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Introduction:

Administration of local anesthetics via neuraxial techniques remains the most common and effective method of providing analgesia during labor. Through adjustment of local anesthetic volume and concentration via an epidural catheter, labor analgesia can quickly be extended to provide surgical anesthesia in case a cesarean delivery is required. Members of the maternal care team should have an understanding of neuraxial complications, including inadvertent intravascular injection of local anesthetic or administration of a toxic dose in the epidural space, to facilitate early recognition and intervention. The patient with local anesthetic systemic toxicity (LAST) may present with neurologic symptoms and/or cardiovascular changes which can rapidly progress to a need for cardiopulmonary resuscitation and a perimortem cesarean delivery (PMCD).

The pregnant patient is physiologically more prone to development of LAST so education through simulation can help lead to early recognition with appropriate and effective management of this potentially life-threatening situation. Maternal cardiac arrest and PMCD will be covered in a subsequent SIMulation-Of-the-Month (SIMOM).

Risk Factors for LAST:

- Extremes of age (<6 months and advanced age), small patient size
- A history of heart failure, ischemic heart disease, conduction abnormalities or rhythm disorders
- Metabolic (mitochondrial disease), liver disease, low plasma protein concentration
- Renal disease, metabolic acidosis
- Medications that inhibit sodium channels
- Risk factors for enhancement of LAST during pregnancy:
 - Distended epidural veins make intravascular catheter migration more likely
 - Altered uptake and distribution of local anesthetic from the epidural space due to the increased cardiac output
 - Decreased protein bound fraction of local anesthetic making more of the free drug available in the intravascular compartment
 - Altered cardiac electrophysiology due to hormonal effects of progesterone and estradiol increasing the incidence of arrhythmias

Educational Rationale: Teach team skills in early recognition and management of LAST including maternal resuscitation

Target Audiences: Nursing, OB, Anesthesiology, and L&D support personnel

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

Upon completion of this simulation (include debriefing after the session) learners will be able to:

- Medical knowledge: Describe clinical signs, symptoms, and treatment options for LAST in a

pregnant patient

- **Patient care**: Describe risk factors that might contribute to LAST in a pregnant patient after neuraxial techniques for labor analgesia and/or cesarean delivery
- **Practice-based learning and improvement**: Identify the equipment/medications necessary to medically manage an obstetric patient who develops LAST, with recognition and treatment including maternal resuscitation (if indicated)
- **Interpersonal and communication skills**: Designation of a team leader who will effectively communicate with labor and delivery teams in order to provide optimal care to the patient, plus maintain on-going communication regarding the maternal status and need for resuscitation
- **Professionalism**: Demonstrate mutual respect for the expertise of other team members
- **Systems-based practice**: Identify that all resuscitation equipment/medications including lipid emulsion/LAST treatment protocols are readily available in delivery locations - including equipment for airway management (plus backup intubation devices), induction/emergency medications, supplies for IV access. Also, identify barriers within the hospital system including staffing, medication(s), equipment, and protocol deficiencies and include set up of cardiopulmonary bypass in your hospital in an emergency.

Questions to ask after the scenario:

- Did a leader emerge who then communicated effectively with all team members?
- Were there system modification opportunities identified during this simulation?

Assessment Instruments:

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

Equipment needed and set up:

In-situ LDR set up

- Mannequin set up supine with blue drapes on the legs, epidural catheter in-situ connected to a running epidural infusion pump, fetal monitoring ongoing
- 18 g IV in hand with Ringer's lactate solution (IV tubing which contains an access port)
- Standard monitors for labor – Pulse oximetry, non-invasive blood pressure, continuous fetal heart rate monitor and uterine tocometry

Simulation scenario set up:

The case

Mrs. Little is a healthy 28-year-old female G₂P₁ at 39 weeks and 4 days gestation at 5 cm cervical dilation who is admitted to L&D for management of labor. BMI is 38 kg/m² (weight 95.2 kg, height 5'2"). She requested an epidural for labor analgesia and the catheter was successfully placed (after three failed attempts) and a test dose with 3 mL of 1.5% lidocaine with epinephrine 1:200K was negative for intrathecal or intravascular injection. The test dose was followed by two 5 mL boluses of 0.125% bupivacaine with fentanyl 2 mcg/mL within a span of 10 minutes, and the epidural infusion (0.125% bupivacaine with fentanyl 2 mcg/mL) was started at 10 mL/hr.

Simulation pre-brief

- Read the scenario and instruct team members on their role during the simulation
- The learners take their places inside or outside of the LDR
- Patient (embedded participant)
- The L&D nurse (embedded participant) is in the LDR assisting the obstetrician (embedded participant)
- The father of the baby is also at bedside (embedded participant or learner)

Local Anesthetic Systemic Toxicity Scenario

Trigger	Patient Condition	Action	Done	Time	Comments
In LDR immediately after epidural placement	Supine, stable vital signs, pain is not well controlled	<ol style="list-style-type: none"> 1. L&D nurse is monitoring the patient with BP and pulse oximetry 2. L&D nurse is monitoring the fetal heart tracing 			
30 min after epidural placement	Patient is supine, anxious and complaining of blurred vision, tingling in the mouth, numbness of the lips	<ol style="list-style-type: none"> 1. Notify anesthesiology and OB teams 2. Anesthesiology team member at bedside, examining the patient 3. Vital signs checked 4. Epidural stopped immediately 5. Epidural catheter aspirated 6. Situation explained to patient and her husband 			
Epidural catheter aspirated with frank blood return, patient has a seizure during the assessment	Left lateral tilt, patient has a generalized tonic-clonic seizure with some respiratory effort	<ol style="list-style-type: none"> 1. Additional help is called for 2. Anesthesiology manages the airway with O₂ via Ambu bag with FiO₂ of 1.00. Team calls for suction set up and advanced airway equipment. 3. Patient is placed on continuous monitors (EKG, NIBP q2 min, SpO₂) 4. Short-acting benzodiazepine administered for seizure treatment (propofol avoided if hemodynamically unstable) 5. LAST Rescue Kit requested - treated with 20% lipid emulsion therapy IV <p>If patient is >70 kg: bolus 100 mL of 20% lipid emulsion IV rapidly over 2-3 min, followed with 200-250 mL IV infusion over 15-20 min.</p> <p>If patient is <70 kg: bolus 1.5 mL/kg</p>			

		20% lipid emulsion IV rapidly over 2-3 min, followed with 0.25 mL/kg/min IV infusion (ideal body weight)			
Seizure attenuated, OB reports prolonged deceleration of FHTs and need for stat cesarean delivery	Patient is hypotensive but is responding to her name and is following commands	<ol style="list-style-type: none"> 1. Provide hemodynamic support with IVF and vasopressors. Use epinephrine <1 mcg/kg IV boluses to treat hypotension. Avoid vasopressin, beta blockers and calcium channel blockers. Avoid lidocaine for treatment of arrhythmias. 2. Transport patient to OR for stat cesarean delivery 3. Patient is pre-oxygenated and intubated using RSI technique 4. Additional IV access obtained 5. Arterial line placed for hemodynamic monitoring if continued hypotension 6. Mobilize team for cardiopulmonary bypass if continued hemodynamic instability 7. Re-bolus lipid emulsion if patient becomes unstable. Dosing limit is 12 mL/kg IV. Total volume of lipid emulsion can approach 1 L in a prolonged resuscitation >30 min. 8. OB deliver the fetus via stat cesarean delivery 			
OB reports successful cesarean delivery with minimal blood loss	Patient hemodynamically stable after lipid emulsion therapy, tolerated stat cesarean delivery under GETA and meets extubation criteria	<ol style="list-style-type: none"> 1. Patient is extubated 2. Continue close monitoring in ICU for 2 hours after isolated CNS event or 4-6 hours after cardiovascular event 			

Appendix 1

Obstetric Interdisciplinary 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 patient risk factors for local anesthetic systemic toxicity?

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 signs and symptoms of local anesthetic systemic toxicity?

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 treatment options for local anesthetic systemic toxicity?

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 maternal cardiopulmonary resuscitation?

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 knowledge of protocols for a perimortem cesarean delivery?

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

Appendix 2

SIMULATION ACTIVITY EVALUATION FORM

DATE OF SIMULATION: _____

OCCUPATION: Consultant PG Year 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
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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 your clinical practice?	1	2	3	4	5	N/A
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To improve your teamwork skills?	1	2	3	4	5	N/A
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To improve your VERBAL communication?	1	2	3	4	5	N/A
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To improve your NONVERBAL communication?	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

References

1. El-Boghdadly K, Pawa A, Chin KJ. Local anesthetic systemic toxicity: current perspectives; *Local Reg Anesth.* 2018;11:35–44
2. Bern S, Weinberg G. Local anesthetic and lipid resuscitation in pregnancy; *Curr Opin Anaesthesiol.* 2011;24:262-7
3. Neal JM, Barrington MJ, Fettiplace MR, et al. The Third American Society of Regional Anesthesia and Pain Medicine Practice Advisory on Local Anesthetic Systemic Toxicity: Executive Summary 2017. *Reg Anesth Pain Med.* 2018;43:113-23