° F																
Pulse Rate	≥ 120																
	110																
	100																
	90																
	80																
	70																
	60																
	50																
	< 50																
Systolic Blood Pressure	≥ 160																
	141-180																
	121-140																
	100-120																
	90-99																
	70-89																
	< 70																
Diastolic Blood Pressure	≥ 100																
	80-99																
	60-79																
	≤ 59																
Passed Urine	Volume																
Proteinuria	≥ 2+																
	< 2+																
Liquor	Clear																
	Pink/Green																
Lochia	Normal																
	Heavy / Foul																
Looks Unwell	yes																
Neuro Response	alert																
	Voice																
	Pain / Unresponsive																
For Patient with Pre-Eclampsia, Knee Jerk Reflex	Brisk																
	Normal																
	Absent																
Pain Score	> 6																
	4 - 6																
	< 4																
Headache, blurring vision, Epigastric Pain																	
Nausea / Vomiting																	
GRBS																	
FHR																	
Total Yellow Score																	
Total Orange Score																	
Doctor Informed																	
Nurse																	
Remarks																	

CONTACT DOCTOR FOR EARLY INTERVENTION IF PATIENT TRIGGERS 1 RED OR 2 YELLOW SCORES AT ANY ONE TIME

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List of Assessors

List of Facilitators

Agnes Mathew
Ajith S
Ajithakumari S
Ambujam K
Beena Guhan
Beenakumari R
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Bindu Sajith
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Chandrika C V
Chellamma V K
Deepthy M
Geetha A P
Geetha Sreenivasan
Girija Gurudas
Hariprasad
Hema Warrier
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Jayasree Thankachi
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Jyoti Ramesh Chandran
Kavitha
Koshy M J
Krishnakumari
Krishnanunni
Kunjamma Roy
Lakshmikutty
Lalitha K
Lalithambica Karunakaran
Lekshmi Ammal
Lekshmy S
Lissiamma George
Lola Ramachandran
Manjula M
Mayadevi Kurup
Megha Jayaprakash
Mini CH
Mumtaz
Nandini V R
Narayanan T
Neetha George
Nirmala C
Nishi Roshini
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Padmam Warrier
Paily V P
Parvathy Deth
Prameela Menon
Pramod Roy John
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Radha Devi
Radha K R
Radhamony D
Radhamony Remanan
Rajalakshmy T N
Rajasekharan Nair V
Ramesh P P
Rani Santhakumari
Reena Ravindran
Reena (Kollam)
Reji Mohan
Resmi C R
Sangeetha Menon
Sareena Gilvas
Sathy M S
Seetha
Sekharan P K
Sheela Shenoy
Sheila Balakrishnan
Shyamala Devi P K
Simi Kurien
Sreedevi N S
Sreekumari R
Sreelatha S
Sreelatha S
Sujamol Jacob
Sujatha T L
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Sumangala Devi
Swarnavalli
Vasanthi Jayaraj
Venugopal
Vijayan C P
Vinayachandran S

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