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MATERNAL MORTALITY IN AUSTRALIA: LEARNING FROM MATERNAL COLLAPSE TO IMPROVE PATIENT SAFETY

ABSTRACT

Cardiorespiratory collapse in pregnancy is fortunately a rare event that few midwives will see during their careers. The increase in maternal age, body mass index (BMI), caesarean sections, multiple pregnancies and co-morbidities over recent years have potentially increased the probability of collapse occurring. The early warning signs of impending maternal collapse are either absent or go unrecognised. Recognition and prompt management is essential to ensuring patient safety in maternity care.

The aim of this paper is to review the physiological changes in pregnant women that complicate the management of cardiopulmonary resuscitation using a case study approach. There are key differences in the management of the collapsed pregnant woman when compared to standard adult resuscitation. The outcome is dependent on the speed of the response and consideration of a number of crucial pregnancy-specific interventions. Health systems need to ensure that staff are adequately trained to deal with maternal cardiopulmonary collapse, and have access to available training packages as well as a relevant inservice education program. As these are rare events, emergency drill simulations are an important component of ongoing education.

Keywords: Maternal mortality, cardio-pulmonary resuscitation, caesarean section, infant mortality, pregnancy, education

INTRODUCTION

Ensuring quality and safety is an important aim for maternity service providers including midwives and nurses. National reports in a number of resource-rich countries like Australia and the United Kingdom (UK) have identified that the overwhelming majority of births are safe, however, some births are less safe than they could and should be (The King's Fund, 2008, Department of Health and Ageing, 2009). One of the roles of the midwife is to recognise and respond effectively in emergencies or urgent situations with timely and appropriate intervention, consultation and/or referral (ANMC, 2006). This also includes updating of skills and knowledge concerning emergency plans and protocols to ensure patient safety is maintained.

The cardiorespiratory collapse of a pregnant or postpartum woman occurs about once every 20-30,000 pregnancies (Morris et al., 2003). This rare event highlights the need for regular updating of emergency skills and knowledge. The survival of both the mother and the baby is dependent on a number of factors including the underlying reason for the collapse, the location of the arrest and the skill and resources of the care providers (Morris et al., 2003). Unfortunately, the early warning signs of impending maternal collapse can be absent or go unrecognised. The normal changes in physiology associated with pregnancy and childbirth, together with the rarity of such an event, compound the problem (Lewis, 2007).

An acute cardiorespiratory maternal collapse in pregnancy or the postnatal period can be a result of direct or indirect factors relating to pregnancy. Direct factors that may lead to a woman collapsing include obstetric complications (for example, thromboembolic disorders, amniotic fluid embolus), and indirect factors are from pre-existing disease (for example, cardiac disease). Much of the maternal mortality results from the acute collapse of a woman leading to cardio-respiratory arrest and death although it is difficult to determine what proportion of maternal mortality is due to an acute event. Given the rarity of such an event and the population in which it occurs it is likely to be a significant proportion.

Monitoring rare events like maternal collapse is essential to improve quality and safety in maternity care. In the UK for example, the Centre for Maternal and Child Enquiries (CMACE) is responsible for producing triennial reports on its enquiries into maternal deaths. The reports contain the results of case reviews of all maternal deaths. They include analyses of trends and recommendations for improving clinical practice and for national policy on maternity. Even with a national triennial reporting system, the infrequency of such events will mean that clinicians (fortunately) are rarely exposed to pregnant women who collapse. Nonetheless, learning from such events is critical but it is unlikely that individuals can actually do this from direct experience as the events are uncommon (Lewis, 2007). A review of management in these acute situations has shown that there are often inadequate resuscitation skills amongst doctors, midwives and other health professionals (Lewis, 2007). The most recent CMACE report on maternal mortality recommended an improvement of all levels of life saving and resuscitation skills and the implementation of regular written, documented, and audited training for early recognition and management of severely ill pregnant women and impending maternal collapse (Lewis, 2007).

As maternal collapse is rare, it is important for midwives to review the management of this event. This article is directed towards improving quality and safety in midwifery care by reflecting on such events. This paper commences with a case story (Figure 1) that highlights the unexpected nature of maternal collapse. The case has been de-identified and is a collation of a number of real stories. These have been combined in such a way to protect anonymity. The paper then reviews the physiological changes of pregnancy that are relevant to resuscitation, discusses the concept of a perimortem caesarean delivery and highlights the key differences in the management of the collapsed pregnant woman. Data from Australian and UK published reports on maternal mortality were sourced and a review of the practice implications relating to maternal cardiorespiratory collapse is presented.

LEARNING FROM PRACTICE

Acute emergencies in maternity rarely happen. When they do occur, the events are often catastrophic and the outcomes can be tragic. It is difficult to learn from such events due to their rarity. Ensuring quality and safety in maternity care however means being able to respond in acute emergencies as well provide high quality ongoing care. Figure 1 describes a story where a woman collapsed in early labour. This event could occur any morning of a busy delivery suite. The case illustrates the resuscitative actions by the staff and the changes that were put in place following the event. Close review of practice and improvements are a vital part of improving quality and safety of maternity care, especially after a maternal collapse scenario that staff may not have experienced before.

<insert Figure 1 here>

Resuscitation of a woman like Penny requires midwives to have knowledge of the physiological changes due to pregnancy in order to adapt their practice. A summary of these are presented in the next section.

PHYSICAL CHANGES DURING PREGNANCY

Several modifications to standard and advanced Basic Life Support approaches are required for the pregnant woman in cardiac arrest because of the physiological changes of pregnancy and the early postpartum period (American Heart Association, 2005, Murphy & Reed, 2007). These changes underpin the reasons pregnant women need special consideration during a maternal collapse.

Cardiovascular changes

Measures to prevent aortocaval compression are essential during resuscitation of pregnant women and are generally recommended in all pregnant women over 20 weeks gestation. A failure to achieve adequate uterine displacement can be a potentially fatal error during cardiopulmonary resuscitation (CPR) as the low output state during cardiac compressions is further compromised by the decreased venous return. A number of techniques are available to displace the uterus when a pelvic wedge is not available, including manual displacement by an assistant or the use of pillows or knees of the person performing CPR. Birth of the baby will cause immediate relief of the aortocaval compression, with a consequent improvement in the venous return and pulmonary mechanics, as well as a decreased oxygen demand.

Respiratory changes

Due to anatomical changes to the lungs during pregnancy, there is an exacerbation of hypoxia during apnoeic episodes. Bag-mask ventilation is more difficult because of the effects of the gravid uterus and engorged breast tissue. There is an increased risk of airway trauma because of capillary and mucosal engorgement, and an increased risk of difficult and failed intubation (McDonnell et al., 2008). Care should be taken to provide only moderate hyperventilation, as placental blood flow falls when the PaCO₂ is lowered excessively (Hughes et al., 2002).

Gastro-intestinal changes

Pregnant women are more prone to regurgitation and aspiration. This is secondary to the combined effects of the gravid uterus displacing the stomach and altering the angle of the gastroesophageal junction as well as decreased gastric motility and emptying, especially during labour (Hughes et al., 2002). The use of cricoid pressure is recommended during cardiac arrest in pregnancy but is often impractical whilst CPR is being performed and may divert valuable resources away from other tasks.

Pharmacological changes

There is little information on the pharmacological management of advanced life support during pregnancy. It is recommended that the same drug protocols for non-pregnant adults are followed. It should be noted that women with pre-eclampsia (which may precede maternal collapse) may already have magnesium therapy in place and have impaired renal function inhibiting the clearance of electrolytes such as magnesium and potassium. This can lead to iatrogenic magnesium toxicity.

CARIOPULMONARY RESUSCITATION IN PREGNANT WOMEN

It is important to differentiate between situations of cardiopulmonary arrest and those of a number of non-fatal and reversible conditions that can occur in pregnancy. For example, a high spinal block, or an eclamptic seizure need prompt intervention, but do not need immediate perimortem caesarean delivery. In these situations, treatment will usually improve the woman's condition allowing time for transfer to an operating theatre.

Maternal collapse can occur without prior warning, or knowledge of existing conditions. In the case report scenario (Figure 1), Penny had no history of aortic aneurysm, or underlying symptoms, and the ruptured aortic aneurysm was only diagnosed upon post mortem. However, many women experiencing maternal collapse would have pre-existing medical or obstetric histories and symptoms leading up to the collapse. Hence the importance in staff recognition of severe illness in women, prompt action and efficient referral systems.

PERIMORTEM CAESAREAN SECTION

A perimortem caesarean section is one of the most difficult aspects surrounding the management of a pregnant woman who collapses and has a cardiac arrest. If there is no response to basic and advanced life support, it is widely believed that the baby needs to be born within five minutes (Katz et al., 1986). A perimortem caesarean section has been found

to be a life-saving intervention (Morris et al., 2003), and those born within this time period have a 70% survival rate (Katz et al., 1986). The fetus has a number of physiological mechanisms in place to cope with hypoxic episodes that last longer than 10 minutes (Low et al., 1997), including high haemoglobin concentrations, higher oxygen affinity, and the ability to increase blood supply to the brain, heart and adrenal glands selectively when required.

Perimortem caesarean delivery also increases the chance of the woman's survival. Birth of the baby results in an improvement in maternal circulation during cardiopulmonary resuscitation (Murphy & Reed, 2007). It is important to have equipment to facilitate perimortem caesarean section on emergency trolleys in emergency departments and labour wards (Dijkman et al., 2010, ARC & ACCN., 2008). This can simply consist of an antiseptic solution, scalpel and packs for the uterus and abdomen.

In the case story (Figure 1), Penny experienced a fatal rupture of an aortic aneurysm and her unresponsive state was apparent in the first few minutes of resuscitation. In Australia, 2003-2005, ten women died from (mostly pre-existing) cardiac conditions; three of which were diagnosed with an aortic dissection (Sullivan et al., 2008). In the UK, cardiac disease (including aortic dissection) was the commonest cause of indirect maternal death in the same time period. In Penny's case, the speed of the perimortem caesarean section was life-saving for her baby, which given the catastrophic event that occurred, was the best outcome possible.

The Confidential Enquiry into Maternal and Child Health (CEMACH) reports 49 women who underwent a perimortem caesarean section, almost twice as many from the previous triennium (Lewis, 2004). Twenty babies survived in the 2003-2005 triennium, including one set of twins. Their chances of neonatal survival were improved with increasing gestational age and the location of the maternal collapse (events outside of hospital had worse outcomes). These findings indicate that with improved resuscitation techniques more babies

are surviving perimortem caesarean sections, particularly where the women collapsed in an already well-staffed and equipped labour ward or operating theatre. However, they also highlight the very poor outcome for babies who are delivered by perimortem caesarean section in Emergency Departments (ED), especially for women who arrive after having undergone CPR for a considerable length of time. The babies who survived were born to mothers who were near or at term, and who suffered a cardiac arrest whilst already undergoing active treatment in the ED.

LEARNING TO MANAGE MATERNAL COLLAPSE

It is necessary to ensure ongoing training in obstetric emergencies to improve quality and safety of maternity care. After the 2000-2002 CEMACH report, an assessment of physician's knowledge of cardiopulmonary resuscitation skills found up to 40% answers were incorrect. (Cohen et al., 2008). Obstetric emergency training should be multi-disciplinary (Banks, 2008), involve established courses such as the MOET course (Managing Obstetric Emergencies and Trauma, www.alsq.org) or the ALSO course (Advanced Life Support in Obstetrics, www.also.net.au), as well as institutional practice drills. An evaluation of the MOET course has shown an increased clinician use of perimortem caesarean section since its introduction in 2004, although outcomes remained poor (Dijkman et al., 2010). Other evaluations include those by Daniels et al, whose simulation training found clinician's knowledge and communication skills in emergency scenarios needed improvement (Daniels et al., 2008). Other sophisticated obstetric emergency simulation training packages are available providing multidisciplinary learning opportunities; however these have differing levels of local transferability and can be prohibitively expensive (Deering et al., 2009, Freeth et al., 2009). Black and Brocklehurst report that very few obstetric emergency training programs have been evaluated in terms of maternal and neonatal outcomes, and that given the implications for mothers and babies, this needs to be addressed (Black & Brocklehurst, 2003).

Since the systematic review (Black & Brocklehurst, 2003), there has been a significant increase in research in this area. The importance of team work in managing obstetric emergencies has been seen as a fundamental aspect of improving patient safety in labour and birth settings. Using work translated from the aviation industry, one study on team work in neonatal resuscitation identified ten effective team work behaviours that could be measured or assessed. These included verbal information sharing, sharing of intentions, evaluation of plans, asking questions of one another (inquiry) and demonstrating assertion and leadership (Harris et al., 2006). Simulation training has been seen as a useful strategy to develop these behaviours.

Training of maternity professionals should comprise a number of elements. It should be multi-disciplinary and undertaken in real-life teams; 'in-house' where possible; relevant to the setting and context with local solutions identified for national problems; and, presented in a non-threatening manner. Local training also seems to facilitate self-directed change which means that other system-level changes can be implemented. Training should also ensure that staff have the skills and ability to recognise symptoms of a deteriorating pregnant women, and enlist prompt treatment or transfer (Lewis, 2007). Early warning systems for the detection and management of unwell pregnant women are beginning to become more mainstream.

The 2003-2005 CEMACH Report emphasised the importance of such training especially to ensure that care provided is of a high quality (Lewis, 2007). The Report provided details of an alarming number of women receiving substandard care by health staff. This included 64% of direct deaths (e.g. thromboembolic disorders, eclampsia, haemorrhage) and 40% of indirect deaths (e.g. cardiac disease, psychiatric, cancer) having some degree of poor quality care.

A maternal death will have a long lasting impact on the staff involved in her care and is likely to impact upon the care of subsequent women. The 2000-2002 CEMACH report states the need for supportive counselling for those involved in a maternal death (Lewis, 2004) and all staff should be offered access to appropriate services (Dietz, 2009).

CONCLUSION

Cardiopulmonary arrest in pregnancy is fortunately a rare event that many midwives will not encounter during their career. Successful outcomes for both mother and baby require prompt care, with attention to several specific differences in the causes and management of collapse in pregnancy. The woman's airway should be secured early and the performance of a perimortem caesarean section should be considered at the outset of the arrest. Institutions should have plans in place for the performance of perimortem caesarean, and pregnancy-specific training, including simulation, should be performed on a regular basis.

Attention needs to be focused on clinician education in early recognition and management of unwell mothers, and awareness that the physiological changes of pregnancy may mask serious pathology until late in the course of the illness. Measures to ensure quality and safety are necessary in all maternity units to care for women who experience collapse.

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CONTRIBUTIONS

Study Design - CH

Data Collection and Analysis – CH, NM, AM

Manuscript Writing – CH, CCP, NM

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