

Resuscitation in the Maternity Population

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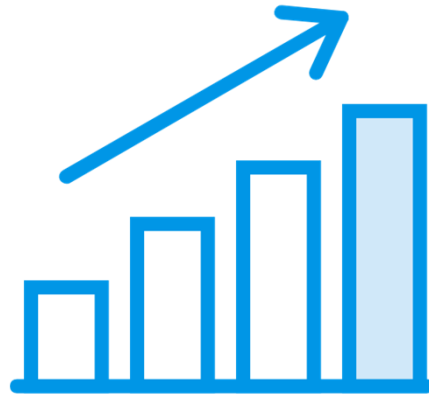
Take Home Points

1. Think of maternal physiology
→ Position mother for optimal CPR
2. Perform standard interventions for ACLS
→ Compression, defibrillation, medications
3. Prompt perimortem cesarean section may save baby AND mother
→ Consider rapid transport if initial resuscitation is unsuccessful

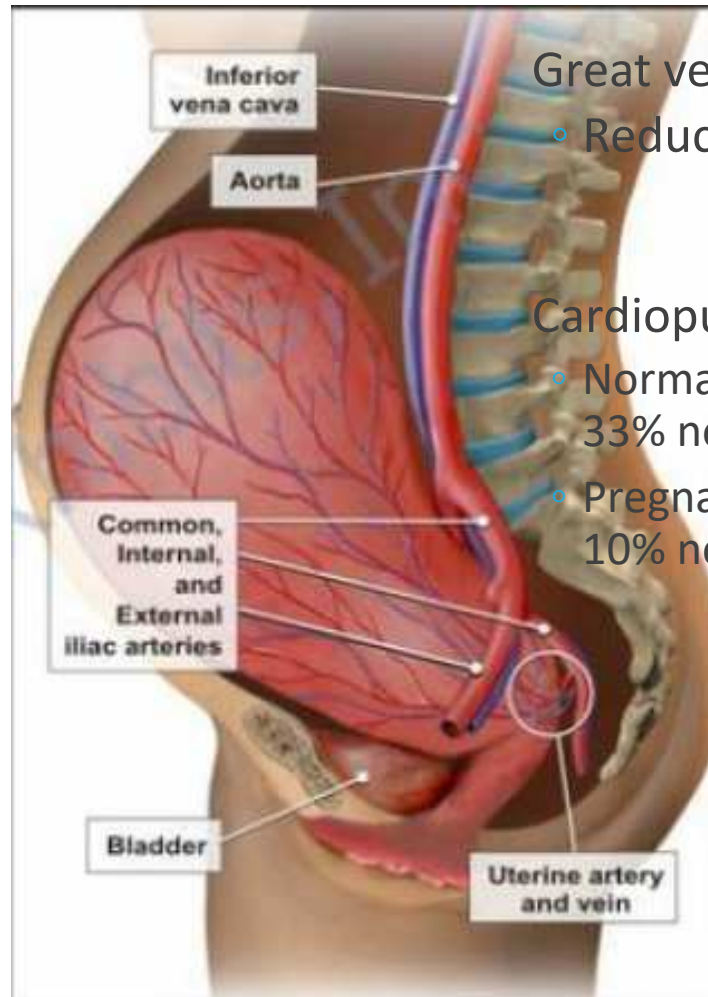
Maternal Cardiac Arrest

Rates of maternal cardiac arrest are rising

- 1987 → 7.2 deaths per 100,000 live births
- 2009 → 17.8 deaths per 100,000 live births



Physiology of Pregnancy in Cardiac Arrest



Great vessels compressed by uterus

- Reduces cardiac output by 2/3

Cardiopulmonary resuscitation

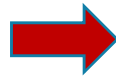
- Normally:
33% normal cardiac output
- Pregnant mother:
10% normal cardiac output

Management of Maternal Cardiac Arrest

Management of Maternal Cardiac Arrest

Begin CPR immediately

Manually displace uterus



A



B



Lavonas EJ et al. Part 10: Special Circumstances of Resuscitation - 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* 2015;132(18 Suppl 2):S501-8.

Management of Maternal Cardiac Arrest



Defibrillate as usual

Class I, LOE C

Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION




Part 10: Special Circumstances of Resuscitation
2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Eric J. Lavonas, Chair; Ian R. Drennan; Andrea Gabrielli; Alan C. Heffner;
Christopher O. Hoyte; Aaron M. Orkin; Kelly N. Sawyer; Michael W. Donnino

Priorities for the pregnant woman in cardiac arrest (AHA 2015 Guidelines)

High-quality CPR
Relief of aortocaval compression
(Class I, LOE C-LD)

Manual left lateral uterine displacement (LUD) can be beneficial in relieving aortocaval compression during chest compressions
(Class IIa, LOE C-LD)



Priorities for the pregnant woman in cardiac arrest (AHA 2015 Guidelines)

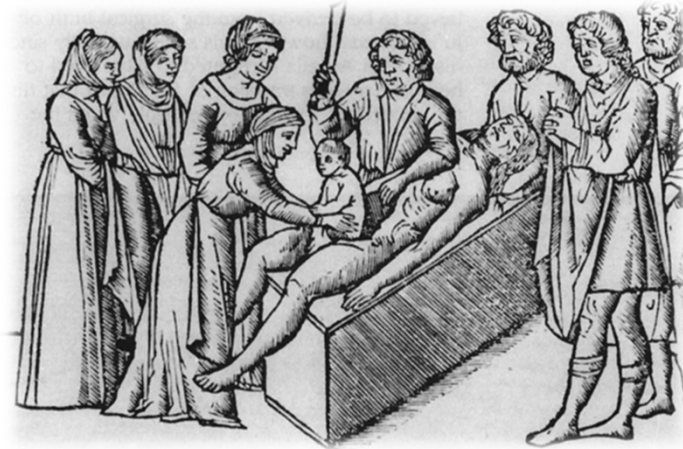
Because immediate ROSC cannot always be achieved, local resources for a PMCD should be summoned as soon as cardiac arrest is recognized in a woman in the second half of pregnancy.

(Class I, LOE C-LD)

PMCD should be considered at 4 minutes after onset of maternal cardiac arrest or resuscitative efforts (for the unwitnessed arrest) if there is no ROSC.

(Class IIa, LOE C-EO)





Perimortem Cesarean Section

Perimortem cesarean section

Christian Martin-Gill

Introduction

While the origin of the perimortem cesarean section is debated, the procedure is reported to have been performed in all cultures dating back to ancient times [1]. The term "cesarean section" is said to come from the performance of the postmortem section, dating back to 715 BC when Roman king Numa Pompilius decreed that no child should be buried within its mother [1,2]. This was first known as *Lex Regis* (the law of the king) and later translated into *Lex Cesare* (the law of Caesar), leading to the term cesarean section. This procedure was described widely through the Middle Ages to aid with baptism, and multiple royal and religious decrees reinforced the performance of postmortem sections. While initially performed to aid in burial, the procedure was later performed in an attempt to save the infant and mother [3]. Literature from the 1800s demonstrates a debate over the pros and cons of the procedure, and medical reports of infants surviving surface at that time [2]. Because of the high frequency of maternal mortality, as well as high rates of sepsis, dehydration, and hemorrhagic shock as the causes of maternal death, infants often died before the mother and survival following postmortem sections remained low for centuries [2,4].

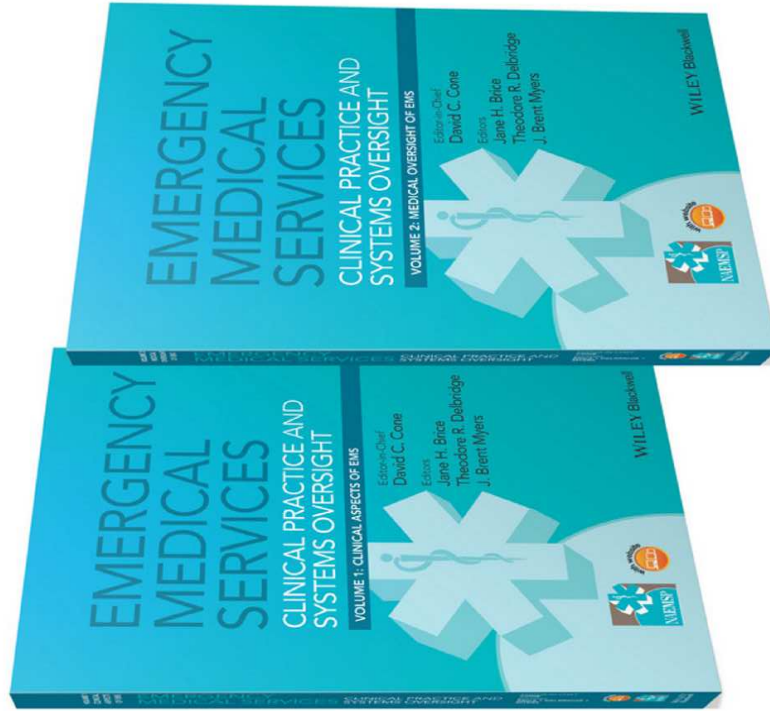
Over time, the leading causes of maternal mortality in pregnancy have changed to trauma, cardiac disease, and embolism [4–6]. In these cases, the mother and infant are generally in good health until an insult results in maternal cardiac arrest. Thus, performance of a postmortem c-section could be more likely to result in birth of a live infant than described historically. The term perimortem cesarean section (PMCS) began to be used widely following a landmark literature review of postmortem cesarean section cases by Katz et al. [5]. Of 269 cases reported from 1879 to 1985, 188 infants (70%) survived, a higher infant survival rate than previously considered. The majority of surviving infants (with timing records) were delivered within 5 minutes from death of the mother. All but one neurologically intact infant was delivered within 15 minutes. Katz et al. recommended performance of PMCS within 4 minutes of maternal

arrest, with delivery by 5 minutes, in any case with fetal viability. This became known as the "4-minute rule" and remains widely referenced today [7]. A follow-up review of 38 cases between 1985 and 2004 supported this recommendation [4].

Potential benefits of perimortem cesarean section

The reasons for performing PMCS have changed over time. While first primarily performed for burial and religious reasons and later to attempt survival of the fetus who would otherwise meet certain death, cases of maternal survival after PMCS reveal the additional potential benefit of the procedure as part of maternal resuscitation. In a pregnant woman at term, the great vessels are compressed by the uterus, which leads to a reduction in cardiac output by two-thirds [1,2,4,7–9]. Considering that cardiopulmonary resuscitation (CPR) already produces a cardiac output that is only one-third of normal, chest compressions in a supine pregnant mother under the best circumstances produce a cardiac output that is 10% of normal. Emptying the uterus through PMCS alleviates compression of the inferior vena cava, improves venous return, and allows redistribution of uterine blood to other organs, which under normal conditions at term contributes up to 25% of cardiac output. Emptying the uterus also increases the functional residual capacity of the mother's lungs, allowing for better oxygenation [1,10]. In combination, this may improve the effectiveness of CPR and lead to successful resuscitation of the mother after delivery of the infant.

In the landmark review by Katz et al., 12 cases were identified where there was sudden and often profound improvement in the mother's condition once the uterus was emptied [5]. There have been multiple additional reports of maternal survival after PMCS, including 13 of 38 mothers discharged in good condition in Katz et al.'s follow-up review of PMCS cases [4]. Dijkman et al. reviewed all cases of maternal cardiac



Cesarean Section

Term based on the postmortem section

In human culture since ancient times

- Greek mythology
- Hindu, Egyptian, Roman and other European folklore
- Ancient Chinese etchings depict the procedure on apparently living women

715 BC – Roman king Numus Pompilius decreed:

No child should be buried within its mother

Later translated into the law of Caesar, leading to term cesarean section



Maternal Causes of Death

PRE-MODERN TIMES

Sepsis

Dehydration

Hemorrhagic shock

MODERN TIMES

Trauma

Cardiac disease

Embolism

PERIMORTEM CESAREAN DELIVERY

Vern L. Katz, MD, Deborah J. Dotters, MD, and William Droegemueller, MD

Postmortem cesarean delivery is an operation that has been practiced since antiquity. In previous centuries low infant survival rates led to negative opinions regarding the operation's usefulness. A review of the past centuries' cases and a review of fetal physiology suggest that to obtain optimum infant survival, cesarean delivery should be initiated within four minutes of maternal cardiac arrest. The physiology of cardiopulmonary resuscitation during pregnancy is analyzed, and recent cases of maternal cardiac arrest with successful maternal resuscitation are reviewed. This data suggests that perimortem cesarean delivery initiated within four minutes of maternal cardiac arrest will yield the highest rates of maternal survival. Legal liability from the operation is minimal. (*Obstet Gynecol* 68:571, 1986)

In the last 50 years, maternal death has become rare. The causes of maternal mortality are now dramatically different than the causes of maternal mortality in previous centuries. Because of the shift in the causes of maternal mortality and advances in neonatology, the

From the Department of Obstetrics-Gynecology, North Carolina Memorial Hospital, Chapel Hill, North Carolina.

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- Literature review of PMCS cases
 - 1879 to 1985
 - N=269; 188 infants (70%) survived
 - Coined term: *Perimortem Cesarean Section*
- Most surviving infants delivered ≤ 5 min from maternal death
 - All but one neurologically intact infant delivered within 15 min
- Recommended performance of PMCS within 4 min of maternal arrest, with delivery by 5 min, in any case of fetal viability

“4-Minute Rule”

Potential Benefits of PMCS

Emptying the uterus

↓ Compression of inferior vena cava

↑ Venous return

Uterine blood flow redistributed to other organs → ↑ 25% cardiac output

↑ Functional residual capacity → ↑ oxygenation

Together, improves effectiveness of CPR and may lead to successful resuscitation of mother after delivery of the infant

PERIMORTEM CESAREAN DELIVERY

*Vern L. Katz, MD, Deborah J. Dotters, MD, and
William Droegemueller, MD*

12 cases of sudden improvement in mother's condition when uterus emptied

Perimortem cesarean delivery: Were our assumptions correct?

Vern Katz, MD,^{a,*} Keith Balderston, MD,^a Melissa DeFreest, MD^b

13 of 38 mothers discharged in good condition

Cardiac arrest in pregnancy: increasing use of perimortem caesarean section due to emergency skills training?

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Review of all maternal cardiac arrests in Netherlands, 1993-2008

8 of 12 mothers regained cardiac output after PMCS

- Only 2 survived
- None performed within 5 minutes – timing may have contributed



Contents lists available at SciVerse ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation



Review article

Maternal cardiac arrest and perimortem caesarean delivery: Evidence or expert-based? ☆, ☆☆

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Review of 94 cases of PMCS

PMCS beneficial to mother in 32% of cases

No demonstrated harm in any case

PMCS in the Field

CASE CONFERENCE

OUT-OF-HOSPITAL PERIMORTEM CESAREAN SECTION

Douglas F. Kupas, MD, Scott C. Harter, MD, Arno Vosk, MD

CASE PRESENTATION

A 39-year-old female, gravida 6, para 4, with an estimated gestational age of 39 weeks, called her county 911 dispatch center with complaints of weakness and dizziness. Her past medical history was remarkable for an admission to a community hospital with hypertension at 37 weeks estimated gestational age (EGA), and she was discharged on nifedipine. The patient resided in a rural area that was more than 20 minutes from a small community hospital, which was the base for an advanced life support (ALS) ambulance.

The initial emergency medical services (EMS) response included a volunteer fire department first responder (FR) unit and an ALS ambulance. An emergency physician neighbor was notified of the incident by another neighbor. The first volunteers arrived in their own ve-

hicles approximately 10 minutes after the patient called 911. They found the patient in cardiac arrest and initiated cardiopulmonary resuscitation (CPR). The FR unit arrived 13 minutes after the 911 call, and the physician neighbor arrived shortly thereafter (Table 1).

Prior to arriving on scene, the ALS provider requested a medical helicopter from the regional tertiary care center. Upon ALS arrival, the patient had an initial rhythm of ventricular fibrillation. This did not respond to defibrillation and Advanced Cardiac Life Support (ACLS) care. In anticipation of a possible perimortem cesarean section (PMCS), a second helicopter with a neonatal transport isolette was dispatched from a satellite base.

The first medical helicopter was staffed with a senior emergency medicine resident, a flight nurse experienced in neonatal transport, and a flight paramedic. When the flight crew arrived, the mother had received more than 30 minutes of CPR and 22 minutes of ACLS. The physician neighbor and the flight physician performed a rapid PMCS via a midline longitudinal incision. Resuscitation attempts were discontinued on the mother.

The male infant had no pulse, no respiratory effort, and central cyanosis when delivered. The infant was resuscitated with oxygen, endotracheal intubation, and a short period of chest compressions. Before transport, the infant had a

pulse of 130 beats/min and some respiratory efforts, and was centrally pink. The 10-minute Apgar score was 4. The infant was transported directly to the neonatal intensive care unit (NICU) of the tertiary care center.

The NICU course was prolonged, and unfortunately at one year the infant is severely neurologically handicapped and most likely has cortical blindness and deafness. The providers received critical incident stress debriefing. The maternal autopsy revealed myocardial infarction as the cause of death.

DISCUSSION

The cesarian section, or surgical removal of a fetus from the uterus, was first reported circa 700 BC. The name results from a decree by Roman emperors that all pregnant women who died must have the fetus removed prior to burial. In 239 BC, Scipio Africanus was reportedly the first survivor of a post-mortem cesarean section. In 1588, a sheep gelder named Jacob Nufer delivered his son by cesarean section, and this is noteworthy because his wife also survived the procedure.¹⁻³

The largest review of PMCS, by Katz et al. revealed fewer than 300 reported attempts, with fewer than 200 survivors from 1879 to 1985,⁴ but it is clear that there is underreporting of attempts without infant survival. Success rates range from none in the late 1800s to 15% in a

39 yo female, 39 wks, myocardial infarct
EM resident as Flight Physician
Assisted by a physician neighbor
Infant survived to 1 year
Mother did not survive



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Presented at the NAEMSP and Janssen Research Foundation First National Prehospital Fascinomas Case Competition, National Association of EMS Physicians annual meeting, Naples, Florida, January 1997.

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Field Perimortem Cesarean Section

Field perimortem cesarean section is a rare and controversial procedure. This article presents a case involving this procedure, a review of current literature, and a discussion of legal considerations.

Case Study

At 2015 hours, local police and fire were dispatched to a home improvement store where a full size sport utility vehicle, traveling at a high rate of speed, had penetrated a brick side wall. After entering the building, the vehicle came to rest under approximately 18,000 pounds of cinder block and curbstone stacked on shelves inside the store. The driver was thought to be the lone occupant of the vehicle. No one inside the store had been injured.

Visualization of the driver initially was impossible because of the large amount of debris. Eventually, on-scene personnel determined the driver was a 31-year-old woman in her last trimester of pregnancy (37 weeks gestation). The woman, restrained in a seatbelt, was feared to be the subject of a missing person report filed earlier that evening—a man had reported his pregnant wife missing and was concerned for her safety because of recent emotional difficulties. After the vehicle stopped inside the store, employees reported hearing the driver cry for help. Extrication attempts continued throughout debris removal. Because of lack of access, medical evaluation was not possible during the initial extrication.

The University of Michigan Medical Center's Survival Flight helicopter (staffed by a senior emergency medicine resident and a registered nurse/paramedic) was activated at 2030 hours to the scene with an initial report of a motor vehicle crash into an occupied building. When the flight crew arrived at 2043, the debris was being removed both manually and with heavy equipment.

At 2110 hours, enough debris was removed from the vehicle to allow minimal access to the patient. Initial assessment revealed a warm, pulseless woman with an obviously gravid abdomen. Ventilation with a bag valve mask was not possible because of patient position and ongoing debris removal.

At 2115 hours, the patient was extricated and placed on a long board. Primary survey revealed an apneic, pulseless woman with an obvious flail chest. Cardiopulmonary resuscitation (CPR) was begun, and the patient was endotracheally intubated. After intubation, venous access was obtained with a 14-gauge angiocath in the left femoral vein. Bilateral needle thoracostomies were performed, followed by bilateral tube thoracostomy. During CPR the patient's uterus was manually displaced to the left.

None of these interventions restored circulation. The decision to perform a cesarean section was made after phone consultation with the attending emergency physician at University of Michigan Medical Center.

A transverse low abdominal incision was performed by the resident, followed by a midline abdominal incision from the xiphoid process to the level of the pubis. The resident encountered a large amount of free blood on entering the peritoneal cavity. The uterus was entered by a midline incision, and the infant was removed from the mother. After delivery, no vital signs were detected on the mother, and she was pronounced dead at 2126 hours.

Primary survey of the infant revealed a mottled, pulseless, apneic female with an estimated weight of 2500-3000 grams. CPR was begun, and the infant was endotracheally intubated. The infant was rapidly dried and secured for flight. Prewarmed intravenous bags were placed directly on the infant to aid in warming during transport. Appgar scores were 0 at 1 minute and 0 at 5 minutes.

En route to the hospital, the infant was given 0.6mL of 1:10,000 epinephrine solution through the endotracheal tube. An intraosseous needle was placed in her right tibia and 10 mL of 0.9% normal saline was administered before arrival at the hospital. At 2152 the helicopter arrived at the medical center; the infant was taken directly to the neonatal intensive care unit. Resuscitation continued for an additional 18 minutes after arrival at the neonatal unit. Initial laboratory results were remarkable for a hematocrit of 4.0 gm/dL and a venous pH of 6.10. The infant remained asystolic throughout the resuscitation and was pronounced dead approximately 20 minutes after arrival.

A postaccident investigation determined the vehicle crash to be intentional.

Discussion

Perimortem cesarean section has been practiced since antiquity. Katz et al.¹ reviewed the 61 cases of infant survival after perimortem cesarean section from 1900 to 1985. Their review suggests that infant survival is closely related to time of delivery after maternal arrest. The only infants in the review with favorable neurologic outcomes were delivered within 15 minutes of maternal cardiac arrest, with the majority of survivors delivered in less than 5 minutes.²

Anecdotal case studies report delivery of surviving, neurologically intact infants with maternal cardiac arrest times of 22 and 25 minutes.^{1,3} Other favorable indicators of infant survival include gestational age greater than 36 weeks and weight greater than 2500 grams.⁴

In-hospital perimortem cesarean sections occasionally are performed as a drastic measure to save the mother.⁵ The terminology for perimortem cesarean section (as opposed to postmortem) is derived from the fact that some women have been successfully resuscitated after delivery of the infant. This ability for maternal resuscitation is presumed to be related to removal of compression of the inferior vena cava. In the prehospital set-

31 yo female, 37 weeks gestation

Motor vehicle collision into a building

EM Resident as Flight Physician

Neither mother nor infant survived



Perimortem Cesarean Section in the Helicopter EMS Setting: A Case Report

Ricky Kue, MD, Cheryl Coyle, BSN, CCRN, CEN, CFRN, EMT-B, Eric Vaughan, MD, and Marc Restuccia, MD, FACEP

Introduction

Perimortem cesarean section in the out-of-hospital setting is a rare and emotionally taxing occurrence. As a leading cause of maternal death, trauma occurs in 5% of all pregnancies, over half of which are attributable to motor vehicle crashes.^{1,2} The decision to perform perimortem cesarean section by emergency care providers can be difficult, especially in the limited out-of-hospital environment, given the time constraints, personnel training, comfort level, and available resources. This technique has only been reported twice in the medical literature, with relatively poor outcomes.^{3,4} We report a case of perimortem cesarean section performed in the emergency department by a helicopter emergency medical services (EMS) crew on a motor vehicle crash victim after maternal assessment by emergency abdominal ultrasonography.

Case Report

Paramedics responding to a motor vehicle crash arrived to find a 21-year-old female driver, 36-weeks pregnant, in cardiac arrest. Cardiopulmonary resuscitation (CPR) was initiated, and the patient was transported to a local emergency department (ED). LifeFlight was dispatched to intercept for transport to a level 1 trauma center. On LifeFlight arrival at the ED, the patient was asystolic despite receiving 3 mg epinephrine and 3 mg atropine sulfate intravenously. Estimated time from EMS scene arrival to LifeFlight contact was 25 minutes. The patient had massive head trauma with an open skull fracture, and fixed and dilated pupils. No fetal heart tones were present. A focused abdominal sonography for trauma (FAST) performed by the flight physician on the mother showed no cardiac activity. Fetal cardiac activity, however, was evident, and a perimortem cesarean

section was performed. A midline vertical incision was made after sterile preparation and a male infant was delivered. A nuchal cord was immediately relieved by cord clamping and cutting. The infant was warmed, dried, and suctioned but did not have spontaneous respiratory efforts or palpable pulses. CPR was initiated immediately. The infant was intubated and received a total of 0.3 mg epinephrine via endotracheal tube. After failed umbilical vein catheterization, intraosseous access was obtained, and 0.1 mg epinephrine, 0.3 mg sodium bicarbonate, and saline bolus were administered without effect. Blood glucose was 400 mg/dL. Cardiac ultrasonography of the infant showed no activity. APGAR scores were 0 at 1 and 5 minutes. Despite resuscitative efforts, the infant was pronounced dead 41 minutes after delivery (56 minutes after LifeFlight arrival). Despite additional epinephrine and atropine after delivery, CPR, and dopamine drip, the mother showed no clinical improvement and was pronounced dead 33 minutes after LifeFlight arrival.

Discussion

According to Greek mythology, the physician Asklepios was delivered by his father Apollo from the womb of the dead Koronis. The first documented case of perimortem cesarean section, however, occurred in 237 bc in relation to the birth of Scipio Africanus, the Roman general who defeated Hannibal.³ Current medical literature reports multiple cases of perimortem cesarean sections⁵⁻⁸; however, only two have been reported in an out-of-hospital setting.^{3,4} Both cases occurred in the setting of a helicopter EMS service whose flight crews were configured with an emergency medicine physician (typically a senior resident). Although this case did not occur in an out-of-hospital setting, it represents only the third case of perimortem cesarean section performed by a helicopter EMS crew reported in the literature, with the most recent reported in this journal in 2001.³

Greatest likelihood of infant survival seems to occur if delivery can be performed within 4 minutes of maternal death. This recommendation was the result of an exhaustive literature review, a case report and experimental data review published by Katz et al⁹ in 1986. In this review, 93% of surviving neonates (57 of 61) were born within 15 minutes of maternal death, and only two had neurologic deficits. Seventy percent of the survivors were delivered within 5 minutes. A 2005 review, again by Katz et al,¹⁰ included literature from 1985 through 2004. Findings supported the recommen-

21 yo female, ? wk, motor vehicle collision

Flight Physician

Ultrasound:

- No maternal / positive fetal cardiac activity

CPR ongoing for 25 min

Neither mother nor infant survived



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PMCS in the field by non-MD providers?

Outside nursing & paramedic
scope of practice

Consider state & local regulations

Develop a policy and procedure

Even if MD on the scene, consider:

- Experience & training
- Transport distance to hospital

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2 Paramedics Face Inquiry Over Surgery In Emergency

By DAVID W. CHEN
Published: September 27, 1997

New Jersey health officials are investigating the actions of two paramedics who performed an emergency Caesarean section on Thursday to deliver the baby of a woman in North Bergen who was in cardiac arrest and could not be revived.

The paramedics acted while consulting by radio with emergency room doctors at Jersey City Medical Center, officials said, but state health regulations forbid paramedics to perform surgical operations. The emergency workers said they believed that the procedure was their only hope of saving the baby.

Indications for PMCS

Postmortem and Perimortem Cesarean Section:
Historical, Religious, and Ethical Considerations

Article DOI: <http://dx.doi.org/10.5915/43-3-7099>
Video DOI: <http://dx.doi.org/10.5915/43-3-7099V>

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Augusta, Georgia

When to Perform PMCS?

Widely supported **within 4 to 5 minutes** of maternal arrest beyond **20-24 weeks**



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SEMINARS IN
PERINATOLOGY

Perimortem Cesarean Delivery: Its Role in Maternal Mortality

Vern L. Katz, MD^{*,†,‡}

Since Roman times, physicians have been instructed to perform postmortem cesarean deliveries to aid in funeral rites, baptism, and in the very slim chance that a live fetus might still be within the deceased mother's womb. This procedure was disliked by physicians being called to a dying mother's bedside. As births moved to hospitals, and modern obstetrics evolved, the causes of maternal death changed from sepsis, hemorrhage, and dehydration to a greater incidence of sudden cardiac arrest from medication errors or embolism. Thus, the likelihood of delivering a viable neonate at the time of a mother's death increased. Additionally, as cardiopulmonary resuscitation (CPR) became widespread, physicians realized that during pregnancy, with the term gravid woman lying on her back, chest compressions cannot deliver sufficient cardiac output to accomplish resuscitation. Paradoxically, after a postmortem cesarean delivery is performed, effective CPR was seen to occur. Mothers were revived. Thus, the procedure was renamed the perimortem cesarean. Because brain damage begins at 5 minutes of anoxia, the procedure should be initiated at 4 minutes (the 4-minute rule) to deliver the healthiest fetus. If a mother has a resuscitatable cause of death, then her life may be saved as well by a prompt and timely cesarean delivery during CPR. Sadly, too often, we are paralyzed by the horror of the maternal cardiac arrest, and instinctively, we try CPR for too long before turning to the perimortem delivery. The quick procedure though may actually improve the situation for the mother, and certainly will save the child.

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KEYWORDS perimortem cesarean, maternal mortality

Cardiac arrest in pregnancy and perimortem cesarean delivery: case report and discussion

Paul T. Engels, MD^{*,†,‡}; Sheila C. Caddy, MD[§]; Gulnaz Jiwa, MD[§]; J. Douglas Matheson, MD^{††}

Perimortem Cesarean Section, *Lanoix et al.*

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Perimortem Cesarean Section: Case Reports and Recommendations

Richard Lanoix, MD, Vijay Akkapeddi, MD, Bruce Goldfeder, MD

ABSTRACT

Perimortem cesarean section is rarely required in the ED. However, since trauma now represents a leading cause of nonobstetric maternal death, emergency physicians (EPs) may more commonly be faced with the difficult decision of performing an emergency cesarean section. Two cases are described of severely traumatized pregnant patients for whom perimortem cesarean section in the ED led to birth of viable infants, with one long-term survivor. The rationale and guidelines for the procedure are discussed, and it is emphasized that the EP should be thoroughly familiar with the procedure and prepared to perform it when indicated to enhance fetal (and potentially maternal) survival.

Key words: perimortem cesarean section; emergency department; trauma; pregnancy.

Acad. Emerg. Med. 1995; 2:1063-1067.

Part 10: Special Circumstances of Resuscitation

2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Eric J. Lavonas, Chair; Ian R. Drennan; Andrea Gabrielli; Alan C. Heffner; Christopher O. Hoyte; Aaron M. Orkin; Kelly N. Sawyer; Michael W. Donnino

What do the guidelines say?

During cardiac arrest, if the pregnant woman with a fundus height at or above the umbilicus has not achieved ROSC with usual resuscitation measures plus manual LUD, it is advisable to prepare to evacuate the uterus while resuscitation continues (Class I, LOE C-LD). In situations such as nonsurvivable maternal trauma or prolonged pulselessness, in which maternal resuscitative efforts are obviously futile, there is no reason to delay performing PMCD (Class I, LOE C-LD). **PMCD should be considered at 4 minutes after onset of maternal cardiac arrest or resuscitative efforts (for the unwitnessed arrest) if there is no ROSC (Class IIa, LOE C-EO).** The clinical decision to perform a PMCD—and its timing with respect to maternal cardiac arrest—is complex because of the variability in level of practitioner and team training, patient factors (eg, etiology of arrest, gestational age), and system resources.

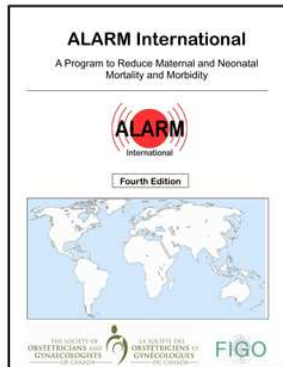
Determine fetal viability first?



Issues:

- Delay to time-dependent PMCS (potential benefit to baby *and* mother)
- Cases of good fetal neurological outcome in spite of no fetal heart tones
- Ultrasound / doppler difficult to perform with CPR
- Fetus may have periods of bradycardia

Education in PMCS



Advances in Labour and Risk Management (ALARM)



Cardiac arrest in pregnancy: increasing use of perimortem caesarean section due to emergency skills training?

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MOET course in Netherlands

→ Increase from 0.36 to 1.6 PMCS per year

Performing Perimortem Cesarean Section

....1,2,3,4 *steps*

Step 1 – Skin incision to peritoneum

Horizontal incision

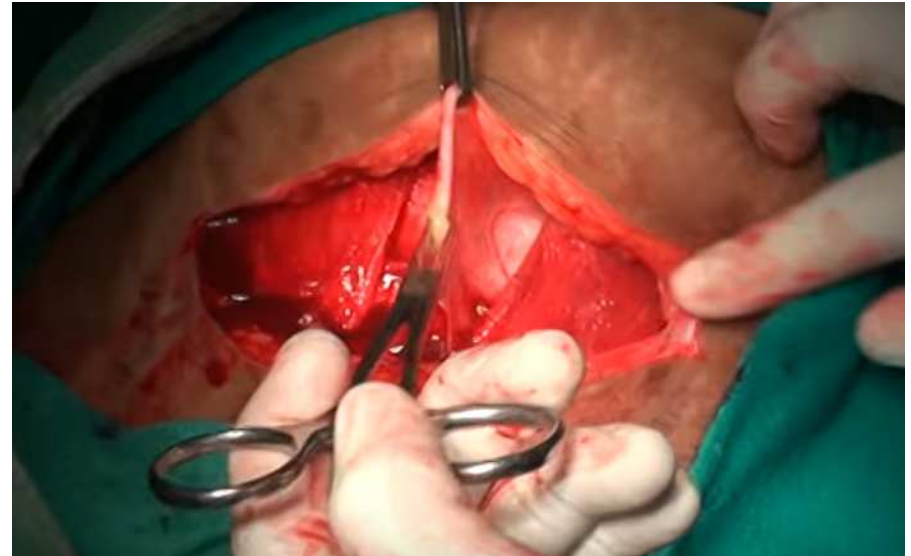
Vertical incision



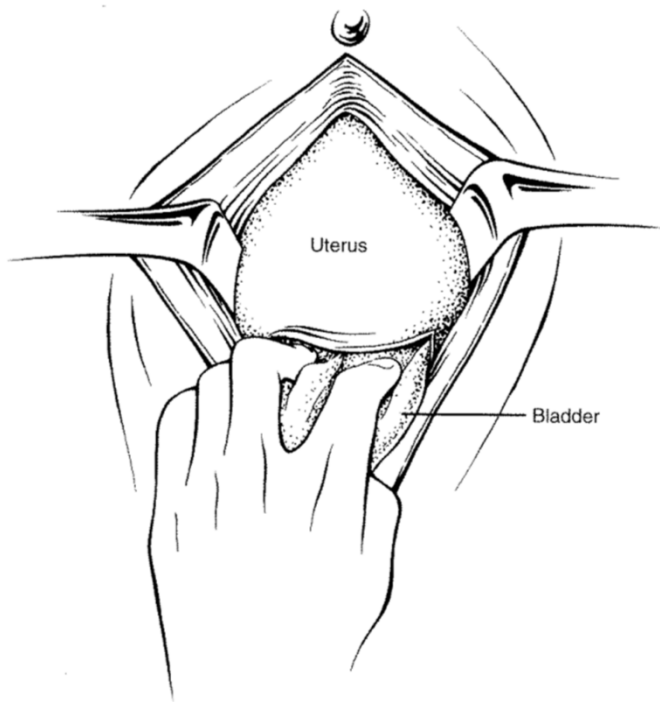
Suggested:



Vertical incision

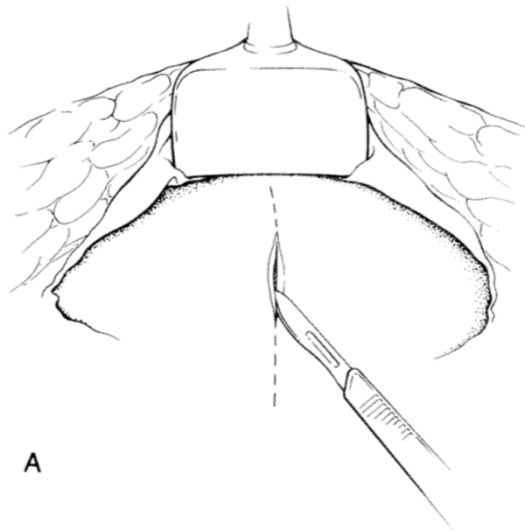


Step 2 – Displace the Bladder



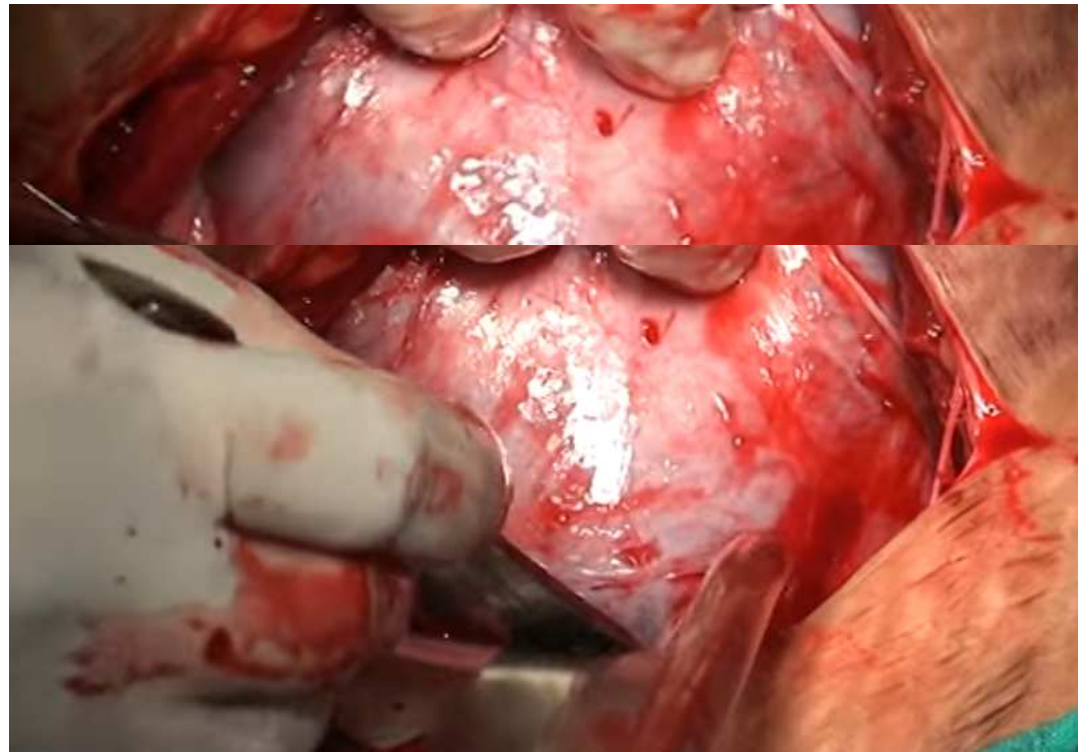
Retract the abdominal wall and
displace the bladder

Step 3 – Incise the Uterus

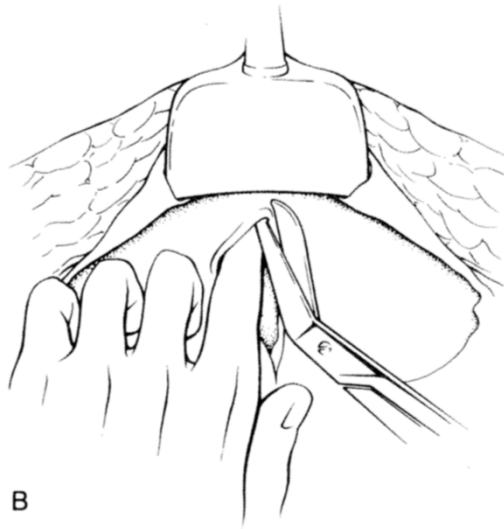


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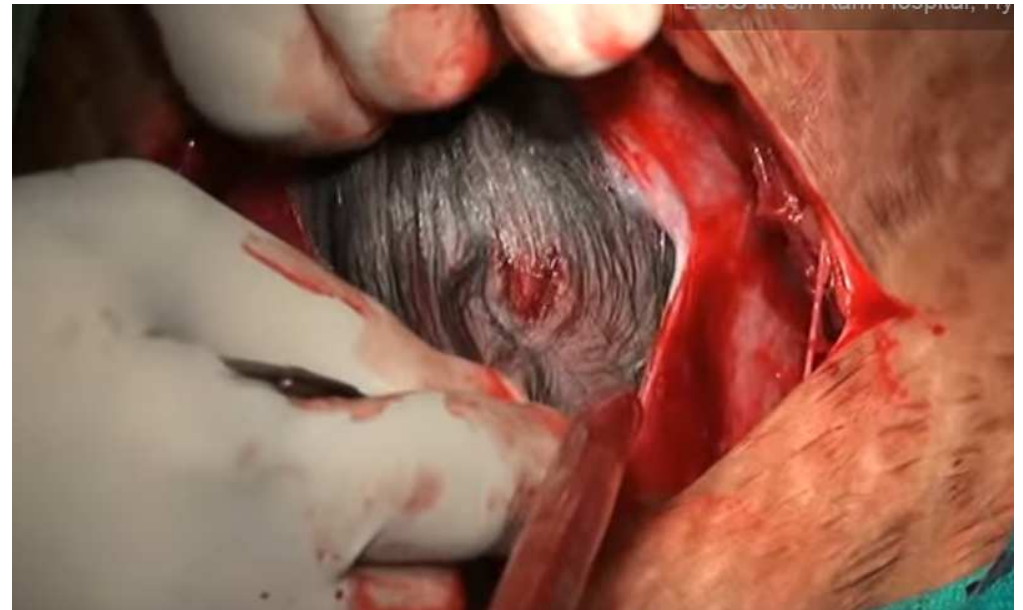
Small vertical incision into
the lower uterine segment



Step 3 – Incise the Uterus

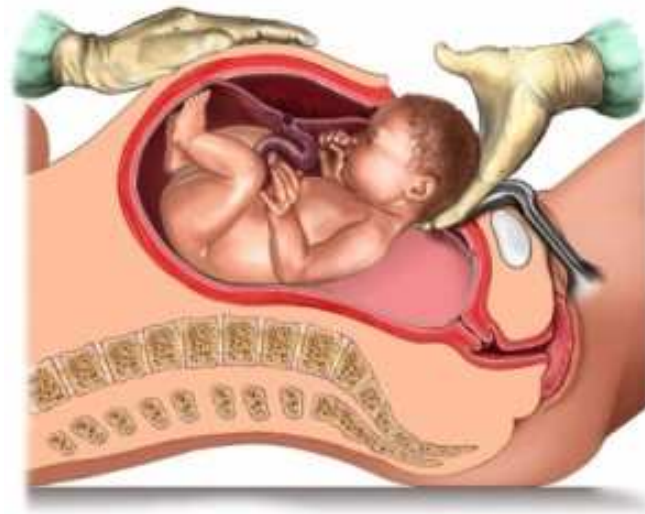
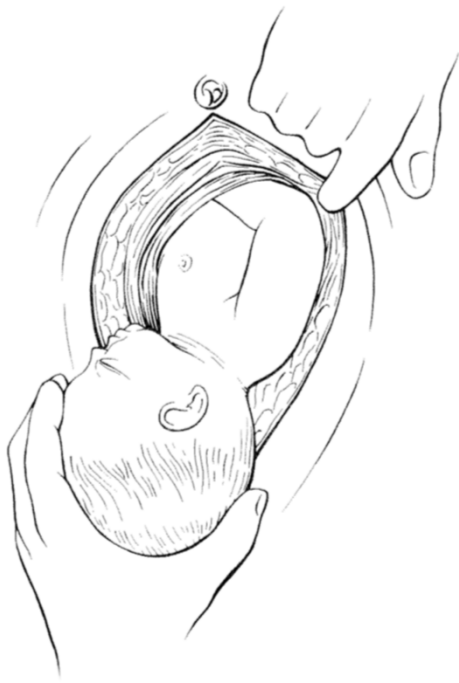


Use bandage scissors to extend the incision toward the fundus while shielding the fetus with your hand



Step 4 – Deliver the Infant

Deliver the infant from a vertex position



The baby is out!

Suction mouth and nose with bulb syringe

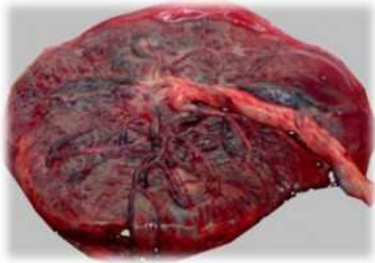
Clamp cord x 2

Assess, clean, and warm infant



What now? *(Depending on resources and ROSC)*

Consider removing placenta



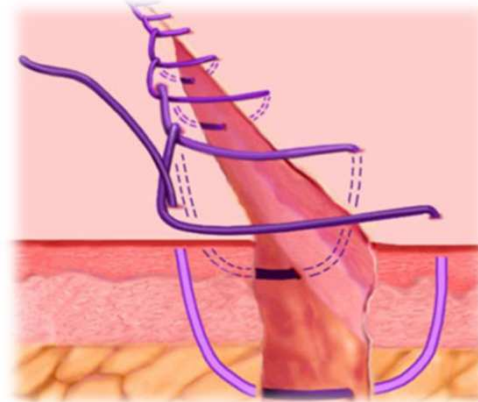
Consider direct pressure on aorta



Pack or suture closed the uterus

No. 0 or N. 1 delayed-absorbable sutures

Locking one-layer closure



Ethical & Legal Considerations

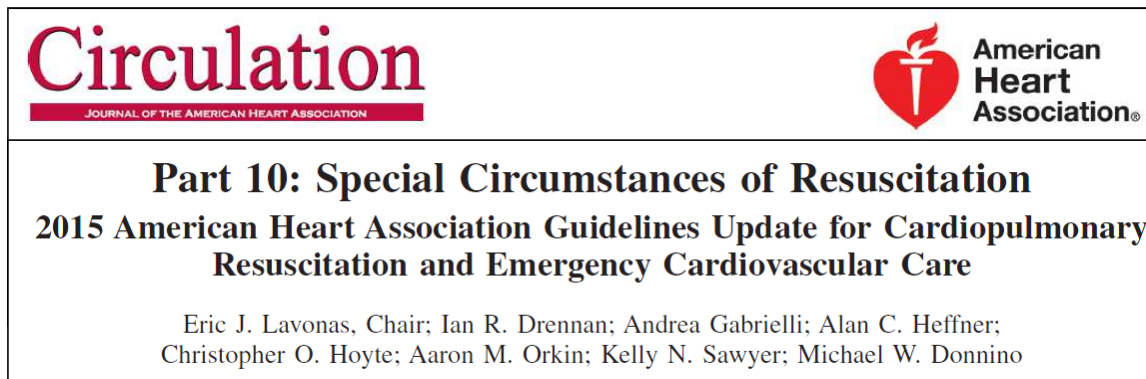


Since PMCS was described in 1986, no physician in the United States has been held liable for performing PMCS

At least two cases identified where lawsuit against physicians and hospital staff for failure to perform a PMCS

A review of all case reports of PMCS over 25 years identified no reported cases where an infant surviving beyond the early neonatal period had significant neurological disability

Peer-reviewed resuscitation guidelines may be the simplest recourse for EM physicians in deciding to perform a PMCS



In situations of nonsurvivable maternal trauma or prolonged pulselessness, there is *no reason to delay performing PMCS* (Class I, LOE C)

Perform PMCS within 4 min of maternal cardiac arrest if no ROSC

- May be considered sooner in cases of obvious nonsurvivable injury (Class IIa, LOE C)

Summary

1. Think of maternal physiology
→ Position mother for optimal CPR
2. Perform standard interventions for ACLS
→ Compression, defibrillation, medications
3. Prompt perimortem cesarean section may save baby AND mother
→ Consider rapid transport if initial resuscitation is unsuccessful