

SIMULATION

Thyroid Storm in the Emergency Department

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ABSTRACT:

Audience: Emergency medicine residents of all levels, and emergency medicine medical students.

Introduction: Thyroid storm represents the extreme manifestation of thyrotoxicosis.¹ It ranks as one of the most critical illnesses in the spectrum of endocrine emergencies.¹ Recognition and appropriate management of life-threatening thyrotoxicosis is vital to prevent the high morbidity and mortality that may accompany this disorder. The incidence of thyroid storm has been noted to be less than 10% of patients hospitalized for thyrotoxicosis; however, the mortality rate due to thyroid storm ranges from 20%-30%.¹ This simulation case allows the trainee to practice important critical decision-making skills in the evaluation and management of a patient presenting with thyroid storm.

Objectives: By the end of this simulation-based session, the learner will be able to: 1) Recognize the signs and symptoms of thyroid storm and appropriately diagnose a patient with thyroid storm. 2) Choose appropriate medications for the treatment of thyroid storm. 3) Determine the appropriate disposition for a patient presenting in thyroid storm. 4) Discuss the rationale behind each drug used to treat thyroid storm. 5) List at least three precipitants of thyroid storm.

Method: This case can be run as a low, medium, or high-fidelity simulation.

Topics: Thyroid storm, thyrotoxicosis, hyperthyroidism, endocrine emergencies.



USER GUIDE

List of Resources:

Abstract	68
User Guide	69
Instructor Materials	70
Operator Materials	80
Debriefing and Evaluation Pearls	85
Simulation Assessment	89

Learner Audience:

Medical students, interns, junior residents, senior residents, community physicians

Time Required for Implementation:

Instructor Preparation: 20-30 minutes

Time for case: 10-15 minutes

Time for debriefing: 10-30 minutes

Recommended Number of Learners per Instructor:

2-5

Topics:

Thyroid storm, thyrotoxicosis, hyperthyroidism, endocrine emergencies.

Objectives:

By the end of this simulation session, the learner will be able to:

1. Recognize the signs and symptoms of thyroid storm and appropriately diagnose a patient with thyroid storm.
2. Choose appropriate medications for the treatment of thyroid storm.
3. Determine the appropriate disposition for a patient presenting in thyroid storm.
4. Discuss the rationale behind each drug used to treat thyroid storm.
5. List at least three precipitants of thyroid storm.

Linked objectives and methods:

Using a simulation case, the learners will be presented with an undifferentiated patient who is febrile, tachycardic, hypertensive, and altered. By evaluating the simulated patient, the participants will be able to recognize the signs and symptoms of thyroid storm and appropriately diagnose it (objective 1). During the simulation, they are expected to appropriately treat the patient with pharmacologic agents (objective 2) and disposition the patient to an intensive care unit (objective 3). During the debriefing, instructors should ask questions that allow discussion of the pathophysiology and rationale of thyroid storm treatment (objective 4), as well as a review of common precipitants (objective 5).

Recommended pre-reading for instructor:

1. Nayak B, Burman K. Thyrotoxicosis and thyroid storm. *Endocrinol Metab Clin N Am.* 35(2006);663-686.
2. Ross D. Thyroid storm. In: Mulder J, ed. *UpToDate*. Waltham, MA: UpToDate Inc. <http://www.uptodate.com/contents/thyroid-storm>. Updated January 8, 2018. Accessed November 26, 2018.
3. Idrose AM. Hyperthyroidism. In: Tintinalli JE, Stapczynski J, Ma O, Cline DM, Cydulka RK, Meckler GD, eds. *Tintinalli's Emergency Medicine: A Comprehensive Study Guide*. 8th ed. New York, NY: McGraw-Hill; 2016:1472-1478.

Results and tips for successful implementation:

This is best implemented in a simulated hospital environment. The ideal number of learners per case is 2-5. After the case, a thorough debriefing should be conducted. The authors often open the debriefing session by eliciting participants' reactions to the case (asking questions such as "how did the case go?"). Then, depending on the level of the learners, the authors use different techniques including plus/delta debriefing (for novice learners) and advocacy/inquiry debriefing (for advanced learners) to review the case and teach learning objectives. Of note, this case contains a large amount of physiology and pharmacology, so the discussion should be guided to fit within debriefing time constraints (recommend 10-30 minutes). Finally, the instructors should take the final 1-2 minutes to ask the participants to reflect on what they've learned in the case (eg, asking everyone to state one new thing that they learned in the case or debriefing).

This case was piloted with approximately 20 emergency medicine residents. The group was comprised of first, second, and third year residents from a three-year emergency medicine residency. Overall, the case was well received by learners, who felt it was useful and were engaged throughout the session. No major changes were made to the case after piloting.

References/suggestions for further reading:

1. Nayak B, Burman K. Thyrotoxicosis and thyroid storm. *Endocrinol Metab Clin N Am.* 35(2006);663-686.
2. Ross D. Thyroid storm. In: Mulder J, ed. *UpToDate*. Waltham, MA: UpToDate Inc. <http://www.uptodate.com/contents/thyroid-storm>. Updated January 8, 2018. Accessed November 26, 2018.
3. Idrose AM. Hyperthyroidism. In: Tintinalli JE, Stapczynski J, Ma O, Cline DM, Cydulka RK, Meckler GD, eds. *Tintinalli's Emergency Medicine: A Comprehensive Study Guide*. 8th ed. New York, NY: McGraw-Hill; 2016:1472-1478.



INSTRUCTOR MATERIALS

Case Title: Thyroid Storm in the Emergency Department

Case Description & Diagnosis (short synopsis): A 67-year-old female presents to the emergency department with a chief complaint of fever, cough, and confusion. Upon further questioning of her family at bedside, participants will discover that she has a history of hyperthyroidism. On exam, she is tachycardic, hypertensive, febrile, and confused. Electrocardiogram (ECG) will show sinus tachycardia. Chest X-ray will show right middle lobe pneumonia. Participants should recognize that the patient is in thyroid storm, likely precipitated by pneumonia, and initiate appropriate treatments and admit the patient to the medical intensive care unit (ICU). If the participant does not initiate appropriate therapies for thyroid storm, the patient will deteriorate into a hemodynamically unstable rhythm, arrest, and will expire if no appropriate thyroid storm treatment is initiated.

Equipment or Props Needed:

High fidelity simulation mannequin

Machines: Defibrillator, suction, intravenous (IV) pumps, high fidelity simulator.

Monitors: Monitor for vital signs, blood pressure cuff, four lead ECG monitor, pulse oximeter.

Airway equipment: Endotracheal tube, bag valve mask, laryngoscope, oral airway, non-rebreather mask.

Medications: IV tubing and bags, labeled syringes representing medications, crash cart.

Confederates needed:

Confederate (actor or faculty member) to play patient's family member (ie, husband, sister, depending on which actor is available). Confederate to play nurse. If actors are not available, confederate information may be conveyed through the simulation instructor.

Stimulus Inventory:

- #1 Electrocardiogram (ECG) showing sinus tachycardia
- #2 Complete blood count (CBC)
- #3 Complete metabolic panel (CMP)
- #4 Troponin
- #5 Creatine kinase (CK)
- #6 Brain natriuretic peptide (BNP)
- #7 Lactic acid
- #8 Urine analysis (UA)
- #9 Thyroid function panel



INSTRUCTOR MATERIALS

#10 Chest X-ray showing right middle lobe infiltrate

#11 Computed tomography (CT) head

Background and brief information: The scenario takes place in an emergency department at a community hospital. The patient is brought in by family for evaluation after fever, cough and confusion for two days.

Initial presentation: The patient presents to the emergency department by private auto complaining of fever, cough, and confusion for two days. She is agitated and the family provides most of the history.

How the scenario unfolds: The case begins with the patient presenting to the emergency department with two days of fever, cough, and confusion. The learners should immediately assess the patient's airway, breathing, and circulation, while requesting that the patient be placed on a cardiac monitor and pulse oximeter, obtaining an initial set of vital signs, and requesting large-bore IV access. Initial vital signs will be significant for tachycardia, hypertension, mild hypoxia, and an elevated temperature. Learners should place the patient on supplemental oxygen, start IV fluids, and request that laboratory studies be obtained. Participants should also perform a targeted history and physical examination. Since the patient will be altered on exam, the companion (husband or sister depending on confederate available) who accompanies the patient provides the majority of the history. The patient's physical examination will be significant for agitation, coarse right-sided lung sounds, and stigmata of hyperthyroidism (exophthalmos, thyromegaly, etc.). A chest X-ray and electrocardiogram should also be obtained. The chest X-ray will be significant for a right middle lobe consolidation.

The learners should recognize that the patient is in thyroid storm, which was likely precipitated by the pneumonia, and should start the appropriate treatment for both. If the learners start a beta-blocker medication, the patient's tachycardia and hypertension will improve. If the beta-blocker is not started, the patient will become increasingly tachycardic and hypertensive. Learners should also initiate treatment with thionamides, preferably propylthiouracil (since it decreases the synthesis of new hormone and inhibits peripheral conversion of T₄ to T₃); however, methimazole may also be used. Iodine therapy such as Lugol's solution or potassium iodide should also be started; however, it is important for the participant to verbalize that iodine therapy should be started at least one hour after thionamides are given. If iodine is given before thionamides, then the patient will develop



INSTRUCTOR MATERIALS

worsening tachycardia and hypertension. Glucocorticoids should also be given. Broad-spectrum antibiotics should also be initiated for the treatment of the pneumonia and sepsis. If the participant does not initiate appropriate therapies for thyroid storm and sepsis, the patient will deteriorate into a hemodynamically unstable rhythm and will have to be intubated. Appropriate disposition for this patient is admission to the ICU.

Critical actions:

1. Assess airway, breathing, circulation.
2. Establish two large bore IV lines.
3. Place the patient on oxygen (at least nasal cannula (NC) 4-6 L/min).
4. Place patient on monitors (cardiac monitor and pulse oximetry monitor).
5. Give broad spectrum antibiotics.
6. Give medication to decrease hormone synthesis (preferably propylthiouracil but methimazole is acceptable).
7. Give medication to prevent hormone release (saturated solution of potassium iodine [SSKI], Lugol solution, or lithium carbonate), and learners should verbalize that it should be given at least one hour after thionamides.
8. Prevent peripheral hormone effects (beta blockade, steroids, guanethidine, or reserpine).
9. Admit patient to MICU service.



INSTRUCTOR MATERIALS

Case title: Thyroid Storm in the Emergency Department

Chief Complaint: A 67-year-old female presents to the emergency department with a chief complaint of fever, cough, and confusion.

Vitals: Heart Rate (HR) 151 Blood Pressure (BP) 195/100 Respiratory Rate (RR) 19
Temperature (T) 38.7°C Oxygen Saturation (O₂Sat) 93% on room air

General Appearance: Appears stated age, thin-appearing, agitated.

Primary Survey:

- **Airway:** Airway is clear.
- **Breathing:** Slightly coarse sounds to right chest, left chest is clear to auscultation.
- **Circulation:** Pulses present in all extremities, tachycardic and regular.

History:

- **History of present illness:** This is a 67-year-old female presenting with fever, cough, and confusion. Per family at bedside, patient has had symptoms of rhinorrhea and cough for the past several days. Cough has become more productive-sounding and patient developed a fever today. Today, they noted that patient became confused and agitated. At baseline, she is alert and oriented and able to care for herself and perform all activities of daily living (ADLs).
- **Past medical history:** Hypertension, diabetes, hyperthyroid, arthritis.
- **Past surgical history:** None.
- **Medications:** “High blood pressure medicine,” insulin, and a “thyroid medication,” per family member.
- **Allergies:** No known drug allergies.
- **Social history:** Occasional alcohol. No smoking, no drugs.
- **Family history:** Non-contributory.

Secondary Survey/Physical Examination:

- **General appearance:** Appears stated age, thin-appearing, agitated and confused.
- **HEENT:**
 - **Head:** Normocephalic, no external signs of head trauma.
 - **Eyes:** Slight exophthalmos present. Pupils 4mm and reactive bilaterally. Extraocular movements intact (EOMI).



INSTRUCTOR MATERIALS

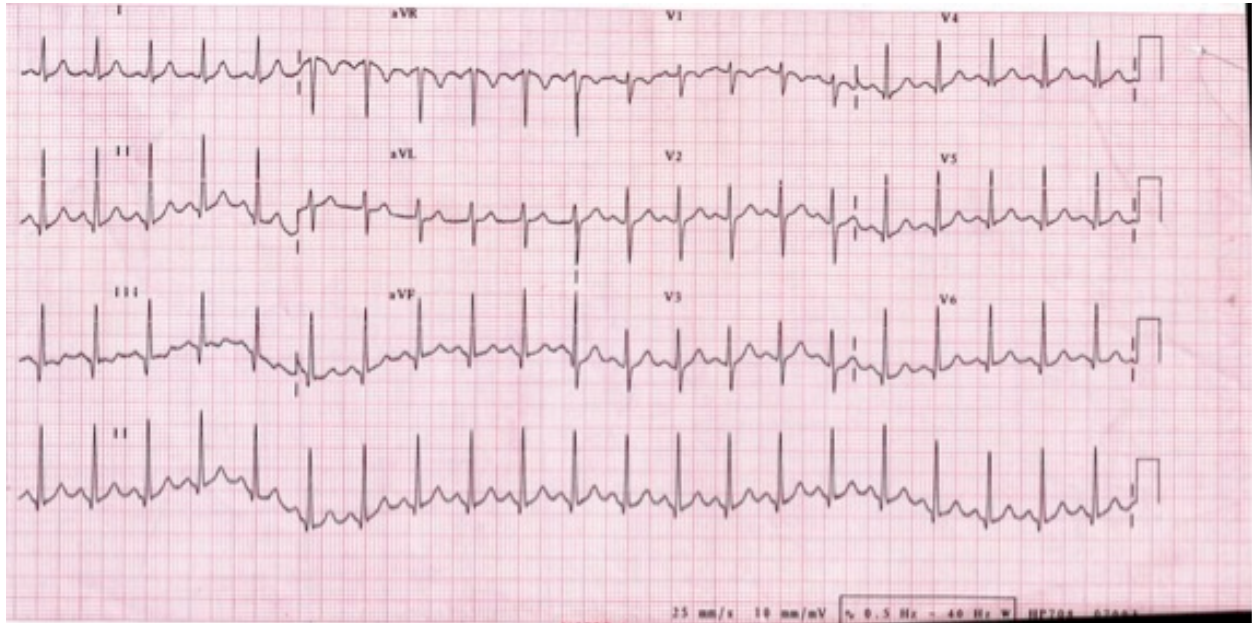
- **Ears:** Normal appearing external ears. Tympanic membrane clear bilaterally.
- **Nose:** Normal appearing external nose. No nasal discharge.
- **Throat:** No erythema of oropharynx, no tonsillar exudates, uvula is midline.
- **Neck:** Palpable thyromegaly to anterior neck, with slight bruit to auscultation. No midline cervical spine tenderness. Full range of motion of neck.
- **Heart:** Tachycardic, regular. No murmurs.
- **Lungs:** Crackles heard in right middle and right lower chest. Left chest is clear to auscultation. No accessory muscle use, no tachypnea, no cyanosis.
- **Abdominal/GI:** Soft, non-distended, non-tender to palpation, no guarding, no rigidity.
- **Genitourinary:** Normal appearing external female genitalia.
- **Rectal:** No melena, no hematochezia. Heme-occult negative.
- **Extremities:** No gross deformities. No lower extremity edema.
- **Back:** Non-tender to palpation, no step-offs, no decubitus ulcers.
- **Neuro:** Awake and alert, not answering questions appropriately. Pupils 4mm equal and reactive bilaterally, extra ocular muscles intact (EOMI). No facial droop. Symmetric smile. Equal upper and lower extremity strength 4/5 bilaterally. Hyperreflexia present. Glasgow coma scale (GCS) 4-5-4 (eyes, verbal, motor).
- **Skin:** Warm and well perfused, forehead is diaphoretic.
- **Lymph:** No palpable lymphadenopathy.
- **Psych:** Agitated.



INSTRUCTOR MATERIALS

Results:

*Electrocardiogram showing sinus tachycardia
(author's own image)*





INSTRUCTOR MATERIALS

Complete blood count (CBC)

White blood count (WBC)	17.0 x1000/mm ³ (H)
Hemoglobin (Hgb)	12 g/dL
Hematocrit (HCT)	35.0%
Platelet (Plt)	309 x1000/mm ³

Complete metabolic panel (CMP)

Sodium	135 mEq/L
Chloride	102 mEq/L
Potassium	4.1 mEq/L
Bicarbonate (HCO ₃)	23 mEq/L
Electrolyte balance	10 mEq/L
Blood Urea Nitrogen (BUN)	11 mg/dL
Creatine (Cr)	0.9 mg/dL
Glucose	209 mg/dL
Calcium	8.7 mg/dL
Protein, Total	7.0 g/dL
Albumin	4.0 g/dL
Alkaline Phosphate (alk phos)	102 Units/L
Aspartate Aminotransferase (AST)	20 Units/L
Alanine Aminotransferase (ALT)	10 Units/L

<i>Troponin</i>	<0.01 mcg/L	(normal <0.1 ng/mL)
<i>Creatine kinase (CK)</i>	141 Units/L	(normal 30-170 Units/L)
<i>Brain natriuretic peptide (BNP)</i>	49 pg/mL	(normal <100 pg/mL)
<i>Lactic Acid</i>	4.5 mEq/L	(normal 0.4-2.3 mEq/L)



INSTRUCTOR MATERIALS

Urinalysis (UA)

Color	yellow
Specific gravity	1.015
pH	6
Protein	negative
Glucose	negative
Ketones	negative
Hemoglobin	negative
Leukocyte esterase	negative
Nitrites	negative
Red blood cells (RBC)	3 RBCs/ high powered field (HPF)
White blood cells (WBC)	1 WBCs/HPF
Bacteria	none
Squamous epithelial cells	5 cells/HPF

Thyroid function panel

Thyroid stimulating hormone (TSH)	<0.01 mIU/L	(normal 0.4 - 4.0 mIU/L)
Free thyroxine (free T4)	25 ng/dL	(normal 0.7 - 1.9 ng/dL)



INSTRUCTOR MATERIALS

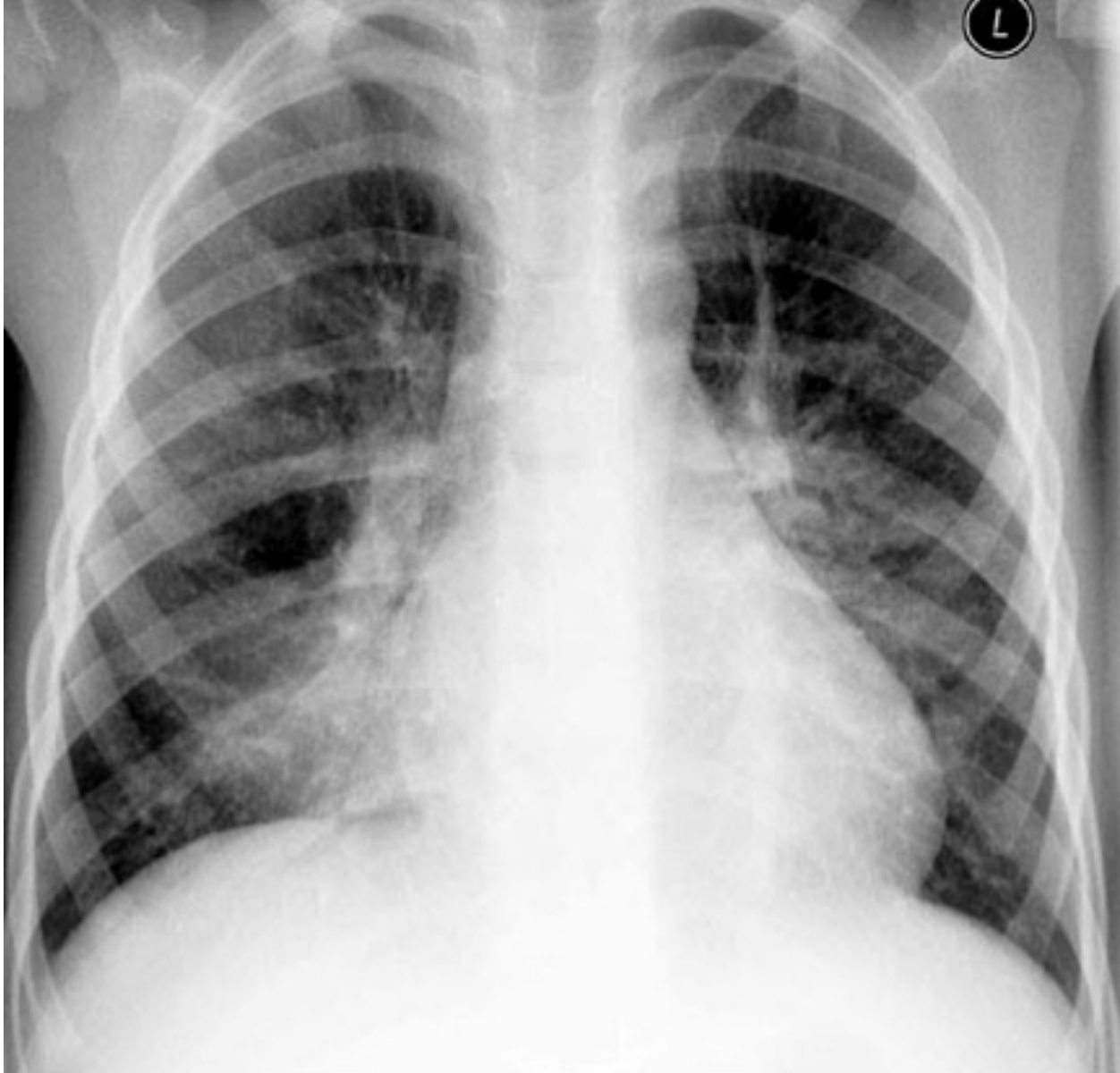
*Non-contrast head CT
(author's own image)*





INSTRUCTOR MATERIALS

*Chest Radiograph showing right middle lobe infiltrate
(author's own image)*





OPERATOR MATERIALS

SIMULATION EVENTS TABLE:

Minute (state)	Participant action/ trigger	Patient status (simulator response) & operator prompts	Monitor display (vital signs)
0:00 (Baseline)	<p>Assess airway, breathing and circulation (ABCs)</p> <p>Start two large bore IV lines.</p> <p>Oxygen (at least NC 4-6 L/min)</p> <p>Attach to monitors (cardiac and pulse ox)</p> <p>Obtain set of vitals</p> <p>Obtain focused history and physical (and necessary information from family member)</p> <p>Order ECG</p>	<p>Patient presenting with fever, cough, and confusion</p> <p>Patient will be agitated and confused, and unable to give history</p> <p>Participant will need to obtain critical history points from family member at bedside</p>	<p>T 38.7°C HR 151 BP 195/100 RR 19 O₂sat 93% on RA</p> <p>If oxygen started: T 38.7°C HR 151 BP 195/100 RR 19 O₂sat 100%</p>
03:00	<p>Order labs: CBC, CMP, coagulation studies, cardiac enzymes</p> <p>Order chest X-ray</p> <p>Head CT can be completed if ordered</p>	<p>ECG tracing available. (sinus tachycardia)</p> <p>Patient continues to be agitated, confused, and coughing</p>	<p>T 39°C BP 200/113 HR 155 RR 23 O₂sat: 100% if on oxygen 88% if not on oxygen</p> <p>Monitor shows sinus tachycardia</p>



OPERATOR MATERIALS

Minute (state)	Participant action/ trigger	Patient status (simulator response) & operator prompts	Monitor display (vital signs)
05:00	<p>Interpret ECG as sinus tachycardia</p> <p>Participants should identify pneumonia once chest X-ray is available</p>	<p>Chest X-ray available (impression: right middle lobe infiltrate)</p> <p>Patient continues with agitation and confusion</p>	<p>T 39°C BP 200/113 HR 155 RR 23 O₂sat: 100% if on oxygen 88% if not on oxygen</p>
06:00	<p>Broad spectrum antibiotics and 30cc/kg fluid bolus should be started for sepsis due to pneumonia</p>	<p>Patient continues with agitation and confusion</p> <p>Heart rate will improve to 130s if patient is given appropriate fluids and antibiotics, but will remain tachycardic and hypertensive until thyroid storm is treated.</p>	<p>Antibiotics given: T 39°C BP 200/113 HR 135 RR 23 O₂sat: 100% if on oxygen 88% if not on oxygen</p> <p>No antibiotics: T 39°C BP 200/113 HR 155 RR 23 O₂sat: 100% if on oxygen 88% if not on oxygen</p>
07:00	<p>Participants should recognize thyroid storm based on history and presentation.</p> <p>Participants should order treatment for thyroid storm:</p>	<p>Show labs to participant (stimulus 2-9)</p> <p>CT head available if ordered</p>	<p>If beta- blocker and thionamide are given: T 38.5°C BP 185/73 HR 119 RR 20 O₂sat 100% (if on oxygen)</p>



OPERATOR MATERIALS

Minute (state)	Participant action/ trigger	Patient status (simulator response) & operator prompts	Monitor display (vital signs)
	<p>Beta-blockers should be started</p> <p>Thionamide should be started (PTU is preferred but methimazole is acceptable)</p>	<p>If beta-blockers and thionamide are started, patient's heart rate and tachycardia will improve</p> <p>If iodine is given before thionamide, patient will become increasingly hypertensive and tachycardic</p>	<p>If one or both not given: T 39°C BP 200/113 HR 135 RR 23 O₂sat: 100% if on oxygen 88% if not on oxygen</p> <p>If iodine is given before thionamide: T 39°C BP: 200/120 HR: 180 RR 23 O₂sat: 100% if on oxygen 88% if not on oxygen</p>
08:00	<p>Participants should order additional treatments for thyroid storm:</p> <p>Iodine (either Lugol's solution or potassium iodide) should be started <i>1 hour after thionamide administration</i></p>	<p>If appropriate therapy with thionamide followed by iodine is ordered, as well as glucocorticoids, patient's vital signs will improve.</p> <p>If iodine and glucocorticoids are not ordered patient will remain hypertensive and tachycardic.</p>	<p>If thionamide, iodine, antibiotics, fluids, and steroids are given: T 38.5°C HR 119 BP 185/73 RR 20 O₂sat 100% if on oxygen</p>



OPERATOR MATERIALS

Minute (state)	Participant action/ trigger	Patient status (simulator response) & operator prompts	Monitor display (vital signs)
	<p>Glucocorticoids should be started</p>		<p>If one or both not given: T 39°C BP 190/103 HR 135 RR 22 O₂sat: 100% if on oxygen 88% if not on oxygen</p>
<p>10:00 (End of case)</p>	<p>Admit patient to ICU ICU service will accept patient for admission</p>	<p>If all of the aforementioned therapy for thyroid storm and pneumonia treatment have been given, the patient will remain stable and the ICU will accept the patient for admission.</p> <p>If participants have missed parts of the treatment above, patient will remain tachycardic and hypertensive and admitting physician should query if anything else can be done to further stabilize the patient.</p> <p>If no thyroid storm therapy has been started by this time, patient will go into a narrow complex tachyarrhythmia and become hypotensive and unresponsive, requiring cardioversion and intubation. The patient will then go into cardiac</p>	<p>If all appropriate therapies completed: HR 119 BP 185/73 RR 20 O₂sat 100% if on oxygen</p> <p>If only partially treated: T 39°C BP 190/103 HR 135 RR 22 O₂sat: 100% if on oxygen 88% if not on oxygen</p> <p>If no thyroid therapy given: HR 220 BP 70/30 RR 8 (agonal) O₂sat 70% (on oxygen)</p>



OPERATOR MATERIALS

Minute (state)	Participant action/ trigger	Patient status (simulator response) & operator prompts	Monitor display (vital signs)
		arrest and will expire if no thyroid storm treatment is started.	Then: PEA arrest

Diagnosis:

Thyroid storm, right middle lobe pneumonia

Disposition:

Admit to ICU



DEBRIEFING AND EVALUATION PEARLS

Thyroid Storm

Debriefing Points:

Note: It is recommended that during the debriefing, the common precipitants of thyroid storm are emphasized, in order to achieve learning objective 5. It is also recommended that the pathophysiology of thyroid storm and how this relates to the various medications for treatment is emphasized, in order to achieve learning objective 4. The following questions may be considered to prompt discussion:

- What are common precipitants of thyroid storm?
- What is the pathophysiology of thyroid storm?
- What are the pharmacologic therapies for thyroid storm?

Pearls:

Brief background:

- In the spectrum of endocrine emergencies, thyroid storm ranks as one of the most critical.
- Incidence of thyroid storm has been noted to be <10% of patients hospitalized with thyrotoxicosis; however, mortality rate due to thyroid storm ranges from 20%-30%.
- Hyperthyroidism refers to disorders that result from overproduction of hormone.
- Thyrotoxicosis refers to any cause of excessive thyroid hormone concentration.
- Thyroid storm represents an extreme manifestation of thyrotoxicosis.

Normal thyroid physiology:

- Anterior pituitary regulates synthesis/release of thyroid hormone through thyroid stimulating hormone (TSH).
- After being released from thyroid gland, thyroid hormones are reversibly bound to circulating plasma proteins, mainly thyronine-binding globulin (TBG).
- Free, unbound portions of hormone are biologically active.
- Thyroxine (T4) is the predominant circulating hormone. It is peripherally deiodinated to triiodothyronine (T3), which is more biologically active than T4.
- Most actions of thyroid hormone are at the cellular level.

Etiology:

- The most common underlying cause of thyrotoxicosis in cases of thyroid storm is Grave's disease.
- Thyroid storm is often precipitated by an acute event:



DEBRIEFING AND EVALUATION PEARLS

- Infection is the most common precipitating cause of thyroid storm.
- Following iodine exposure (ie: radiocontrast dye, amiodarone).
- Discontinuation of anti-thyroid drugs.
- Thyroid surgery (now not as common).

Signs and symptoms of thyrotoxicosis:

- Constitutional: Weight loss, increased perspiration, heat intolerance, generalized weakness, fatigue.
- Cardiorespiratory: Tachycardia, palpitations, increased pulse pressure, strong apical impulse, dyspnea on exertion, evidence of heart failure.
- Neuropsychiatric: Emotional lability, restlessness, anxiety, agitation, confusion, psychosis, coma.
- Gastrointestinal: Increased frequency of bowel movements.
- Thyroid: Findings vary depending on etiology.
 - Graves' disease: Diffuse enlargement of thyroid gland, bruit, inflammatory ophthalmopathy, localized dermal myxedema.
 - Toxic multinodular goiter: Nodules on thyroid gland.
 - Subacute thyroiditis: Tender thyroid gland.
- Reproductive:
 - In women: oligomenorrhea, anovulation.
 - In men: decreased libido, gynecomastia, spider angiomas.
- Note that in older individuals, the typical symptoms of thyrotoxicosis may not be present. They may present with "apathetic" thyrotoxicosis, with atypical symptoms including weight loss, palpitations, weakness, dizziness, syncope, memory loss, and physical findings of sinus tachycardia or atrial fibrillation.¹

Diagnosis:

- Diagnosis of thyroid storm is based on the presence of severe and life-threatening symptoms (hyperpyrexia, cardiovascular dysfunction, altered mentation) in a patient with biochemical evidence of hyperthyroidism (low TSH/high T4 or T3).²
- There are no universally accepted criteria or validated clinical tools for diagnosing thyroid storm.
- An objective scoring system, developed in 1993 by Burch and Wartofsky, uses precise clinical criteria for the identification of thyroid storm.¹ However, distinction between severe thyrotoxicosis and thyroid storm is a matter of clinical judgment. It is recommended to treat patients in an active preemptory fashion when possible, instead



DEBRIEFING AND EVALUATION PEARLS

of excessively contemplating whether the patient really meets criteria for thyroid storm.¹

Differential diagnosis: (note: this is not an exhaustive differential)

- Sepsis
- Sympathomimetic ingestion
- Heat stroke
- Delirium tremens
- Malignant hyperthermia
- Neuroleptic malignant syndrome
- Stroke
- Pheochromocytoma
- Medication withdrawal
- Central nervous system (CNS) infections

Treatment:

- Goal is to stop synthesis of new hormone within the thyroid gland, halt the release of stored hormone in the thyroid gland, decrease conversion of T4 to T3, control the adrenergic symptoms of thyrotoxicosis, and control systemic decompensation with supportive therapy.
- It is very important that a thionamide is initiated before iodine therapy, to prevent the stimulation of new thyroid hormone synthesis that can occur if iodine is given initially.
- **Thionamides:**
 - Stops synthesis of thyroid hormone by interfering with the thyroperoxidase-catalyzed coupling process within 1-2 hours of administration.
 - Propylthiouracil or methimazole can be used.
 - Propylthiouracil is preferable since it decreases the synthesis of new hormone and inhibits peripheral conversion of T4 to T3.
- **Iodine:**
 - Blocks the release of prestored hormone (Wolff-Chaikoff effect).
 - Iodine therapy should be delayed for at least one hour after thionamide therapy.
 - Oral formulations include Lugol's solution and saturated solution of potassium iodide (SSKI).
- **Beta blockade:**
 - Propranolol most commonly used beta blocker. In addition to beta blockade, it also reduces serum T3 levels in high doses.
 - Can also consider esmolol.



DEBRIEFING AND EVALUATION PEARLS

- Use beta blockers with caution in those with decompensated heart failure or other contraindications (eg, asthma).
- **Glucocorticoids:**
 - Recommended in life-threatening thyroid storm.
 - Has an inhibitory effect on peripheral conversion of T4 to T3, and also treats possible relative adrenal insufficiency.
- **Antipyretics:**
 - Acetaminophen is preferable.
 - Salicylates should be avoided because they can increase free thyroid hormone levels.
- **Alternative therapies:**
 - Only considered when first-line therapies fail or are contraindicated.
 - **Lithium:**
 - Can be used when thionamides therapy is contraindicated.
 - Directly decreases thyroid hormone secretion.
 - **Reserpine, guanethidine:**
 - Inhibits release of catecholamines.
 - Only indicated in rare situations where beta blockers are contraindicated, and there is no evidence of hypotension or CNS-associated mental status changes.¹
 - **Cholestyramine:**
 - Decreases absorption of thyroid hormone from enterohepatic circulation.
- **Definitive treatment:**
 - Radioactive iodine ablation.
 - Thyroid surgery.



SIMULATION ASSESSMENT

Thyroid Storm in the Emergency Department

Learner: _____

Assessment Timeline

This timeline is to help observers assess their learners. It allows observer to make notes on when learners performed various tasks, which can help guide debriefing discussion.

Critical Actions:

1. Assess airway, breathing, circulation.
2. Establish two large bore IV lines.
3. Place the patient on oxygen (at least nasal cannula (NC) 4-6 L/min).
4. Place patient on monitors (cardiac monitor and pulse oximetry monitor).
5. Give broad spectrum antibiotics.
6. Give medication to decrease hormone synthesis (preferably propylthiouracil but methimazole is acceptable).
7. Give medication to prevent hormone release (saturated solution of potassium iodine [SSKI], Lugol solution, or lithium carbonate), and learners should verbalize that it should be given at least one hour after thionamides.
8. Prevent peripheral hormone effects (beta blockade, steroids, guanethidine, or reserpine).
9. Admit patient to MICU service.

0:00



SIMULATION ASSESSMENT

Thyroid Storm in the Emergency Department

Learner: _____

Critical Actions:

- Assess airway, breathing, circulation.
- Establish two large bore IV lines.
- Place the patient on oxygen (at least nasal cannula (NC) 4-6 L/min).
- Place patient on monitors (cardiac monitor and pulse oximetry monitor).
- Give broad spectrum antibiotics.
- Give medication to decrease hormone synthesis (preferably propylthiouracil but methimazole is acceptable).
- Give medication to prevent hormone release (saturated solution of potassium iodine [SSKI], Lugol solution, or lithium carbonate), and learners should verbalize that it should be given at least one hour after thionamides.
- Prevent peripheral hormone effects (beta blockade, steroids, guanethidine, or reserpine).
- Admit patient to MICU service.

Summative and formative comments:



SIMULATION ASSESSMENT

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Milestones assessment:

	Milestone	Did not achieve level 1	Level 1	Level 2	Level 3
1	Emergency Stabilization (PC1)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Recognizes abnormal vital signs	<input type="checkbox"/> Recognizes an unstable patient, requiring intervention Performs primary assessment Discerns data to formulate a diagnostic impression/plan	<input type="checkbox"/> Manages and prioritizes critical actions in a critically ill patient Reassesses after implementing a stabilizing intervention
2	Performance of focused history and physical (PC2)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Performs a reliable, comprehensive history and physical exam	<input type="checkbox"/> Performs and communicates a focused history and physical exam based on chief complaint and urgent issues	<input type="checkbox"/> Prioritizes essential components of history and physical exam given dynamic circumstances
3	Diagnostic studies (PC3)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Determines the necessity of diagnostic studies	<input type="checkbox"/> Orders appropriate diagnostic studies. Performs appropriate bedside diagnostic studies/procedures	<input type="checkbox"/> Prioritizes essential testing Interprets results of diagnostic studies Reviews risks, benefits, contraindications, and alternatives to a diagnostic study or procedure
4	Diagnosis (PC4)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Considers a list of potential diagnoses	<input type="checkbox"/> Considers an appropriate list of potential diagnosis May or may not make correct diagnosis	<input type="checkbox"/> Makes the appropriate diagnosis Considers other potential diagnoses, avoiding premature closure



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	Milestone	Did not achieve level 1	Level 1	Level 2	Level 3
5	Pharmacotherapy (PC5)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Asks patient for drug allergies	<input type="checkbox"/> Selects an medication for therapeutic intervention, consider potential adverse effects	<input type="checkbox"/> Selects the most appropriate medication and understands mechanism of action, effect, and potential side effects Considers and recognizes drug-drug interactions
6	Observation and reassessment (PC6)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Reevaluates patient at least one time during case	<input type="checkbox"/> Reevaluates patient after most therapeutic interventions	<input type="checkbox"/> Consistently evaluates the effectiveness of therapies at appropriate intervals
7	Disposition (PC7)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Appropriately selects whether to admit or discharge the patient	<input type="checkbox"/> Appropriately selects whether to admit or discharge Involves the expertise of some of the appropriate specialists	<input type="checkbox"/> Educates the patient appropriately about their disposition Assigns patient to an appropriate level of care (ICU/Tele/Floor) Involves expertise of all appropriate specialists
9	General Approach to Procedures (PC9)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Identifies pertinent anatomy and physiology for a procedure Uses appropriate Universal Precautions	<input type="checkbox"/> Obtains informed consent Knows indications, contraindications, anatomic landmarks, equipment, anesthetic and procedural technique, and potential complications for common ED procedures	<input type="checkbox"/> Determines a back-up strategy if initial attempts are unsuccessful Correctly interprets results of diagnostic procedure



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	Milestone	Did not achieve level 1	Level 1	Level 2	Level 3
20	Professional Values (PROF1)	<input type="checkbox"/> Did not achieve Level 1	<input type="checkbox"/> Demonstrates caring, honest behavior	<input type="checkbox"/> Exhibits compassion, respect, sensitivity and responsiveness	<input type="checkbox"/> Develops alternative care plans when patients' personal beliefs and decisions preclude standard care
22	Patient centered communication (ICS1)	<input type="checkbox"/> Did not achieve level 1	<input type="checkbox"/> Establishes rapport and demonstrates empathy to patient (and family) Listens effectively	<input type="checkbox"/> Elicits patient's reason for seeking health care	<input type="checkbox"/> Manages patient expectations in a manner that minimizes potential for stress, conflict, and misunderstanding. Effectively communicates with vulnerable populations, (at risk patients and families)
23	Team management (ICS2)	<input type="checkbox"/> Did not achieve level 1	<input type="checkbox"/> Recognizes other members of the patient care team during case (nurse, techs)	<input type="checkbox"/> Communicates pertinent information to other healthcare colleagues	<input type="checkbox"/> Communicates a clear, succinct, and appropriate handoff with specialists and other colleagues Communicates effectively with ancillary staff