Simulation Patient Design (January 2024)
Case of Hypotension during Cesarean Section

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Introduction
Hypotension is commonly encountered in obstetric anesthesia, and it has the potential to cause harm to both the mother and fetus. The mother often experiences nausea and vomiting, and more serious risks include aspiration, apnea, loss of consciousness, and cardiac arrest. The fetus receives less perfusion from the placenta and can experience acidosis, hypoxia, and suffer neurologic damage. [1] In a cesarean delivery, the necessary level for coverage is T4, and the subsequent sympathetic blockade can cause hypotension in up to 70-80% of patients who do not receive pharmacologic prophylaxis. [2,3]

Although the most common culprit is the neuraxial anesthesia, there are other causes of intraoperative hypotension that should be considered. Some of these causes include supine positioning (aortocaval compression syndrome), hypovolemia (including dehydration and hemorrhage), anaphylaxis (including amniotic fluid embolism and medication reaction), and embolic events (including pulmonary embolism and venous air embolism). [3]

Postpartum hemorrhage is the primary reason for intraoperative hypotension during cesarean delivery that is not caused by neuraxial anesthesia. It is also the leading cause of maternal morbidity. It has traditionally been defined as losing >500mL of blood during vaginal delivery and >1000mL of blood during cesarean delivery. It has also been defined as a decrease in hematocrit of >10% pre- and post-delivery, or as the need for packed red blood cell transfusion. In 2017, the American College of Obstetrics and Gynecology redefined postpartum hemorrhage as cumulative blood loss >1000mL with signs and symptoms of hypovolemia within 24 hours of delivery. The “4 T’s” mnemonic of the most common causes of postpartum hemorrhage include Tone (uterine atony), Trauma (laceration, inversion, rupture, etc.), Tissue (retained tissue or invasive placenta), and Thrombin (coagulopathy). [4] Of these, uterine atony is the primary cause of postpartum hemorrhage and is the cause in approximately 80% of postpartum hemorrhage. [4]

Educational Rationale: To teach differential diagnosis and management of hypotension during cesarean section.

Target Audiences: Anesthesiologists, Obstetricians, Resident Physicians, L&D nurses, L&D support personnel, and medical students

Learning Objectives: As per Accreditation Council for Graduate Medical Education (ACGME) Core Competencies. Upon completion of this simulation (including the debrief) learners will be able to:

- *Medical knowledge:* Describe the causes of hypotension during cesarean delivery.
- *Patient care:* Evaluate and treat intraoperative hypotension.
- *Practice-based learning and improvement*: Effectively implement an interdisciplinary emergency response and identify all necessary skills and equipment needed to correctly manage an obstetric patient with life-threatening hypotension

- *Interpersonal and communication skills*: Utilize closed-loop communication with the surgical team, nursing team, and other anesthesiologists to identify pathology of intraoperative hypotension
- *Systems-based practice:* Identify the location of all emergency equipment (rapid infuser), code carts, the blood bank, ultrasound machine, and understand existing barriers within the system such as shortage of equipment, personnel, knowledge gaps, and institutional protocols

Questions to Ask After the Scenario:

1. How did the scenario go? What went well? What could be improved on?
2. What is the differential diagnosis for hypotension in a patient undergoing cesarean delivery?
3. What is the differential diagnosis for postpartum hemorrhage during a cesarean delivery?
4. What were the barriers in diagnosing the cause of hypotension in this patient?
5. How was the communication between the obstetricians, nurses, and anesthesiology team?

Assessment Instruments:

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

Equipment Needed and Set-up:

In-situ OR set-up

- Mannequin with left uterine displacement
- 18 gauge IV in left antecubital fossa
- Blood pressure cuff, pulse oximetry, EKG
- Anesthesia machine and cart
- Mannequin draped for cesarean delivery
- Red dye-stained pads underneath mannequin and surgical drapes
- Empty suction canister with suction tubing and Yankauer attached in surgical field

Needed, not in OR at start

- Suction canister with 250 cc red fluid

Simulation Scenario Set-up:

The case

Ms. Smith is a 37-year-old G4P2012 at 40 weeks who presents for elective repeat cesarean delivery. She has a history of chronic hypertension and two prior cesarean deliveries. She takes aspirin 81 mg daily and denies any allergies to medications. After being consented, she is taken to the operating room by your colleague where she receives a single-shot spinal with 10.25 mg hyperbaric bupivacaine, 12.5 mcg fentanyl, and 0.125 mg morphine. Patient is started on infusion of 1.0 mcg/kg/min of intravenous phenylephrine prophylactically. A few minutes later, she has loss of sensation to cold to the T4 level bilaterally. She has just been prepped and draped. The Allis clamp test is negative. Her IV access is one 18G PIV in R forearm.

Exam
Height: 5’5”
Weight: 75 kg
BMI: 27.5

Airway: Mallampati 2, normal mouth opening

Simulation Pre-brief

- Read the scenario and instruct team members on their roles during the simulation
- Learners take their places at bedside
- Simulation driver plays the voice of the patient
- Confederate plays the surgeon, if there is another confederate available, they play the part of the circulating nurse
- Learner starts simulation by relieving his/her colleague after receiving a patient hand-off before skin incision.

Scenario Details

Trigger	Patient Condition	Action	Done	Time	Comments
Patient in OR Surgery begins, After short period uterine incision is made Baby delivered	Patient complains of nausea HR 95 bpm BP 90/61 mm Hg Resp 16/min O_2 sat 100%	1. Reassure patient 2. Increase phenylephrine infusion or give additional vasopressor bolus. 3. Put IV fluids on pressure bag if not already. 4. After delivery, oxytocin infusion started per institution protocol			
Placenta delivered. Obstetricians working on achieving hemostasis.	Patient says she feels increasingly nauseated. HR 102 bpm BP 87/55 mm Hg Resp 20/min O_2 sat 100% If they look at suction cannister, it is empty at this point	1. Reassure patient 2. Titrate vasopressor infusion in conjunction with resuscitation 3. Consider additional IV access for fluids 4. Ask Obstetricians about state of hemostasis/ongoing blood loss 5. Ask RN to do QBL 6. Consider calling for uterotonics. Avoid methergine due to history of chronic HTN.			

Patient complains of feeling dizzy and short of breath.	Patient is pale and diaphoretic HR 113 bpm BP 70/51 mm Hg Resp 20/min O_2 sat 100% QBL pending.	1. Treat low blood pressure with increasing doses of pressors (i.e. phenylephrine and ephedrine) 2. Discuss patient's condition including increasing hypotension, state of hemostasis, and uterine tone with the OB team 3. Discuss differential diagnosis of intraoperative hypotension: aortocaval compression, hypovolemia, anaphylaxis, embolic event, 4 T's of postpartum hemorrhage, etc.			
Obstetricians insist there is not much bleeding in the surgical field and uterine tone is adequate. Obstetricians and circulating nurse note no blood pooling in the surgical field.	Patient complains of brief ringing in her ears HR 124 bpm BP 60/40 mmHg Resp 20/min O_2 sat 98% QBL=400 ml If they look at suction cannister, it has additional 250 cc of red liquid	1. Continue treatment of blood pressure with vasopressors. Consider escalation to vasopressin. Consider LAST and calling for intralipid in room. 2. Continue ongoing communication about hypotension with the obstetric team 3. Place second large bore intravenous line and arterial line 4. Call for ultrasound for POCUS assessment 5. Increase frequency of NIBP measurement (q1 min or STAT) until arterial line placed.			

Obstetricians state they have achieved hemostasis, and they begin uterine closure.	Patient becomes drowsy and less responsive HR 32 bpm BP 52/30 mmHg Resp 20/min O_2 sat 98%	1. Treat blood pressure and heart rate with epinephrine (20 mcg bolus and escalate as needed). 2. Communicate peri-code status with obstetric team. 3. Request crash cart to be brought to room. 4. Send arterial blood gas.			
Circulating nurse looks under drapes, notices pooling blood under patient on OR table. As closure is starting, the obstetrician notices and removes small additional piece of placenta. Uterine tone is adequate.	Patient states she feels "tired". Post-epinephrine bolus: HR 130 bpm BP 82/60 mmHg Resp 24/min O_2 sat 100% ABG shows: pH 7.28 Hct 24 Lactate 1.5	1. Call blood bank for "fast blood"/MTP 2. Continue blood pressure management with IV fluids and vasopressors until blood arrives 3. Send additional labs including considering sending viscoelastic test: ROTEM or TEG 4. Discuss assessment of on-going blood loss/qualitative blood loss. Ask for updated QBL.			
Obstetricians check abdomen after uterine closure. No source of further bleeding seen. Blood arrives in the OR.	After blood products given, patient begins to feel improved. Vitals stabilize after blood: HR 95 bpm BP 98/64 mmHg Resp 16/min O_2 sat 100%	1. Check units of blood with RN 2. Give 1 unit of pRBC on pressure bag. 3. Consider hanging second unit of blood after seeing improvement in vitals with first unit or get repeat ABG. 4. As patient is transfused, attempt to wean pressor support. 5. Consider calling for other blood products: FFP, platelets, and cryoprecipitate.			

Appendix 1

Learner Knowledge Assessment
Labor and Delivery Multidisciplinary Team Simulation

Name of simulation: _____ Date: _____

OB Nursing Anesthesiology

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 to evaluate your perspective at the completion of the simulation.

1. **How would you rate your knowledge of the risk factors for intraoperative hypotension in an obstetric patient?**

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

2. **How would you rate your knowledge of the differential diagnosis of intraoperative hypotension in an obstetric patient?**

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

3. **How would you rate your knowledge of the treatment of intraoperative hypotension in an obstetric patient?**

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

4. **How would you rate your ability to effectively communicate changes in vital signs with the surgical team intraoperatively?**

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

5. **How would you rate your overall confidence managing intraoperative hypotension in the obstetric patient?**

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

Appendix 2

Simulation Activity Evaluation

DATE OF SIMULATION:

OCCUPATION: 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

Use "N/A" if you did not experience or otherwise cannot rate an item

INTRODUCTORY MATERIALS						
Orientation to the simulator	1	2	3	4	5	N/A
PHYSICAL SPACE						
Realism of the simulator space	1	2	3	4	5	N/A
EQUIPMENT						
Satisfaction with the mannequin	1	2	3	4	5	N/A
SCENARIOS						
Realism of the scenarios	1	2	3	4	5	N/A
Ability of the scenarios to test technical skills	1	2	3	4	5	N/A
Ability of the scenarios to test behavioral skills	1	2	3	4	5	N/A
Overall quality of the debriefings	1	2	3	4	5	N/A
DID YOU FIND THIS USEFUL?						
To improve your clinical practice?	1	2	3	4	5	N/A
To improve your teamwork skills?	1	2	3	4	5	N/A
To improve your VERBAL communication?	1	2	3	4	5	N/A
To improve your NONVERBAL communication?	1	2	3	4	5	N/A
FACULTY						
Quality of instructors	1	2	3	4	5	N/A
Simulation as a teaching method	1	2	3	4	5	N/A

COMMENTS/SUGGESTIONS:

References

1. Chooi C, Cox JJ, Lumb RS, Middleton P, Chemali M, Emmett RS, Simmons SW, Cyna AM. Techniques for preventing hypotension during spinal anaesthesia for caesarean section. Cochrane Database Syst Rev. 2017 Aug 4;8(8):CD002251. doi: 10.1002/14651858.CD002251.pub3. Update in: Cochrane Database Syst Rev. 2020 Jul 1;7:CD002251. PMID: 28976555; PMCID: PMC6483677.
2. Klöhr S, Roth R, Hofmann T, Rossaint R, Heesen M. Definitions of hypotension after spinal anaesthesia for caesarean section: literature search and application to parturients. Acta Anaesthesiol Scand. 2010;54(8):909-921. doi:10.1111/j.1399-6576.2010.02239.x
6. Mercier FJ, Augè M, Hoffmann C, Fischer C, Le Gouez A. Maternal hypotension during spinal anesthesia for caesarean delivery. Minerva Anestesiol. 2013;79(1):62-73.
7. Rogers J, Wood J, McCandlish R, Ayers S, Truesdale A, Elbourne D. Active versus expectant management of third stage of labour: the Hinchingbrooke randomised controlled trial. *Lancet*. 1998;351(9104):693-699. doi:10.1016/S0140-6736(97)09409-9