

Simulation Patient Design (May, 2020) Maternal Cardiac Arrest and Perimortem Cesarean Delivery

Authors: Sapna Ravindranath, MD, Kokila Thenuwara, MD, University of Iowa

Editors: Sonal Zambare, MD, Gillian Abir, MBChB

Introduction

Maternal cardiac arrest (MCA) is a rare event occurring in approximately 1:12,000 women hospitalized for delivery.¹ If MCA occurs, maternal and fetal lives are at great risk. Advanced cardiac life support (ACLS) training is mandatory for the majority of clinical care providers, but it has been shown that those who treat pregnant women possess limited knowledge of the specific recommendations for MCA.² Anesthesiology teams are aware of handling crisis situations in the operating room (OR), however managing a cardiac arrest outside of the OR creates additional unique challenges which include: patient positioning, availability of necessary airway equipment and medications at the arrest location.

Communication and coordination among multiple care teams (nursing, obstetric, neonatal, anesthesiology and the adult code team) has a major impact on maternal and neonatal outcomes following MCA.

Table 1. Potential contributing factors to maternal cardiac arrest³

A	Anesthetic complications (high neuraxial block, loss of airway, aspiration, respiratory depression, hypotension, local anesthetic systemic toxicity)
B	Bleeding (coagulopathy, uterine atony, placenta accreta, placental abruption, placenta previa, uterine rupture, trauma, surgical, transfusion reaction)
C	Cardiovascular disease (cardiomyopathy, myocardial infarction, aortic dissection, arrhythmias)
D	Drugs (Anaphylaxis; illicit; drug error; magnesium, opioid, insulin, or oxytocin overdose)
E	Embolic (pulmonary embolus, amniotic [AFE], air)
F	Fever (infection, sepsis)
G	General non-obstetric causes of cardiac arrest (Hs and Ts)
H	Hypertension (preeclampsia/eclampsia/HELLP, intracranial bleed)

AFE = amniotic fluid embolism; HELLP = hemolysis, elevated liver enzymes, low platelets

Most likely causes: Cardiac, hemorrhage and AFE (suspect AFE with any sudden MCA, particularly when accompanied by bleeding)

Hs and Ts = Hypoxia, hypovolemia, hyper/hypokalemia, hypo/hyperthermia, hydrogen ion (acidosis), hypoglycemia, tension pneumothorax, tamponade, toxins, thromboembolism, thrombosis (myocardial infarction), trauma

Cardiopulmonary resuscitation guidelines

The majority of the steps involved with cardiopulmonary resuscitation (CPR) for pregnant patients are the same as for non-pregnant adults, however they include pregnancy-specific additions⁴:

- Chest compressions over the lower half of the sternum at a rate of at least 100 per minute, with a depth of at least 2 inch (5 cm)
- Compression-ventilation ratio of 30:2 (if the patient's trachea is intubated, chest compressions should be performed continuously)
- Continuous manual left uterine displacement (LUD) with two hands displacing the uterus to the left and upwards (if the uterus is palpated at the level of, or above the level of umbilicus)
- Defibrillation should be considered for shockable rhythms (it is recommended to remove external/internal fetal monitors prior to delivery of a shock)
- Resuscitation drugs should be administered as per AHA guidelines, however vasopressin (due to its effects on the uterus), is no longer recommended as an alternative to epinephrine during CPR in the obstetric patient.⁴
If local anesthetic-induced cardiac arrest is suspected, lipid emulsion should be administered early on

Perimortem cesarean delivery (PMCD):

- A pregnant patient with in-hospital cardiac arrest should not be transported to an operating room for cesarean delivery, resuscitation should occur at the site of the arrest⁵
- The team should not wait for surgical equipment to begin the procedure; only a scalpel is required
- Decision regarding optimal timing of a PMCD for both the infant and mother should be based on multiple factors such as the etiology of the arrest, maternal pathology, maternal cardiac function, fetal gestational age (the fundal height should be at or above the level of the umbilicus), and available resources⁴
- Delivery should be performed as soon as possible if return of spontaneous circulation (ROSC) has not occurred, aiming for skin incision by 4 minutes with delivery of the fetus by 5 minutes from the start of cardiac arrest^{3,4}

Post-resuscitation care:

- In patients who are refractory to post-resuscitation interventions, despite delivery, mechanical circulatory support with extracorporeal membrane oxygenation or cardiac bypass can be considered⁴
- Therapeutic hypothermia has been recommended for non-pregnant comatose adult patients with ROSC after out-of-hospital ventricular fibrillation cardiac arrest, and despite lack of data in the obstetric population this should be considered in obstetric and postpartum patients³

Educational Rationale: Teach team skills in early recognition and management of MCA, including PMCD

Target Audience: Anesthesiology, obstetric, neonatology and labor and delivery (L+D) nursing

Learning Objectives: As per Accreditation Council for Graduate Medical Education (ACGME) Core Competencies

Upon completion of this simulation (including debrief) learners will be able to:

- Medical knowledge: Recognize clinical symptoms/signs of MCA
- Patient care: Describe key actions in managing MCA and the physiological basis for these actions
- Practice-based learning and improvement: Identify the required equipment/medications necessary to manage MCA and PMCD, and know the exact location of these items on L+D
- Interpersonal and communication skills: Designate a team leader who will effectively communicate with labor and delivery teams and maintain communication regarding the maternal resuscitation and timing of PMCD
- Professionalism: Demonstrate mutual respect for the expertise of other team members
- Systems-based practice: Identify that all resuscitation equipment, medications, and protocols are readily available (and identify any barriers, if applicable) in delivery locations including: equipment for airway management; vascular access; defibrillation; resuscitation medications and cesarean delivery kit

Questions to ask after the scenario:

- Was a leader identified?
- Did each team member have well-defined roles and use closed loop communication?
- Was the necessary resuscitation equipment readily available?
- Were there any barriers for performing a PMCD and care of the neonate?
- Was there appropriate communication with the partner/family members?
- Were any system improvement opportunities identified during this simulation?

Assessment Instruments:

- Learner Knowledge Assessment form (Appendix 1)
- Simulation Activity Evaluation form (Appendix 2)

Simulation set up and equipment needed in labor and delivery suite:

- Mannequin set up in left lateral decubitus position with fetal monitoring in place
- 18 G IV in hand with Lactated Ringer's bag (with access ports)

Simulation scenario set up:

Ms Oh Bee, 34 years old, G2P1 at 36 weeks gestation diagnosed with preeclampsia was admitted to the labor and delivery unit in active labor. Her prenatal record is significant for elevated blood pressures of 140-150/90-100 mm Hg during the last two prenatal visits. She is otherwise healthy, with no known allergies and takes labetalol 200 mg PO twice daily along with prenatal vitamins. She had an uneventful cesarean delivery under spinal anesthesia 2 years ago and now desires VBAC.

Vital signs on admission: BP 190/105 mm Hg, HR 90 bpm, SpO₂ 97% (room air)

Fetal heart rate: 140 bpm with normal variability (Cat 1)

Cervical exam: 100% effaced, 4 cm dilated

Urine dip stick: 3+ protein

Labs: Hb 10.2 g/dL, Hct 30.5%, Plts 98 x 10⁹/L, PTT 28 sec, PT 12 sec, INR 1

Blood type: B positive with negative antibody screen

Na 132 mEq/L, K 3.9 mEq/L, Cl 110 mEq/L, HCO₃ 17 mEq/L, BUN 15 mg/dL, Cr 1.1 mg/dL, glucose 140 mg/dL

She has been started on magnesium sulfate (4 g bolus followed by infusion) and is complaining of a throbbing headache. She does not have an epidural yet but is considering getting one later.

Simulation pre-brief:

- Read the scenario and instruct team members on their role during the simulation
- The learners take their places in the Labor and Delivery unit
- Patient (mannequin/actor for voice of patient)
- L+D nurse is a confederate who triggers the learners to the cardiac arrest
- Father of the baby at the bedside (actor or confederate)

Maternal Cardiac Arrest and Perimortem Cesarean Delivery Scenario:

Trigger	Patient condition	Action	Done	Time	Comments
The husband of the patient alerts the nurse that the patient is drowsy	Patient is drowsy but arousable Vital signs: BP 80/40 mm Hg HR 110 bpm SpO ₂ 89% RR 14/min	<ol style="list-style-type: none"> 1. L+D nurse at bedside 2. Assess patient 3. Call for help immediately 4. Start fluid bolus 5. Place oxygen mask 			
Patient's condition worsens	Patient with shallow gasping breaths and barely responsive Vital signs: BP 65/32 mm Hg HR 72 bpm SpO ₂ 85% RR 10/min FHR 80 bpm	<ol style="list-style-type: none"> 1. Anesthesiology and OB team members at bedside 2. Assess vital signs 3. Administer 100% oxygen 4. Assist breathing with Ambu bag 5. Call for intubation equipment 6. Administer phenylephrine 7. Reassure husband + escort him out of LDR 8. Identify differential diagnosis 9. Call for neonatologist 			
Patient becomes unconscious and unresponsive	Patient looks pale with bluish discoloration of lips Vital signs: Un-recordable Pulse not palpable FHR 40 bpm	<ol style="list-style-type: none"> 1. Check pulse 2. Call "OB Code" and start timer 3. Assign roles 4. Call for Code cart 5. Call for back board 6. Use checklist 7. Initiate ACLS 8. Manual LUD 9. Intubate with endotracheal tube (with/without cricoid pressure) 10. Monitor waveform capnography 11. Administer epinephrine 12. Call for 			

		scalpel/cesarean pack 13. Obtain 2nd large-bore IV access (above level of diaphragm) 14. Send labs (including ABG)			
Patient remains unconscious	AED/defibrillator shows ventricular fibrillation	1. Apply AED 2. Assess cardiac rhythm 3. Remove internal/external fetal monitors, if present 4. Deliver shock 5. Continue CPR 6. Rule out etiology (A-H)			
CPR continues (no ROSC)	PMCD performed with delivery of a floppy male infant	1. Start PMCD in LDR at 4 minutes from the start of MCA 2. Neonatology team arrive 3. Hand-over neonate to the neonatologist 4. Continue maternal CPR			
ROSC	Post-resuscitation care Vital signs: BP 72/38 mm Hg HR 115 bpm SpO ₂ 94% RR - intubated	1. Transfer to OR to complete surgery 2. Place arterial line 3. Repeat labs (including ABG) 4. Perform TTE 5. Transfer to ICU 6. Administration of vasopressors, inotropes and anti-arrhythmic agents (as needed)			

L+D = Labor and delivery; OB = obstetrician; LDR = Labor and delivery room; ACLS = Advanced cardiac life support; LUD = left uterine displacement; IV = intravenous; ABG = arterial blood gas; AED = automated external defibrillator; CPR = cardiopulmonary resuscitation; ROSC = return of spontaneous circulation; PMCD = perimortem cesarean delivery; OR = operating room; TTE = transthoracic echocardiogram; ICU = intensive care unit

Appendix 1

Learner Knowledge Assessment Labor and Delivery Interdisciplinary Team Simulation

Name of simulation: _____

Date: _____

OB Nursing Anesthesia Support Personnel

Each item has two components:

The “Before the Simulation” column (left side) examines your perspective at the beginning of the simulation.

The “End of Simulation” column (right side) is meant to evaluate your perspective at the completion of the simulation.

1. How would you rate your knowledge of the causes of MCA?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none					Knowledgeable		Little/none					Knowledgeable	

2. How would you rate your knowledge of the key steps and their physiological basis in managing MCA?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none					Knowledgeable		Little/none					Knowledgeable	

3. How would you rate your knowledge of timing of a PMCD?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none					Knowledgeable		Little/none					Knowledgeable	

4. How would you rate your knowledge of post-resuscitation care?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none					Knowledgeable		Little/none					Knowledgeable	

5. How would you rate your overall comfort in managing such a scenario in the future?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none					Comfortable		Little/none					Comfortable	

Appendix 2

Simulation Activity Evaluation

Date: _____

Designation: Consultant PG Yr 1 2 3 4 STUDENT NURSE MIDWIFE OTHER

Specialty: _____

Years in practice: _____

Please rate the following aspects of this training program using the scale listed below:

1 = Poor, 2 = Suboptimal, 3 = Adequate, 4 = Good, 5 = Excellent, N/A= Not applicable

Introductory Materials

Orientation to the simulator	1	2	3	4	5	N/A
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Physical Space

Realism of the simulator space	1	2	3	4	5	N/A
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Equipment

Satisfaction with the mannequin	1	2	3	4	5	N/A
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Scenarios

Realism of the scenarios	1	2	3	4	5	N/A
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Ability of the scenarios to test technical skills	1	2	3	4	5	N/A
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Ability of the scenarios to test behavioral skills	1	2	3	4	5	N/A
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Overall quality of the debriefings	1	2	3	4	5	N/A
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Did you find this useful?

To improve <i>clinical practice</i> ?	1	2	3	4	5	N/A
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To improve <i>teamwork skills</i> ?	1	2	3	4	5	N/A
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To improve <i>verbal communication</i> ?	1	2	3	4	5	N/A
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To improve <i>nonverbal communication</i> ?	1	2	3	4	5	N/A
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Faculty

Quality of instructors	1	2	3	4	5	N/A
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Simulation as a teaching method	1	2	3	4	5	N/A
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Comments/Suggestions:

References:

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