SOAP
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Simulation Patient Design (November 2023)
Case of Cardiac Arrest following a Neuraxial Block

Author: Yunus M. Shah, MD; Louisville, KY
Editors: Kokila Thenuwara, MD, MME MHCDS, Jessica Sheeran, MD

Introduction:

Cardiac arrest following neuraxial block is a rare event with potential for devastating outcomes. Kopp et al. published a retrospective study of 20-year data (1983-2002) from the Mayo Clinic looking at cardiac arrest rates during neuraxial anesthesia. In this review, the overall frequency of cardiac arrest during neuraxial anesthesia was 1.8 per 10,000 with higher rates (2.9 per 10,000) for spinal anesthesia vs. 0.9 per 10,000 for epidural anesthesia.[1] Other studies have described variables associated with the cardiac arrests during or following neuraxial and survival therefrom.[2,3,4] For example, Caplan et al. revealed that anesthetic care was ongoing for an average 36 +/- 18 minutes at the time of arrest, with hypotension, bradycardia, and/or cyanosis frequently preceding the arrest.[2] In contrast, asystole was the presenting rhythm in a study by Kopp et al.[1]

A circulatory etiology for the arrest is a much more accepted hypothesis rather than a primarily respiratory etiology since block levels up to T4 do not typically cause hypoventilation. The preload decrease due to the neuraxial block likely shifts cardiac autonomic balance towards parasympathetic pathway, causing bradycardia. Three major mechanisms are proposed – activation of low-pressure baroreceptors in right atrium, receptors within myocardial pacemaker cells, and mechanoreceptors in left ventricle stimulating a paradoxical Bezold-Jarisch reflex. Finally, sedation, hypoxemia, hypercarbia and medications like beta blockers may all be contributory.[5] Multiple mechanistic studies appear to demonstrate that with neuraxial block, hypovolemia is sufficient and perhaps necessary to precipitate classic vagal symptoms, and even full cardiac arrest in healthy patients.[6,7,8]

The risk factors that may point to a need for higher vigilance include baseline heart rate <60 bpm, ASA physical status I, use of beta-blocking drugs, sensory block level above T6, age < 50 years old, and prolonged PR interval.[9] The term “vagotonia” describes the clinical situation of resting bradycardia, atrioventricular block, or complete atrioventricular dissociation that is present in 7% of the population. In this subset, asystole can occur when pro-vagal maneuvers are performed.[14] One peculiar risk factor may be the placement of a pannus retraction device which can potentially rapidly increase the intraabdominal pressure.

Successful management to improve survival is predicated on early recognition followed by fluid administration, administration of mixed alpha and beta agonists, and appropriate vagolytic therapy.[9] Multiple simultaneous interventions may be necessary to prevent vagal predominance. Using atropine to counteract increased baroreflex activity during spinal anesthesia is recommended because glycopyrrolate may be ineffective in this setting.[10,11] Prophylactic atropine treatment of bradycardia may decrease both the frequency and morbidity of the arrests that occur during spinal anesthesia. A case series of 4000 patients reported by Geffin and Shapiro showed full recovery in 12 patients treated for bradycardia or asystole following spinal anesthesia.[12] This treatment included atropine for 11 of the 12 cases, typically used in combination with a vasopressor (ephedrine, epinephrine or phenylephrine). Atropine and a vasopressor (ephedrine) were also utilized in the five successful resuscitations reported by Lovstad et al.[13]

Educational Rationale: To teach team skills in managing cardiac arrest following spinal anesthesia
Target Audiences: Nursing, OB, Anesthesiology, OR personnel
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*: Recognize clinical signs and symptoms and describe treatment options for cardiac arrest following neuraxial block.
- *Patient care*: Understand risk factors that predispose patients to cardiac arrest post neuraxial procedures in order to prioritize management strategies.
- *Practice-based learning and improvement*: Identify the setting, equipment, and medications necessary to manage an obstetric patient who develops cardiac arrest post neuraxial block.
- *Interpersonal and communication skills*: Assign roles such as a team leader who will coordinate the team to provide optimal care to the patient and maintain ongoing communication about the evolution of the clinical situation among the providers.
- *Professionalism*: Understand and demonstrate mutual respect for team members.
- *Systems-based practice*: Ensure all personnel, resuscitation equipment, medications, and protocols are readily identifiable and available in delivery locations including airway management, anesthesia induction/emergency medications, and vascular access. Include identification of barriers within the hospital system such as staffing (including non-OB staff like General surgery, IR,etc.), medications, and appropriate protocols.

Questions to ask after the scenario:

1. Was the emergency response appropriately activated?
2. Did each member of the response team have well-defined roles?
3. Were the next steps for management clearly outlined by the care team?
4. What is the physiologic mechanism for cardiac arrest after neuraxial block?
5. What are the risk factors for cardiac arrest after neuraxial block?
6. Were there any barriers or system issues identified when caring for the patient?
7. Were opportunities for improvement(s) identified during the scenario?

Assessment Instruments:

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

Equipment Needed and Set-up:
In-situ set-up

1. Mannequin set-up in OR using standard C-section set-up
2. One 18G IV setup with fluids attached and multiple access ports on the line
3. Standard monitors (e.g. EKG, NIBP, SpO_2)

Simulation Scenario Set-up:
The case
Mrs. Cardy Stopp is a 31-year-old G2P1 with at 39 weeks gestational age. She presents to Labor and Delivery floor for a scheduled elective repeat cesarean section. Her history is significant for morbid obesity with a BMI of 45. She also happens to mention in passing that she was told she has a first-degree heart block, but she has no symptoms. The rest of her pre-anesthesia evaluation is unremarkable.

Simulation Pre-brief

- Read the scenario and instruct team members on their role during the simulation
- The learners take their places

Scenario Details

Trigger	Patient Condition	Action	Done	Time	Comments
Patient in L&D OR with standard 18G IV access.	Patient awake and appropriately responsive. HR: 65 bpm BP: 129/86 mm Hg SpO_2: 96% (room air) Temp: 36.9° C	• Patient positioned for neuraxial block on OR table • Standard ASA monitors applied • Vitals assessed • Spinal anesthesia administered using standard technique with hyperbaric bupivacaine • IV Lactated Ringers solution co-load started on pressure bag • Phenylephrine infusion started			
S/p spinal anesthesia. Patient placed in supine position with LUD.	5 minutes post-spinal anesthesia placement, patient begins complaining of vague nausea. HR: 90 bpm BP: 104/55 mm Hg SpO_2: 96% (room air)	Anesthesia team initiates management of normal post-spinal anesthesia hypotension: • Continue IV fluid bolus • Standard initial doses of pressors given in the form of Phenylephrine 100 mcg boluses or increased titration on phenylephrine infusion			
Neuraxial block level assessed and found satisfactory to a level of T4. Pannus retraction device placed per OB and surgical prep initiated.	Patient complaining of a feeling of significant unease, nausea, followed by vomiting. Marked facial pallor noted. Patient exhibiting increasing agitation. HR: 49 bpm BP: 75/45 mm Hg SpO_2: 93% (room air) FHR: 80 bpm if checked	• IV fluid bolus continued • Escalating doses of pressors initiated in the form of Ephedrine along with increased titration of Phenylephrine infusion • O2 administered using nasal cannula • OB nurse checks FHR			
C-section started and in-progress.	Patient exhibiting episodic altered mentation with slurred	• Increased IV fluid bolus on pressure bag			

Surgery proceeding quickly if FHR tones checked.	speech/unresponsiveness. Family member also expressing concern over patient condition. HR: 30 bpm BP: 65/30 mm Hg SpO_2: 88% on nasal cannula	• Vagolytic medications initiated in the form of glycopyrrolate and eventually atropine alongside ephedrine • Epinephrine bolus (10-20 mcg initially) • Oxygen delivered via facemask • Family member escorted out of OR • OB requested to expedite surgical procedure to facilitate quick delivery			
Live infant delivered and handed off to delivery team. Infant noted to be minimally active. Apgars 4,5 at 1 and 5 minutes respectively.	Patient suddenly completely unresponsive to verbal and painful stimulus. Frank cyanosis noted. No palpable pulse and no discernable activity on EKG monitor. No obvious coagulopathy signs reported by OB. HR: 0 bpm (asystole) BP: unrecordable, cycles with no numbers SpO_2: no waveform	• OB instructed to hasten closure • OB OR code called • Immediate CPR commenced • Preparations made to secure airway via endotracheal intubation. Patient masked with Ambu bag while preparing intubation supplies. • ACLS medications including 1 mg Epinephrine initiated • Additional IV access obtained			
Incision closed. After 2 minutes of chest compressions and 1 mg epinephrine, patient has ROSC at pulse check.	Patient exhibiting signs of responsiveness to stimuli with eye opening and limb movement. HR: 92 bpm with occasional PAC's and PVC's BP: 89/52 mm Hg SpO_2: 92% on FIO_2 of 1.0 via ambu bag	• Vigilant close observation continued • Readiness to secure airway via intubation maintained but not executed. Assisting ventilation with Ambu bag as patient is awakening • Labs drawn including ABG, CBC, CMP, and coag panel • Call placed to ICU for transfer after surgery • Family updated • Consider TTE to evaluate heart function			

Appendix 1

Learner Knowledge Assessment
Labor and Delivery Multidisciplinary Team Simulation

Name of simulation: _____ Date: _____

OB Nursing Anes

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 risk factors for Cardiac arrest following neuraxial block?

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 differential diagnosis of Cardiac arrest following neuraxial block?

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 signs and symptoms of Cardiac arrest following neuraxial block?

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 knowledge of delivery planning for Cardiac arrest following neuraxial block?

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 when confronted with Cardiac arrest following neuraxial block

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:

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