

Simulation Patient Design

Case: Thyroid Storm in Pregnancy

Authors: Lisbeysi Calo, MD¹; Elvera L. Baron, MD PhD²; Daniel Katz, MD³.

1 Yale School of Medicine, New Haven, CT

2 Case Western Reserve University School of Medicine, Cleveland, OH

3 Icahn School of Medicine at Mount Sinai, New York, NY

Editors: Sonal Zambare, MD FASA, Kokila Thenuwara MD, MME MHCDS, Jessica Sheeran, MD

Introduction:

A pregnant laboring patient in fulminant thyroid storm constitutes an emergency with high mortality rates¹. There is a need for a high level of suspicion by clinicians to identify and prevent an impending thyroid storm. Prompt recognition with effective and expeditious treatment is of paramount importance to avoid further compromise to the well-being of both mother and fetus.

Pregnant patients with known hyperthyroidism should have their thyroid function monitored and controlled even before pregnancy, and especially during pregnancy and delivery as they are more likely to develop thyroid storm when compared to their non-pregnant counterparts¹. Since symptoms such as heat intolerance, headache, anxiety, and diarrhea are non-specific and are common in normal pregnancies, they could easily be misinterpreted, delaying proper diagnosis and prompt treatment related to uncontrolled hyperthyroidism. Surgery, trauma, and delivery are some of the known precipitating factors that could trigger the impending thyroid storm. Pregnant patients are at particularly higher risk of developing a thyroid storm (10-fold)¹, with additional risk factors of pre-eclampsia, diabetic ketoacidosis, and infection¹.

Though there are no uniform diagnostic criteria for impending thyroid storm in a pregnant patient, Burch and Wartofsky Point Scale (developed in 1993) is often used. This point system includes clinical symptoms and signs in the following areas: thermoregulatory, gastrointestinal-hepatic, cardiovascular, and neurologic, with a score of > 45 defining thyroid storm². The definitive diagnosis of hyperthyroidism requires TSH levels, reflex T3 and T4 hormone levels, and exclusion of infectious sources. The level of free T4 is of utmost importance as T4 concentration is affected by thyroid hormone protein-binding capacity (TBG), whose levels are typically increased in normal pregnancies³. If the original symptoms of hyperthyroidism worsen (specifically, if the temperature increases to above 39C and/or heart rate above 120-159 bpm, accompanied by nausea, irritability, and sweating), the impending thyroid storm could be still reversible if properly identified and treated. However, if the temperature stays or continues to rise > 39C, HR continues to increase > 160 bpm, and the patient is displaying an altered level of consciousness (delirium, lethargy or obtundation to coma), then this patient has reached a stage of thyroid storm that is subject to a high mortality rate.

The treatments for impending thyroid storm are aimed at slowing down symptomatic worsening to avoid reaching thyrotoxicosis. These include supportive measures (such as cooling blankets, acetaminophen, cold IV fluids), titration of antithyroid drugs (including propylthiouracil (PTU), and methimazole), and the use of beta blockers and steroids. PTU directly affects the thyroid gland to decrease TSH production and blocks the peripheral conversion of thyroid hormones from T4 to T3. Methimazole is often also used due to its shorter onset of action than PTU. Beta blockers are beneficial both for their heart rate and blood pressure effects as well as their shared capacity in decreasing

peripheral conversion of T4 to T3 when co-administered with steroids³. They typically require titration and redosing, as the beta blockers' rate of excretion are increased with concurrent use of PTU. Finally, steroids are used to avoid potential adrenal insufficiency that could result from an untreated hypermetabolic state². Certain anesthetic medications should be avoided in a patient with suspected impending thyroid storm. These include any histamine-releasing medications, such as morphine and hydromorphone, and catecholamine-releasing medications, such as epinephrine and ketamine², as they could disproportionally elevate heart rate and blood pressures.

The objectives of this simulation are:

- To identify the signs and symptoms of impending thyroid storm
- To discuss broader differential diagnosis
- To review which medications should be used versus avoided in the perioperative/predelivery management of a pregnant patient with risk for thyroid storm
- To manage impending thyroid storm

Educational Rationale: To teach team skills in managing thyroid storm, recognize signs and symptoms of impending thyroid storm in pregnancy during delivery, review medications that may worsen hemodynamic stability in those with thyroid storm, and discuss perioperative management goals.

Target Audiences: OB Nursing, OB team, Anesthesiology personnel, OR personnel, medical and nursing 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:* Identify signs and symptoms of thyroid storm in a pregnant patient. Treat impending thyroid storm in peri-delivery setting, either in the labor suite or Operating Room. Review which medications may be detrimental or beneficial in management of parturient at risk for or in thyroid storm. Utilize appropriate monitors.
- *Patient care:* Effectively recognize and effectively provide treatment for the hyperthyroid parturient and her fetus on the verge of a thyroid storm.
- *Practice-based learning and improvement:* Identify location of emergency equipment and drugs, familiarize with algorithms and local policies in management of impending thyroid storm in a pregnant patient.
- *Interpersonal and communication skills:* Practice closed-loop communication, team dynamics, calling for help early, and role assignment / delegation during peri-delivery management of a patient in thyroid storm.
- *Professionalism:* Demonstrate professionalism and respect for all team members while managing an emergency, validate and recognize the difficulty and stress of the situation.
- *Systems-based practice:* Review activating additional help in a setting of perioperative emergency and discuss local policies and procedures.

Questions to ask after the scenario / debrief guidance:

- 1) How do you think this scenario went? What do you think your team did well (provide specifics, examples)? What do you think the team could have done better?
- 2) What problems or concerns have you noticed regarding professionalism? Regarding environmental safety and system-based practice?

- 3) What differential diagnoses do you, as a team, consider when presented with this scenario?
- 4) Discuss treatment, including medications to avoid, in a pregnant patient suspected of having a thyroid storm.

Assessment Instruments:

1. Learner Knowledge Assessment form (Appendix1)
2. Simulation Activity Evaluation form (Appendix 2)

Equipment Needed and Set-up:

- Arterial line equipment
- Epidural kit with medications
- Adult and pediatric code carts
- Anesthesia machine
- Airway equipment
- IV medications
- IV set, IV fluids
- Monitors: 5 lead EKG, NIBP, temperature, HR, EtCO₂, invasive blood pressure monitoring

Simulation Scenario Set-up:**Case**

35 year-old G1P0 at 38 week gestation with a past medical history significant for hyperthyroidism on propylthiouracil with known medication non-adherence, bulimia nervosa, and generalized anxiety disorder, who presents in labor after hours to the labor and delivery (L&D) suite. Her pregnancy is also significant for hyperemesis gravida requiring hospitalization in the first trimester due to acute dehydration and electrolyte abnormalities and suspected SGA for the fetus. She has scant prenatal care and her most recent labs are only from the last admission. Denies any recent illnesses or allergies.

Initial Exam. General appearance: thin pregnant patient, anxious and complaining of pain with contractions. BP 119/78 mmHg, HR 90 bpm, RR 15/min, Temp 36.6C, 98% sat on RA. First vaginal exam: 3cm dilated, closed, long, no evidence of meconium. Reassuring fetal tracing. 18G peripheral IV placed.

Labor epidural placed uneventfully and patient begins to feel hot and anxious one hour after epidural placement. OB and Anesthesia are called to the room to evaluate the patient's symptoms.

Labs: WBC 5.1×10^9 / L, Hg 11.8 g/dL, Plt 144×10^3 / mL. BMP and coagulation studies WNL.

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
<p>Called to patient room 1 hour after uneventful labor epidural placement.</p> <p>Patient used PCEA bolus x1 time, continuous epidural infusion in progress.</p>	<p>S/p epidural placement</p> <p>Patient is awake and responsive, lying in bed, complaining of feeling hot and more anxious. Denies any pain with contractions.</p> <p>FHR: reassuring, 130s with moderate variability</p> <p>HR 110 bpm BP 148/85 mm Hg SpO₂ 97% (air) Resp 16/min Temp 37.1C No pain</p>	<p>1. L&D nurse</p> <ul style="list-style-type: none"> <input type="checkbox"/> Informs the OB team of pt symptoms, calls OB team to evaluate uteroplacental contractions and fetal well being <input type="checkbox"/> Calls anes team to evaluate epidural <input type="checkbox"/> Sends additional STAT labs: TSH with reflex, T3 and T4 <input type="checkbox"/> Initiates IV fluid infusion <p>2. Ob Team</p> <ul style="list-style-type: none"> <input type="checkbox"/> Repeat vaginal exam - 4cm dilated, long, closed <input type="checkbox"/> Consider beta-blocker initiation <input type="checkbox"/> Call OR to prep for potential emergency Cesarean delivery <p>3. Anesthesia Team</p> <ul style="list-style-type: none"> <input type="checkbox"/> Place second 18G PIV <input type="checkbox"/> Check epidural functioning properly 			
<p>30 min elapsed</p> <p>Patient used PCEA bolus x2 time, continuous epidural infusion in progress.</p>	<p>s/p 5mg labetalol IV</p> <p>Patient is more restless.</p> <p>Lab results from initial presentation (> 2 hours ago): TSH: 0.2 mIU/L FT4: 2.6 ng/dL T3: 2.0 ng/dL</p> <p>The patient complains of headache, nausea, and palpitations. Sweating and</p>	<p>1. L&D nurse</p> <ul style="list-style-type: none"> <input type="checkbox"/> Informs the OB team and Anesthesia Team of worsening patient symptoms and vital signs <input type="checkbox"/> OB and Anesthesia teams at bedside <input type="checkbox"/> OR on standby <p>2. OB Team</p> <ul style="list-style-type: none"> <input type="checkbox"/> Discuss TSH/FT4/T3 results with the patient and needed urgent treatments <input type="checkbox"/> Consult endocrine service <input type="checkbox"/> Consider differential diagnosis and treatment options <input type="checkbox"/> Discuss with the patient potential need for emergency cesarean 			

	<p>anxious. Denies significant pain with contractions.</p> <p>FHM: reassuring</p> <p>HR 140 bpm BP 154/86 mm Hg SpO₂ 97% (air) Resp 16/min Temp 38.1C Minimal pain with contractions</p>	<p>delivery, based on patient symptoms and FHM</p> <ul style="list-style-type: none"> <input type="checkbox"/> OR on standby <input type="checkbox"/> Discuss delivery plan with Ob and NICU teams <p>3. Anesthesia Team</p> <ul style="list-style-type: none"> <input type="checkbox"/> Consider differential dx <input type="checkbox"/> Obtain 12 lead EKG – narrow complex tachycardia <input type="checkbox"/> Prep OR emergency medications <input type="checkbox"/> Continuous patient monitoring <input type="checkbox"/> Emergency crash cart at bedside <input type="checkbox"/> Arterial line and central line kits ready in the OR <input type="checkbox"/> Check blood availability 			
<p>Non-reassuring fetal heart tracing. Baseline of 105 bpm with increasing late decelerations</p>	<p>s/p additional 5mg labetalol IV, initial dose PTU PO, methimazole IV, steroids IV, and 1g acetaminophen IV</p> <p>s/p 1L IV fluids since admission with minimal UOP</p> <p>The patient complains of severe headache, and severe nausea without vomiting. Anxious and restless. Reports feeling weak, hot, and sweaty. Closes her eyes intermittently.</p> <p>HR 136 bpm BP 162/88 mm Hg SpO₂ 97% (air) Resp 18/min Temp 38.4C</p>	<p>1. OB team and patient decide to proceed to Cesarean delivery</p> <p>2. Anesthesia Team</p> <ul style="list-style-type: none"> <input type="checkbox"/> D/c epidural PCEA <input type="checkbox"/> Dose epidural with 20mL 2% lidocaine in aliquots to achieve surgical analgesia on the way to the OR. Motor and sensory block achieved. <input type="checkbox"/> Continue supportive measures (cooling, antipyretic, supplemental O₂) on the way to the OR <input type="checkbox"/> Can consider ending scenario here after stabilization with IV labetalol, PO PTU, IV methimazole, and IV steroids. Otherwise, can proceed to OR if continued non-reassuring FHR tracing. 			

Arrived in the OR	<p>Patient is placed into supine position with left uterine displacement. She is more visibly tired.</p> <p>Once transferred onto the bed and monitors attached, surgeons went to scrub, patient loses consciousness.</p> <p>HR 111 bpm, intermittent PVCs BP 152/72mm Hg SpO₂ 97% (air) Resp 15/min Temp 37.5°C</p>	<ol style="list-style-type: none"> Anesthesia Team <ul style="list-style-type: none"> <input type="checkbox"/> Announce change in the patient status including LOC <input type="checkbox"/> Prepare for rapid sequence intubation: succinylcholine vs rocuronium, lidocaine, propofol; fentanyl after fetal delivery <input type="checkbox"/> Call for additional help <input type="checkbox"/> Inform Ob team – STAT cesarean delivery indicated <input type="checkbox"/> Place arterial line, send off ABG once intubated <input type="checkbox"/> Correct any electrolyte abnormalities <input type="checkbox"/> Continue beta-blocker titration as needed OB Team <ul style="list-style-type: none"> <input type="checkbox"/> Expedited prep and drape <input type="checkbox"/> Call for additional assistance <input type="checkbox"/> Delivery of SGA fetus within 3 minutes of incision OR Nursing Team <ul style="list-style-type: none"> <input type="checkbox"/> Call for NICU, for fetus delivery under GA <input type="checkbox"/> Update family 			
Delivery of SGA fetus with APGARs 6 and 8, taken to NICU due to low weight	<p>Patient intubated and sedated</p> <p>Intermittent PVCs are continuously noted. Normal electrolytes on ABG, with mild acidemia. Otherwise, stable vital signs and uneventful anesthetic record. Fever with slow but continuous improvement throughout the OR case duration.</p>	<ol style="list-style-type: none"> Continue current monitoring and management Update family 			
Uneventful primary uterine closure.	Patient extubated on the OR table.	<ol style="list-style-type: none"> Continue to administer oxygen 10 L/min via a non-rebreather facemask Fully monitored, including a line 			

	Drowsy HR 100 bpm BP 140/76 mm Hg SpO ₂ 96% (air) Temp: 37°C Complains of sore throat. Denies headache. Minimal abdominal discomfort.	3. Continue beta blocker titration 4. Consider discharge to PACU vs ICU/step down unit 5. Update family 6. Repeat labs 7. Consider repeating 12 lead EKG			
--	--	--	--	--	--

References:

1. Ma, Y., Li, H., Liu, J., *et al.* "Impending thyroid storm in a pregnant woman with undiagnosed hyperthyroidism: A case report and literature review." *Medicine (Baltimore)*. **2018**; 97(3): e9066. PMID: 29504986.
2. Bacuzzi, A., Dionigi, G., *et al.* "Predictive features associated with thyrotoxic storm and management." *Gland Surg.* **2017**; 6(5):546-551. PMID: 29142847.
3. Barash, P. G., Cullen, B. F., *et al.* "Clinical Anesthesia, Chapter 47: Endocrine Function." **2017**; Wolters Kluwer, 8th edition, p.1328.

Appendix 1

Learner Knowledge Assessment Labor and Delivery Multidisciplinary Team Simulation

Name of the Simulation: **Thyroid Storm in Pregnancy**

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 an impending thyroid storm?

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 differential diagnosis of hyperthyroidism?

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 impending thyroid storm?

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 delivery planning for a patient in fulminant thyroid storm?

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 overall confidence when confronted with a pregnant patient with uncontrolled hyperthyroidism?

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			

Appendix 2

Simulation Activity Evaluation

DATE OF SIMULATION: _____

OCCUPATION: Consultant PG Yr1 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: