

Maternal resuscitation drills for perimortem Caesarean section: use of a prepacked instrument set and a manikin model

Shuk-Leung MA, MSc in WHS, BSc, RNM

Wing-Yan SHIU, MSc in Nursing, RNM

William Wing-Kee TO, MD, FRCOG, FHKAM (Obstetrics and Gynaecology)

Choi-Wah KONG, MBChB, MSc in Medical Genetics, MRCOG, FHKAM (Obstetrics and Gynaecology)

Department of Obstetrics and Gynaecology, United Christian Hospital, Hong Kong

Prompt delivery of the baby by emergency perimortem Caesarean section (PMCS) in the event of maternal cardiac arrest is crucial for improving maternal and neonatal outcomes. Regular training and drills are essential to improve staff competence. We recommend the use of a prepacked set of instruments for PMCS and a manikin model for simulation training.

Introduction

Perimortem Caesarean section (PMCS) was originally performed as a religious ritual in Roman times to save the soul of the child from the womb of a dying mother through baptism and burial¹. The unexpected benefits of neonatal or maternal survival were only recognised centuries afterwards. Maternal recovery and neonatal survival after PMCS was formally reported in the late 19th and early 20th centuries^{2,3}. PMCS is now considered as a legitimate medical intervention during resuscitation of maternal cardiac arrest to improve maternal survival and save the baby.

Importance of perimortem Caesarean section

PMCS should be initiated within 4 minutes after maternal cardiac arrest for women with ≥ 20 weeks of gestation in order to relieve the aortocaval compression from the gravid uterus to increase maternal venous return and cardiac output⁴. PMCS can also help to decrease oxygen demand and improve pulmonary mechanics. A review of 38 cases of PMCS in 2005 reported that 34 fetuses survived and 13 of 20 mothers with reversible causes survived to time of discharge, and that there was no evidence of maternal deterioration after PMCS⁵. A review in 2012 reported a maternal survival rate of 54.3% (51/94) and no worsening of maternal status after PMCS⁶. Neonatal survival and neurologic outcome were related to the time between maternal death and delivery⁶. There is a consensus that PMCS should be performed promptly in order to improve maternal and neonatal outcomes.

Importance of training for perimortem Caesarean section

The incidence of maternal cardiac arrest in the peripartum period is around 2.8 to 3.6 per 100000 pregnancies, and the incidence is found to be increasing in the recent decade^{7,8}. This is postulated to be related to an increase in women with advanced maternal age and multiple pregnancies and thus an increase in pre-existing maternal medical disorders such as cardiac diseases. In Hong Kong, only two cases of pre-hospital maternal cardiac arrest treated with PMCS in the accident and emergency department have been reported^{9,10}. Medical staff generally lack the experience of PMCS. However, prompt PMCS with ongoing effective maternal cardiopulmonary resuscitation can potentially improve maternal and neonatal outcomes. Therefore, practical training in maternal resuscitation and PMCS is crucial to both obstetrics and accident and emergency staff, and thus it has been included in the curriculum of obstetric emergency training courses¹¹. The Society for Obstetric Anesthesia and Perinatology and the American Heart Association have each published a statement on maternal resuscitation for cardiac arrest in pregnancy^{12,13}. Both have provided comprehensive guidelines and protocols on effective maternal resuscitation, as well as recommendations on clinical practice during the management of such emergencies. Flowcharts provided

Correspondence to: Dr Choi-Wah KONG

Email: melizakong@gmail.com

are precise and easy to follow, delineating the steps in managing maternal cardiac arrest. These guidelines are equally useful for team and skills training for real-life management, emphasising the need to perform manual left uterine displacement to relieve aortocaval compression until after delivery, and the need to proceed to PMCS if no return of spontaneous circulation after 4 minutes. A review on PMCS in 2014 outlined a succinct synopsis on practical PMCS procedures¹⁴. PMCS should be performed at the site of maternal cardiac arrest (for in-hospital cases). Consent for PMCS and urinary bladder drainage as well as strict sterility are not necessary. Midline incision may provide the quickest way to deliver the fetus. Individual units can use the above recommendations to work out their own workflow logistics and protocols. Simulation training can improve team training and enhance didactic teaching¹⁵. As effective management of maternal cardiac arrest inevitably involves various disciplines and specialties, simulation exercises have an important role to play. Maternal cardiac arrest drills should be held regularly in obstetric units in order to increase staff awareness, update staff knowledge, enhance team cooperation, and identify deficient areas.

Instruments for perimortem Caesarean section

Time should not be wasted for waiting availability of surgical equipment for PMCS¹². The only mandatory instrument is a scalpel. We suggest using a disposable scalpel (which does not need to mount the blade onto the

handle) to save the blade-mounting time and the time to find instruments (such as forceps or needle holders) to mount the blade, and to avoid sharps injuries during the mounting procedure. PMCS can be carried out more smoothly if a prepacked set of instruments are readily available, especially if surgical difficulties are encountered. The prepacked set of instruments should be stored in or near the resuscitation trolley in each obstetric unit and accident and emergency unit. The prepacked set contains a disposable scalpel, a bladder retractor, a pair of scissors, 2 metal clamps, 3 cord clamps, a kidney dish, a pack of antiseptic pour solution, and abdominal pads (Figure 1). Time should not be spent on lengthy antiseptic procedures; a very abbreviated antiseptic pour should suffice or the anti-septic step can be omitted¹². An optional anti-septic pour solution is prepared, and it takes <5 seconds for the assistant to pour the solution. The abdominal pads are used to pack the uterine wound in case of bleeding after maternal circulation returns. The kidney dish enables safe placing of the scalpel, scissors, and metal clamps after use to avoid the risks of sharps injury to resuscitating staff after delivery of the baby while the maternal cardiac resuscitation continues.

Manikin model for perimortem Caesarean section

A manikin model that mimics human anatomy can help the staff to learn and perform the procedures more effectively. An inexpensive model for PMCS has been

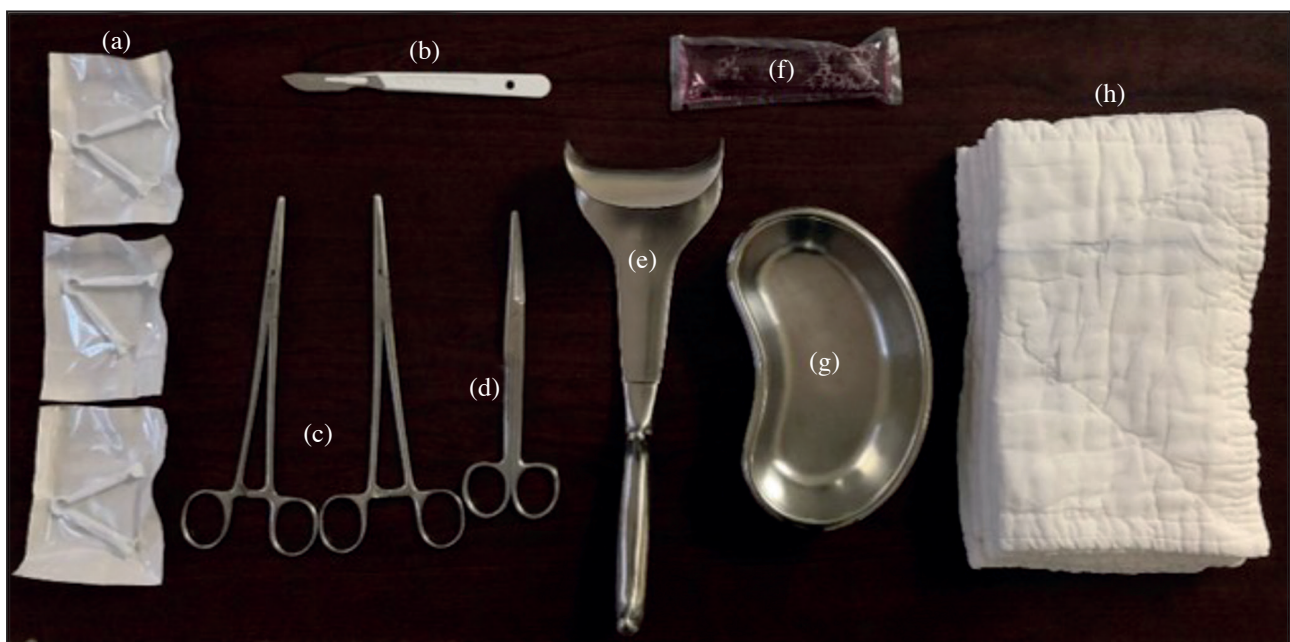


Figure 1. A prepacked set of instruments for perimortem Caesarean section: (a) cord clamps x3, (b) disposable scalpel, (c) metal clamps x2, (d) scissors, (e) bladder retractor, (f) antiseptic pour solution, (g) kidney dish, and (h) abdominal pads.

developed¹⁶. Training equipment is the most expensive component of emergency obstetric care training¹⁷. Therefore, an inexpensive replicable human anatomy training model is valuable for promoting PMCS simulation training. Our unit has developed a simple inexpensive manikin model for maternal cardiac arrest drills in 2019.

The model is constructed with a 28-cm diameter plastic beach ball, a latex glove, a baby manikin, a 0.5-inch-thick sponge mat, a transparent film, an adhesive tape, and a cable tie (Figure 2). A uterus filled with liquor with a fetus inside is assembled: the latex glove is filled with water with the end tied; the beach ball is trimmed to make an opening; a baby manikin is placed inside the beach ball and the water-filled glove is placed on top of the baby manikin inside the beach ball; and the opening of the beach ball is tied with the cable tie (Figure 3). The uterus is then wrapped with the sponge mat (as the abdominal wall), and the whole structure is secured on the abdomen of an adult manikin with adhesive tape and transparent film (Figure 4). A cross is marked on the position of the maternal umbilicus, and cardiocographic sensors are attached on the abdomen to mimic continuous fetal heart rate monitoring during labour (Figure 5). During simulation training for PMCS,

the abdomen and uterus are incised by the scalpel, and the leakage of water mimics liquor coming out (Figure 6). Videos demonstrating how the manikin model is made and how PMCS is simulated are available at the journal website (<https://www.hkjgom.org>).

Usefulness of the manikin model

The manikin model requires incision of several layers before the fetus is delivered. It mimics human anatomy from skin (transparent film), subcutaneous fat (sponge mat), uterine wall (beach ball) to amniotic membranes (surgical glove). This manikin model simulates the real-life procedure in which the fetus is not delivered by a single incision. This helps the staff to know the difficulties when PMCS is carried out while maternal cardiopulmonary resuscitation is simultaneously performed. The optimal positions for different members of the resuscitation team to take around the patient's bed should be practiced and ascertained. In our drill, the splash of liquor (from water-filled glove) on the floor after the PMCS can put the staff at risk of electric shock during cardiac defibrillation (when staff stepping on the wet floor). Therefore, the staff who performs the defibrillation should alert all staff to move away from the wet floor before pressing the defibrillation



Figure 2. Materials for assembling a manikin model for perimortem Caesarean section: (a) 28-cm diameter beach ball, (b) latex glove, (c) baby manikin, (d) 0.5-inch-thick sponge mat, (e) transparent film, (f) adhesive tape, and (g) cable ties.



Figure 3. A uterus filled with liquor with a fetus inside is assembled: (a) the latex glove is filled with water with the end tied; (b) the beach ball is trimmed to make an opening; (c) a baby manikin is placed inside the beach ball and (d) the water-filled glove is placed on top of the baby manikin inside the beach ball; and (e) the opening of the beach ball is tied with the cable tie.

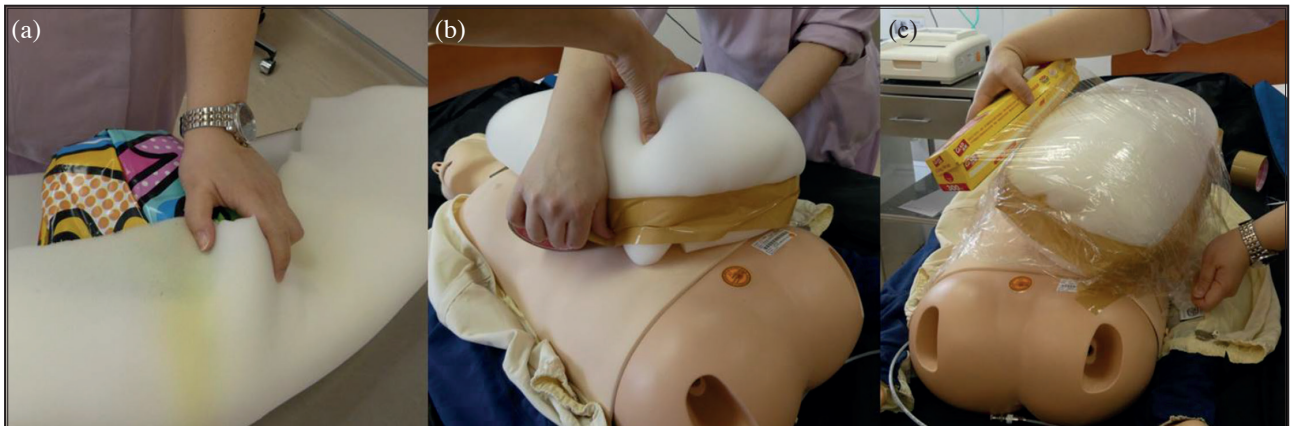


Figure 4. (a) The uterus is wrapped with the sponge mat (as the abdominal wall); (b) the whole structure is placed onto the abdomen of an adult manikin and (c) secured with adhesive tape and transparent film.

button. Indeed, if spare manpower is available, the floor should be dried with a towel or blanket after PMCS in order to avoid electric shock as well as slip and fall accidents. Although our model is primitive, many real-life issues during urgent resuscitation can be tested out. We have invited colleagues from other specialties (emergency medicine, anaesthesiology, paediatrics) to participate and

observe. All found the manikin model very useful to help them to understand the procedure of PMCS and its role in maternal resuscitation.

Conclusion

Prompt delivery of the fetus by PMCS is crucial for improving maternal and neonatal outcomes. Training



Figure 5. (a) A cross is marked on the position of the maternal umbilicus, and (b) cardiocographic sensors are attached on the abdomen to mimic continuous fetal heart rate monitoring during labour.



Figure 6. Perimortem Caesarean section is simulated: (a) the abdomen and (b) uterus are incised with the scalpel, and the leakage of water mimics liquor coming out. (c and d) The baby manikin is delivered.

and drills are crucial to improve staff competence and confidence to manage maternal cardiac arrest. A prepacked set of instruments for PMCS should be stored in appropriate

wards in the obstetrics and accident and emergency departments. A simple and inexpensive manikin model is recommended for simulation training in PMCS.

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