

## **Case of Increased Intracranial Pressure (ICP)**

**Authors:** Samantha Smith, DNAP, CRNA, Sharon Abramovitz, MD, Alaeldin Darwich, MD, Weill Cornell Medicine, NewYork-Presbyterian

**Editors:** Sonal Zambare, MD : Jessica Sheeran, MD

### **Introduction**

A widespread differential diagnosis for the neurological manifestations of increased intracranial pressure (ICP) exists amongst parturients (Table 1).<sup>1</sup> Pregnancy can exacerbate pre-existing neurological conditions ranging from brain tumors to arteriovenous malformations.<sup>1</sup> Disorders specific to pregnancy, including preeclampsia, may progress to severe acute hypertension syndromes and neurologic sequelae, such as intracranial hemorrhage, reversible cerebral vasoconstriction syndrome, and posterior reversible encephalopathy syndrome (PRES).<sup>1,2</sup> Specifically, disruptions in cerebral autoregulation and the blood-brain barrier may cause vasogenic edema.<sup>2</sup> This radiological marker of PRES signals the potential rapid deterioration of severe preeclampsia to eclampsia.<sup>2</sup>

Prompt and accurate diagnosis of increased ICP is essential for appropriate treatment and peripartum management.<sup>1</sup> Optimal ICP thresholds and clinical presentations during pregnancy align with the general population.<sup>1</sup> Brain Trauma Foundation's guidelines recommend treating ICP greater than 22mmHg because higher ICP levels are associated with an increased mortality.<sup>3</sup> The clinical presentation of increased ICP varies from early non-specific complaints of headache and vomiting to a late manifestation of Cushing's triad in the setting of brain herniation.<sup>4</sup> Papilledema is typically associated with a gradual onset of increased ICP; conversely, an absence of papilledema does not rule out pathological changes.<sup>1</sup> While the exact incidence of increased ICP amongst parturients is unknown, the occurrence is more prevalent in the second and third trimesters.<sup>1</sup>

A dynamic risk-benefit analysis is fundamental for peripartum management of parturients with increased ICP. The suspected etiology is weighed against fetal exposure risk when deciding on diagnostic radiologic imaging.<sup>1</sup> Furthermore, the preferred mode of delivery and safest method of labor analgesia depends on the anatomical impact of the pathology.<sup>5</sup> For example a space-occupying lesion obstructing cerebral spinal fluid flow increases the risk of brain herniation from dural puncture.<sup>5</sup> For patients with idiopathic intracranial hypertension, exacerbation of optic nerve ischemic from the valsalva maneuver during a prolonged second stage is likely a negligible risk for vision damage.<sup>6,7</sup> Overall, optimal management depends on many factors, from etiology to the peripartum phase of care.<sup>1,5,6</sup> The timely recognition of presenting signs and symptoms for a prompt differential diagnosis of increased ICP remains crucial.<sup>1</sup>

**Educational Rationale:** To teach team skills in diagnosing and managing increased intracranial pressure in the obstetric patient

**Target Audiences:** Obstetric Anesthesiology Team, Obstetric Team, Nursing Team

**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:* Recall signs and symptoms, definition, and causes of increased intracranial pressure (ICP)
- *Patient care:* Incorporate increased ICP management with intrapartum care delivery. Modify the anesthetic plan to adapt changes in maternal and fetal conditions.
- *Practice-based learning and improvement:* Develop and adjust plan of care through multi-disciplinary discussion, evaluation, and management.
- *Interpersonal and communication skills:* Demonstrate effective communication skills (i.e., closed loop communication, debriefing, recapping) to promote a shared mental model.
- *Professionalism:* Engage all members of the interdisciplinary team by assigning appropriate roles, maintaining open dialogue on status updates, and soliciting feedback.
- *Systems-based practice:* Incorporate and review institutional policies for escalating care (if applicable) and related workflows.

**Questions to ask after the scenario:**

- 1) What are signs and symptoms of increased ICP?
- 2) Which unique conditions seen in pregnancy are associated with elevated ICP?
- 3) What are obstetric and anesthetic considerations for increased ICP?
- 4) Describe how the fetal status impacted the plan of care.
- 5) How was the plan of care communicated throughout the case?
- 6) How were roles assigned? Did each team member have a defined role?
- 7) Describe what went well. What could have been done better? Are there any institutional/systems issue to follow-up?

**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**

- Personnel: Labor and delivery nurse, obstetrician, obstetric anesthesiologist/nurse anesthetist
- Location: Standard obstetric operating room set-up
- Equipment:
  - o Pregnant manikin
  - o Neuraxial supplies, back-trainer (if available)
  - o Standard monitors: blood pressure, heart rate, pulse oximeter, EKG
  - o IV catheter, fluids
  - o Intubation supplies, anesthesia machine, induction medications
  - o Resuscitation medications to stabilize hemodynamics

### Simulation Scenario Set-up:

Ms. Rose Miller is a 34-year-old G1P0 at 37w1d admitted for primary cesarean section in the setting of breech presentation and active labor at 3cm dilation. During her second trimester, the patient was diagnosed with idiopathic intracranial hypertension (IIH) with symptoms of persistent headaches, nausea, vomiting, and papilledema. At 26 weeks, her neurological work-up included a lumbar puncture with an opening CSF pressure of 27mmHg and imaging ruled out a space-occupying lesion. She has a history of obesity (BMI 46) and is a former smoker. The onset of elevated blood pressures (140s-160s/90s-100s) is a new finding during preoperative admission and the obstetrician orders rule out preeclampsia labs.

Rose Miller, 34-year-old female

Weight: 121 kg Height: 5'4" BMI: 46

Airway: MP-II

FHR: 142 bpm, moderate variability with accelerations, cat I tracing

Toco: contractions q 2-3 minutes, 60 sec in duration

Lab results:

- T&S: A+, no antibodies
- CBC: WBC 7.17, H/H 10.6/31.9, Platelet 98K
- Preeclampsia labs pending

### Simulation Pre-brief

- Simulation facilitator will assign participant professional roles (at least 1 per discipline):
  - Anesthesiology: Anesthesiology attending/resident/nurse anesthetist
  - Obstetrics: Attending/resident/physician assistant
  - Nursing: triage nurse/OR nurse
- The scenario begins with after all providers read the scenario and patient enters operating room signaling "Anesthesia Start."

### Scenario Details

Trigger	Patient Condition	Action	Done	Time	Comments
Patient enters OR for cesarean section delivery	HR 125 BP 167/105 SPO2 99% Resp 23/min Temp 36.8	1. Anesthesiology team initiates plan of care <ul style="list-style-type: none"><li>• Neuraxial anesthesia (in the setting of IIH without space occupying lesion obstructing flow of cerebral spinal fluid)</li></ul> 2. Recognition of severe range blood pressures <ul style="list-style-type: none"><li>• Consider first-line IV anti-hypertensive agents (labetalol 20mg, hydralazine 5-10mg).</li></ul>			

		<ul style="list-style-type: none"> <li>• Discuss blood pressure management goals in setting of neuraxial anesthesia placement.</li> <li>• Consider seizure prophylaxis (magnesium sulfate, per institutional policy)</li> </ul>			
<p>After neuraxial placement, patient moved from sitting to supine position with left uterine displacement.</p> <p>FHR monitor applied; surgical dermatomal level of anesthesia not established</p>	<p>HR 111 bpm BP 145/82 mm Hg SpO<sub>2</sub> 97% (air) Resp 20/min</p> <p>FHR: 80 bpm, minimal variability, cat 3 tracing</p>	<p>1. Category 3 tracing noted; decision for emergency/imminent delivery</p> <p>2. Decision for general anesthesia</p> <ul style="list-style-type: none"> <li>• Perform rapid sequence induction (RSI) to minimize risk of aspiration</li> <li>• Blunt sympathetic response to endotracheal intubation by combining induction agents with opioids or labetalol</li> <li>• Consider RSI dose of rocuronium to avoid theoretical increase of ICP with succinylcholine</li> </ul>			
<p>After airway secured, baby delivered</p> <p>Apgar score 8 and 9</p>	<p>HR 101 bpm BP 188/107 mm Hg SpO<sub>2</sub> 99% Resp 15/min (mechanical ventilation) Temp 36.9°C</p> <p>Preeclampsia labs resulted: protein/creatinine ratio 0.4</p>	<p>1. Recognize severe range blood pressures</p> <ul style="list-style-type: none"> <li>• Administer first-line IV anti-hypertensive agents (labetalol 20mg, hydralazine 5-10mg). Consider other medications to temporarily decrease blood pressure.</li> <li>• Initiate seizure prophylaxis (magnesium sulfate 4-6gm loading dose over 15 min; 1-2gm/hr maintenance dose)</li> </ul>			
<p>45 min later, obstetricians closing skin</p> <p>Patient on Magnesium drip (2gm/hr)</p>	<p>HR 98 bpm BP 205/104 mm Hg SpO<sub>2</sub> 99% Resp 20/min Temp 36.8°C</p>	<p>1. Initiate nicardipine drip to titrate anti-hypertensives agent to non-severe range, within 20% of baseline, and above systolic of 110mmHg</p> <p>2. Decision to wean patient for extubation while stabilizing hemodynamics</p>			

<p>Patient extubated in OR on nicardipine drip (5mg/hr)</p>	<p>HR 122 bpm BP 112/84 mm Hg SpO<sub>2</sub> 98% Temp 36.9° C</p> <p>Patient awake, alert, and oriented; reporting headache and *new onset of visual disturbances; papilledema noted</p>	<ol style="list-style-type: none"><li>1. Recognize new onset of visual disturbance and discuss differential diagnosis</li><li>2. Initiate neurology consult and order imaging to rule out Posterior Reversible Encephalopathic Syndrome (PRES)</li></ol>			
---	---	--	--	--	--

**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 signs and symptoms of increased intracranial pressure (ICP)?**

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

**2. How would you rate your knowledge of differential diagnosis of increased ICP?**

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 management for ICP in the parturient?**

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 overall confidence when confronted with increased ICP?**

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

**5. How would you rate your overall confidence with effective interdisciplinary communication?**

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

## Appendix 2

### Simulation Activity Evaluation

DATE OF SIMULATION: \_\_\_\_\_

OCCUPATION: STUDENT      NURSE      MIDWIFE      PA      CRNA      RESIDENT      ATTENDING

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
---------------------------------	---	---	---	---	---	-----

**Table 1 Causes and mechanisms of production of intracranial hypertension during pregnancy**

Etiology of intracranial hypertension	Mechanism of production
Tumors	Mass lesion Vasogenic edema
Traumatic Brain Injury with or without polytrauma	Mass lesions Vasogenic, cytotoxic edema Extracranial causes (intrathoracic or intrabdominal hypertension) Secondary insults (hypercapnia)
Idiopathic Intracranial Hypertension	Unclear
Preeclampsia Posterior Reversible Encephalopathy Syndrome	Vasogenic edema
Cerebrovascular Diseases Spontaneous Intracerebral Hemorrhage Secondary Intracerebral Hemorrhage Arteriovenous Malformations Rupture Subarachnoid Hemorrhage Cerebral venous Thrombosis	Mass effect, Vasogenic edema Cytotoxic edema, Hydrocephalus, CSF circulation alteration
CNS infections Encephalitis/Meningitis Brain Abscess	Vasogenic, cytotoxic edema Mass lesion, Vasogenic edema
Acute fatty liver	Vasogenic, cytotoxic edema
Shunt Malfunction	Hydrocephalus

Godoy DA, Robba C, Paiva WS, Rabinstein AA. Acute intracranial hypertension during pregnancy: special considerations and management adjustments. *Neurocrit Care*. 2022;36(1):302-316. doi:10.1007/s12028-021-01333-x



## References:

1. Godoy DA, Robba C, Paiva WS, Rabinstein AA. Acute intracranial hypertension during pregnancy: special considerations and management adjustments. *Neurocrit Care*. 2022;36(1):302-316. doi:10.1007/s12028-021-01333-x
2. Chao A-S, Chen Y-L, Chang Y-L, Chao A, Su S-Y, Wang T-H. Severe pre-eclamptic women with headache: is posterior reversible encephalopathy syndrome an associated concurrent finding? *BMC Pregnancy Childbirth*. 2020;20(1):336. doi:10.1186/s12884-020-03017-4
3. Carney N, Totten AM, O'Reilly C, et al. Guidelines for the management of severe traumatic brain injury, fourth edition. *Neurosurgery*. 2017;80(1):6-15. doi:10.1227/NEU.0000000000001432
4. Stocchetti N, Maas AIR. Traumatic Intracranial Hypertension. *N Engl J Med*. 2014;370:2121-2130.
5. Leffert LR, Schwamm LH. Neuraxial anesthesia in parturients with intracranial pathology: a comprehensive review and reassessment of risk. *Anesthesiology*. 2013;119(3):703-718. doi:10.1097/ALN.0b013e31829374c2
6. Thaller M, Wakerley BR, Abbott S, Tahrani AA, Mollan SP, Sinclair AJ. Managing idiopathic intracranial hypertension in pregnancy: practical advice. *Pract Neurol*. 2022;22(4):295-300. doi:10.1136/practneurol-2021-003152
7. Alves S, Sousa N, Cardoso L, Alves J. Multidisciplinary management of idiopathic intracranial hypertension in pregnancy: case series and narrative review. *Braz J Anesthesiol*. Published online March 20, 2021. doi:10.1016/j.bjane.2021.02.030