Management of Profound Hypotension Secondary to Spinal Anesthesia: Simulation Case Scenario

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DEMOGRAPHICS
Case Title: Dante Jackson’s Anterior Cruciate Ligament (ACL) Repair (Cardiovascular collapse from a “high spinal”).
Patient Name: Dante Jackson.
Case Description and Diagnosis: A spinal anesthetic that results in cardiovascular collapse in a 24-year-old healthy male presenting for repair of the left ACL injury.
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Target Audience: Medical students (4th year), Anesthesiology residents (post-graduate year 2–5), Anesthesiology faculty for continuing medical education (CME), student registered nurse anesthetist (SRNA), or certified registered nurse anesthetist (CRNA).

CURRICULAR INFORMATION
Educational Rationale
Spinal anesthesia [or subarachnoid block (SAB)] is a common intraoperative technique for surgical pain relief. The physiologic changes associated with this technique and their treatments are commonly included in undergraduate and graduate medical education. This scenario allows participants to encounter an extreme complication of a SAB (hypotension, bradycardia, and apnea) and experience the responses to its treatment. Additionally, the scenario dictates that successful participants apply crisis management skills to affect a positive outcome for the simulated patient.

Learning Objectives
Accreditation Council for Graduate Medical Education General Competencies:
1. Medical knowledge
2. Patient care
3. Practice-based learning and improvement
4. Interpersonal and communication skills
5. Professionalism
6. Systems-based practice

Presimulation Learning Objectives
1. State the indications and contraindications of a SAB
2. Describe common complications of a SAB and their treatments

Simulation Performance Objectives
1. State the diagnosis
2. Call for help
3. Treat the patient with:
   a. Intravenous (IV) fluid
   b. One milligram of epinephrine or 40 units vasopressin (phenylephrine, ephedrine, or atropine will not have an effect in this scenario)
   c. Place an endotracheal tube and start mechanical ventilation
   d. Have one of the confederates perform chest compressions

Debriefing Learning Objectives
1. State the diagnosis
2. Describe the mechanism for the patient’s cardiovascular collapse
3. Describe the rationale for your treatment
4. Evaluate the proposed treatment of administering epinephrine or vasopressin, endotracheal intubation, and chest compressions
5. Describe the challenges in having nonanesthesia providers, such as the operating room (OR) nurse and surgeon, help in resuscitating this patient
6. Justify your delegation of tasks (such as chest compressions or drug administration) in the scenario

Guided Study Questions
1. What are the structures through which a spinal needle passes if placed in the midline of the spine between the second and third lumbar vertebrae on a path toward the thecal sac?
2. Where are the motor neurons of the sympathetic nervous
system located, and how does their location explain the physiologic effects associated with spinal anesthesia?
3. What are common agents, doses, and volumes of local anesthetics used in spinal blocks?
4. What is the mechanism of action of local anesthetics in blocking nerve conduction?
5. What are the advantages of spinal anesthesia versus epidural anesthesia?
6. What are the indications and contraindications for spinal anesthesia?
7. What resources are available to an anesthesia provider working alone in the operating room?
8. How would you cope with a surgeon who is becoming frantic or panicked about this patient in the OR?
9. What would you say to the anesthesiology resident who performed the SAB?

Didactics
None.

Assessment Instruments
None.

PREPARATION

Monitors Required
1. Noninvasive blood pressure cuff
2. Electrocardiogram
3. Pulse oximeter
4. Capnograph

Other Equipments Required
1. Anesthesia machine
2. Simple face mask
3. Laryngoscope blade and handle
4. IV fluids
5. Medications: sodium thiopental, succinylcholine, phenylephrine, ephedrine, atropine, vasopressin, and epinephrine
6. Confederates needed:
   a. Anesthesiology resident who performed the SAB—this person will leave immediately after giving report
   b. Operating room nurse present throughout the simulation
   c. Surgeon present throughout the simulation
   d. “Help,” in the form of skilled anesthesia providers may be needed for SRNA, CRNA or junior resident participants

Supporting Files
None.

Duration
Presimulation: 10 minutes.
Simulation: 10 to 15 minutes.
Debrief: 25 to 30 minutes.

Room/Mannequin Set Up
The simulator is laying supine with large bore peripheral IV access. Standard monitors [electrocardiogram, noninvasive blood pressure (BP), and pulse oximetry] are in place. The anesthesia machine is on and functioning properly. In the room, additional crystalloid and colloid fluids, the previously mentioned medications, and equipment for endotracheal intubation are available.

SIMULATION EXERCISE

Case Stem to be Read to Participants
You will be taking care of a 24-year-old healthy male athlete who is having an ACL repair. His medical history is negative for any systemic illness. He does not take medications and does not have any allergies to medications. He has never had anesthesia nor does he have a family history of anesthesia complications. He sustained a traumatic knee injury 1 week ago playing football with his college team.

The anesthesia machine and room have been set up for you according to normal protocols. All equipment is functioning properly. About 10 minutes ago, a junior resident gave the patient 3.5 mL of preservative-free 0.75% bupivacaine in 8.25% dextrose into the subarachnoid space, then placed the patient in the supine position. Now you have been asked to relieve that resident for a lecture.

Information for Facilitator/Simulator Operator Only
This “high spinal” scenario was created to give participants a simulated experience with an extreme complication associated with neuroaxial local anesthetics-cardiovascular collapse. Because the scenario is intended to produce this severe collapse, no vasoactive medications besides epinephrine or vasopressin improve the patient’s condition. A literature search did not reveal expert consensus or recommendations for treating this condition; therefore, the authors consulted the Anesthesia Patient Safety Foundation for recommendations in managing this complication. Consultants from that foundation recommended epinephrine or vasopressin as the correct vasoactive drugs to treat the condition.

The patient is a previously healthy, athletic male without medical problems. It takes place in the operating room, starting 10 minutes after the simulated patient has received too much local anesthesia in a spinal anesthetic. The anesthesia machine and room have been properly set up for the participants. All equipment is functioning properly and is intended to work correctly throughout the scenario. An operating room nurse and surgeon will be present throughout the scenario. They can do chest compression and administer medications, if asked, but they do not offer advice during the scenario.

The patient is laying supine on the OR table, breathing oxygen through a simple face mask. Initially, the patient is hemodynamically stable, but 3 minutes after the start of the scenario the patient complains of nausea, then loses consciousness and becomes apneic. During the first 5 minutes of the scenario, the blood pressure deteriorates to a systolic BP of 60, and his heart rate decreases into the low 20s. Because of hypoperfusion, the pulse oximeter stops functioning.

The scenario typically lasts either 10 minutes or until all the performance objectives have been completed. Successful participants will (in this anticipated order): call for help, open up the IV fluid administration set, give 1 mg of epinephrine or 40 units vasopressin, intubate the patient’s trachea, start
### Table 1. Simulation Events

<table>
<thead>
<tr>
<th>State</th>
<th>Patient Status</th>
<th>Operator</th>
<th>Student Learning Outcomes or Actions Desired and Trigger to Move to Next State</th>
<th>Teaching Point(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Baseline</td>
<td>Patient is hemodynamically stable and breathing spontaneously through a simple face mask</td>
<td>Patient is lying supine on OR table, awake, alert, and breathing through a simple face mask</td>
<td>The participant receives report from the junior resident</td>
<td>Continuous observation of patient</td>
</tr>
<tr>
<td>2. Hemodynamic state of patient begins to decline</td>
<td>Patient appears less alert and complains of nausea and light headedness</td>
<td>About 3 min from the participant assuming care, the patient begins complaining of nausea and light headedness. His HR, RR, BP, and Sats slowly trend downward</td>
<td>Initially, administration of volume, phenylephrine, ephedrine, or atropine is appropriate</td>
<td>Recognize signs and symptoms of mild anesthesia-related bradycardia and hypotension and treat appropriately with volume and/or pressors</td>
</tr>
<tr>
<td>3. Patient develops high spinal blockade; becomes profoundly bradycardic, hypotensive, and apneic with loss of consciousness, and eventually cardiopulmonary arrest</td>
<td>Patient loses consciousness</td>
<td>Patient becomes unresponsive. Bradycardia and hypotension will worsen until chest compressions and either epinephrine or vasopressin has been administered</td>
<td>Call for help</td>
<td>Recognize severe bradycardia and hypotension as a complication of subarachnoid block secondary to blockade of upper thoracic nerve roots resulting in unopposed vagal stimulation. Recognize need to call for help, secure airway. Efficiently utilize available resources (like the OR nurse and surgeon) to perform tasks like chest compressions and drug administration</td>
</tr>
<tr>
<td>4. Patient recovery</td>
<td>HR 110&lt;br&gt;B P 85/42&lt;br&gt;Sats 99% on mechanical ventilation</td>
<td>Gradual improvement in VS</td>
<td>Treatment of &quot;high spinal&quot; physiology</td>
<td>Notice how the principles of crisis resource management (task delegation, closed-loop communication, and avoidance of idea fixation) contribute to a good patient outcome in this scenario</td>
</tr>
</tbody>
</table>

HR, heart rate; RR, respiratory rate; BP, blood pressure; Sats, oxygen saturation; OR, operating room; VS, vital signs.

### Patient Data Background and Baseline State

The patient is a 24-year-old healthy athlete without significant medical history who has had a spinal block for an ACL repair.

### Review of Systems

- **Central nervous system:** Initially awake and alert but loses consciousness secondary to hypoperfusion
- **Cardiovascular:** NA
- **Pulmonary:** NA
- **Renal/Hepatic:** NA
- **Endocrine:** NA
- **Heme/Coag:** NA
- **Current Medications and Allergies:** None, no know drug allergies

### Physical Examination

- **General:** Muscular and well-developed man who is initially alert and oriented

### Weight and Height:

- **Weight:** 183 cm and 85 kg
- **Height:**

### Vital Signs:

- **Temperature:** 37°C
- **Heart rate:** from 82 to 20 bpm
- **Blood pressure:** BP: 120 to 40 systolic mm Hg
- **Respiratory rate:** 15 breaths/min
- **Oxygen saturation:** 99% on simple face mask to nonfunctioning

### Airway:

- **Mallampatti class II airway,** normal anatomy, and no limitation in cervical motion

### Lungs:

- **Clear to auscultation bilaterally**

### Heart:

- **Initial normal sinus rhythm,** deteriorates to sinus bradycardia, regular rate and rhythm, normal S1/S2, no S3/S4, and no rubs/gallops/murmurs

### Head, eyes, ear, neck, throat:

- **Unremarkable**

### Laboratory, Radiology, and Other Relevant Studies

- **Hematocrit:** 41%
- **Chest x-ray:** No active disease

### Electrocardiogram:

- **Sinus rhythm**

### REFERENCES

2. Chabbouh T, Lentschener C, Zuber M. Persistent cauda equine syndrome with no identifiable facilitating condition after an uneventful single spinal administration of 0.5% hyperbaric bupivacaine. *Anesth Analg* 2005;101:1847–1848.


