Thyroid Storm

February 12, 2017 by Josh Farkas

CONTENTS

- Approaching the diagnosis (#approaching_the_diagnosis)
- Diagnostic criteria (#diagnostic_criteria)
- Management
  - Evaluation & treatment of any trigger (#getting_started_evaluation&_tx_of_cause)
  - Endocrine manipulations (#endocrine_manipulations)
  - Cardiovascular stabilization (#cardiovascular_stabilization)
  - Management of hyperthermia & agitation (#management_of_hyperthermia&_agitation)
- Refractory thyroid storm (#refractory_storm)
- Checklist (#checklist)
- Podcast (#podcast)
- Questions & discussion (#questions&_discussion)
- Pitfalls (#pitfalls)

approaching the diagnosis

Thyroid storm is the most severe form of hyperthyroidism, wherein organ failure begins to occur. If left untreated, this may lead to multi-organ failure and death. Due to the rarity of this condition and its multitude of diverse presentations, diagnosis can be extremely challenging.

when to consider thyroid storm

- Thyroid storm is very rare, so the main challenge is considering it. The possibility should be entertained in the following situations:
  - (1) Patient with known hyperthyroidism plus any acute illness/deterioration.
  - (2) New-onset atrial fibrillation and/or dilated cardiomyopathy.
(3) New-onset delirium/psychosis plus abnormal vital signs (fever, tachycardia).
(4) Hyperthermia (temperature above ~40C).
(5) Septic-appearing patient without any focus of infection (i.e. distributive shock of unknown origin).

**precipitants of thyroid storm**

- General stressors
  - #1 = Infection
  - Surgery or trauma (especially trauma involving the neck, such as strangulation)
  - Pulmonary embolism, myocardial infarction, stroke
  - Labor, preeclampsia
  - Diabetic ketoacidosis, hypoglycemia
- Thyroid-related
  - Thyroid surgery, radioiodine therapy
  - Noncompliance with anti-thyroid medications
  - Overdose of thyroid hormone
  - Acute iodine load from contrast dye or amiodarone
  - [Checkpoint inhibitors](https://emcrit.org/ibcc/checkpoint/), Sorafenib (NEXAVAR, agent used for renal cell carcinoma)
- ~30% of patients have no identifiable precipitant.¹

**signs & symptoms**
Thyroid Storm will usually present as a mimic

neuro-type presentations
- Psychosis mimic
- Meningitis mimic
- Hyperthermia mimic

cardiac-type presentations
- Sepsis mimic (fever, vasodilatory shock)
- Heart failure (can drop the ejection fraction)
- AF with intractably elevated heart rate

Cardiac (often predominant feature)
- Tachycardia, atrial fibrillation
- High-output, distributive heart failure state
- Systolic heart failure can occur

Neurologic
- Delirium, agitation, psychosis
- Stupor/coma

Hyperthermia is nearly universal
- May reach 40-41C (104-106F), classically with associated diaphoresis

Gastrointestinal
- Diarrhea, nausea, vomiting
- Abdominal pain
- Jaundice, hepatic failure

Other features may suggest hyperthyroidism
- Tremor
- Goiter, scar from partial thyroidectomy
- Exophthalmos

Thyroid labs aren’t worse than uncomplicated hyperthyroidism. The differentiation between hyperthyroidism and thyroid storm is based on clinical findings – not how severe the lab abnormality is.

Key findings: Low TSH & elevated free T4 and free T3

May also see:
- Hyperglycemia
- Hypercalcemia
- Low or high WBC
- Abnormal liver function tests

Thyroid Storm - EMCrit Project
https://emcrit.org/ibcc/thyroid-storm/
Thyroid storm.

AMS febrile tachy tremors hx of "gland" prob. TSH lab down 5 hrs for results #POCUS  #FOAMed #FOAMus

Burch criteria for thyroid storm

- **Temperature**
  - 37.2-37.7 (99-99.9) = 5 points
  - 37.8-38.2 (100-100.9) = 10 points
  - 38.3-38.8 (101-101.9) = 15 points
  - 38.9-39.4 (102-102.9) = 20 points
  - 39.5-39.9 (103-103.9) = 25 points
  - 40+ (104+) = 30 points

- **Tachycardia**
  - 99-109 = 5 points
  - 110-119 = 10 points
  - 120-129 = 15 points
  - 130-139 = 20 points
  - >140 = 25 points

- **CNS effects**
  - Mild (e.g. agitation) = 10 points
  - Moderate (e.g. delirium, psychosis) = 20 points
  - Severe (e.g. seizure, coma) = 30 points

- **Gastrointestinal**
  - Diarrhea, n/v, abdominal pain = 10 points
  - Unexplained jaundice = 20 points

- **Heart failure**
  - Mild (e.g. edema) = 5 points
  - Moderate (e.g. rales) = 10 points
  - Severe (e.g. pulmonary edema) = 15 points

- **Atrial fibrillation present** = 10 points
- **Precipitant history present** = 10 points

**interpretation of Burch criteria**

- 45 or more: Highly suggestive of thyroid storm
- 25-44: Supports diagnosis of thyroid storm or impending storm

https://emcrit.org/ibcc/thyroid-storm/
• <25: Thyroid storm unlikely


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<tr>
<th>Thyroid Storm Presenting as Psychosis</th>
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<tr>
<td><strong>Case Presentation</strong></td>
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<td>A 28-year-old Hispanic female with a past medical history of migraine, depression, and a family history of schizophrenia was brought to the emergency room by her family as she was not acting her usual self and was demonstrating strange behavior for 1 week prior to admission. The patient’s family described new onset, and rapidly worsening paranoid delusions along with auditory and visual hallucinations. Associated symptoms included nausea, vomiting, and diarrhea. She denied taking any medications or supplements. Vital signs at the time of admission showed temperature of 99.6°F, heart rate of 144 beats per minute, and elevated blood pressure of 160/72 mm Hg. Physical examination was notable for an enlarged and smooth thyroid gland with an audible bruit. At the time of initial interview, she was emotional and tearful, talking and smiling inappropriately, and admitted to seeing people in the room who were not present.</td>
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Thyroid storm is a very difficult diagnosis. This case has all the elements of storm, but the patient will still look like a patient who has schizophrenia and gastroenteritis. (Desai D et al. 2018; 29796397)


• Thyroid storm is difficult to diagnose because there is a *continuum* of severity, ranging from severe hyperthyroidism to thyroid storm. Any specific binary cutoff is artificial.

• These diagnostic criteria are helpful because they provide a *systematic framework* to think about the diagnosis. However, we aren’t forced to adhere rigidly to these criteria, for a few reasons:
  • 1) The diagnosis of thyroid storm is a partially a diagnosis of *exclusion*. For example, sepsis with multi-organ failure could easily score >45 points on the above criteria. Therefore, a score >45 doesn’t prove a diagnosis of thyroid storm.
  • 2) Treatment for thyroid storm is reasonable in any patient with severe hyperthyroidism causing organ failure (especially heart failure). Therefore, even if the patient doesn’t have a score >45, it may be prudent to initiate therapy for thyroid storm. Patients with borderline storm may improve rapidly and then therapy can be de-escalated.

**getting started: evaluation & tx of cause**

Evaluation includes securing a diagnosis of thyroid storm and simultaneously looking for any potential trigger of the episode. Consider the list of common precipitants above (approaching the diagnosis).

**basic studies to order**

- Glucose, electrolytes including Ca/Mg/Phos
- Liver function tests
- CBC
- Coagulation studies (can cause DIC)
- Creatinine kinase (can cause rhabdomyolysis)

**if infection is suspected**

- Blood cultures & infectious workup as indicated.
- There should generally be a low threshold for initiation of antibiotics (e.g. if the patient has vasodilatory shock, or focal signs of infection). If antibiotics are being started, check procalcitonin.
endocrine manipulations

steroid

- Steroid blocks release of T4 from the thyroid and also blocks peripheral activation of T4 into T3.
- **Dose**
  - The loading dose of hydrocortisone is 300 mg IV.
  - The maintenance dose of hydrocortisone 100 mg IV Q8hr.
- If hydrocortisone isn't immediately available, may use methylprednisolone 60 mg.

thionamide

- Thionamides block thyroid hormone synthesis. This is generally a cornerstone of therapy, although it may be ineffective in rare cases of thyroid storm due to thyroiditis.\(^2\)
    - The safest thionamide (less hepatotoxic).
    - Clinical evidence suggests that it may be equally effective as propylthiouracil.
    - May be the preferred agent, especially in patients with hepatitis.
    - Methimazole dose is 40 mg loading dose, then 20 mg q4 hours.
    - Theoretically more effective than methimazole, because it reduces peripheral conversion of T4 into T3.
    - Propylthiouracil is more hepatotoxic, with an FDA **black box warning** for causing hepatic failure.
    - Might be preferred in more fulminant and definite cases of thyroid storm, or in pregnancy.
    - Dose is 200 mg propylthiouracil q4.
    - Transition to methimazole once patient is improving clinically.

iodine

- Immediately suppresses thyroid hormone release via the [Wolff-Chiakoff effect](https://en.wikipedia.org/wiki/Wolff–Chaikoff_effect).
- Must be given at least an hour *after* thionamide (to prevent increasing thyroid hormone synthesis).
- Different hospitals have different formulations:
  - Lugol's Solution 8 drops PO q6hr (take with fluid/food to avoid gastritis).
  - Saturated solution of KI (SSKI), 5 drops PO q6hr.
- For patients allergic to iodide, lithium may be used instead (300 mg PO q6-8hr, target lithium level of 0.6-1 mEq/L).

cholestyramine

- This binds thyroid hormone in the gut and prevents enterohepatic re-absorption.\(^3\)
- Effective even in patients who haven't taken exogenous thyroid hormone (e.g. Graves disease).
- Extremely safe (available over-the-counter for treatment of diarrhea).
- Dose is 4 grams orally q6hrs.
- Continue until patient is clinically improved.

cardiovascular stabilization

**thyroid storm may cause numerous hemodynamic derangements:**

- 1) Hypovolemia (from diaphoresis, vomiting, diarrhea)
- 2) Systolic heart failure, including cardiogenic shock
- 3) Distributive shock (increased tissue oxygenation causes systemic vasodilation)
- 4) Tachycardia (either sinus tachycardia or atrial fibrillation).
  - Moderate tachycardia may be a **compensatory response** to shock, which improves cardiac output.
● Severe tachycardia may be *pathological*, reducing ventricular filling and thereby exacerbating cardiovascular dysfunction.

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**Initial stabilization**

- **Volume** should be repleted based on echocardiography, lung sonography, and history (e.g. history of poor oral intake, fever, and diarrhea suggest volume depletion).
- **Vasopressors** may be needed to maintain an adequate blood pressure. If the patient is already very tachycardic, phenylephrine might be a reasonable consideration to avoid exacerbating tachycardia.
- **Magnesium** repletion is a good first step for patients with atrial fibrillation and rapid ventricular rate. Hyperthyroidism itself may cause hypomagnesemia.

**Be careful about beta-blockers**

- Widely recommended for thyroid storm, but be very careful: beta-blockade may exacerbate shock (especially in patients with systolic heart failure). A moderate degree of compensatory tachycardia (e.g. heart rate 110-130 b/m) may be necessary to maintain adequate perfusion in some patients.
  - Tachycardia is *not* the primary problem here. Aggressive beta-blockade may cause more harm than benefit.
  - The literature contains numerous reports of patients who crash within 6 hours of initiation of therapy for thyroid storm. In many of these cases, beta-blockade may be the cause of deterioration.\(^4\)
- Don't blindly give beta-blockers without first performing a complete hemodynamic evaluation (echocardiogram plus lung ultrasonography to look for evidence of cardiogenic pulmonary edema).
  - More on hemodynamic evaluation in heart failure [here](https://emcrit.org/ifc/#hemodynamic_evaluation_&_risk_stratification).
- Contraindications to beta-blockade:
  - Shock (especially cardiogenic shock with severely reduced ejection fraction)
  - Cardiogenic pulmonary edema
- **Esmolol infusion** is probably the safest initial agent [Medscape monograph on esmolol](https://reference.medscape.com/drug/brevibloc-esmolol-342358)\(^2\)
  - Up-titrate to ensure that the patient can tolerate beta-blockade.
  - Japanese guidelines recommend esmolol, due to increased mortality in patients with heart failure treated with propranolol.\(^5\)
- **Propranolol** [Medscape monograph on propranolol](https://reference.medscape.com/drug/inderal-inderal-la-propranolol-342364)\(^3\)
  - Ideal beta-blocker, because it blocks peripheral activation of T4 to T3.
  - Starting dose is 20-40 mg PO q6hr. If tolerated, may up-titrate to a dose of 80 mg q6.
management of hyperthermia & agitation

hyperthermia management

- General principles:
  - Hyperthermia is harmful because it increases cardiac workload and can also cause organ damage (e.g. rhabdomyolysis, delirium).
  - However, induction of shivering is potentially dangerous, as this also increases myocardial workload. Fortunately, hyperthermia is due to increased heat generation by the tissues (rather than a change in hypothalamic set point), so shivering may not be a problem in these patients.

- Management
  - Acetaminophen 650-1000 mg q6hr scheduled.
  - Use of cooling blankets is recommended for high fever, if tolerated without shivering.\(^1\),\(^5\)
  - Avoid salicylates or NSAIDs, since these may increase free thyroid hormone levels.

agitation management

- Agitation may worsen hyperthermia and impede ability to provide care.
- Olanzapine might be a good choice, either by PO, IM, or IV routes.\(^5\)
  - Case studies exist suggesting that haloperidol may precipitate thyroid storm. Although this is dubious, it might be a reason to prefer olanzapine over haloperidol.\(^5\)

refractory storm

refractory thyroid storm

- Clinical improvement should ideally be seen reasonably soon (e.g. ~24-48 hours).
- Some patients will fail to respond to optimal medical management.
- Treatment options for refractory thyroid storm include plasmapheresis or thyroidectomy.

checklist
Thyroid storm checklist

- Evaluation to guide etiology & management
  - Glucose, electrolytes including Ca/Mg/Phos, CBC
  - Liver function tests
  - Coagulation studies (INR, PTT)
  - Creatinine kinase
  - If infection suspected: cultures +/- procalcitonin

- Investigate/treat cause (if one exists)
  - E.g. if sepsis possible, culture and provide broad-spectrum antibiotic

- Steroid
  - Hydrocortisone 300 mg IV loading dose then 100 mg IV q8h
  - Hydrocortisone not immediately available: 60 mg IV methylprednisolone

- Thionamide
  - Methimazole 40 mg loading dose then 20 mg q6h

- Iodine
  - At least >1 hour post thionamide
  - Lugol’s solution 8 drops PO q6h <OR> Saturated Solution of KI (SSKI) 5 drops PO q6h

- Cholestyramine: 4 grams PO q6hrs

- Hemodynamic stabilization
  - Perform echo & lung sonography before initiation of any cardiovascular therapies.
  - If shocked/unstable, use fluid +/- pressor +/- inotrope depending on history & echo.
  - Aggressive IV magnesium repletion may help control heart rate
  - If persistent tachycardia (e.g. >150) & BP adequate then trial esmolol infusion to see if this is tolerated. Caution: β-blocker may worsen cardiogenic or distributive shock, monitor closely. Allowing moderate tachycardia initially may be beneficial in unstable patients (e.g., HR ~130).

- Hyperthermia management
  - Acetaminophen 650-1000 mg scheduled q6h


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podcast


The Podcast Episode

Want to Download the Episode?

Right Click Here and Choose Save-As (http://traffic.libsyn.com/bccpodcast/IBCC_EP_23_Thyroid_Storm_Final.mp3)

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questions & discussion


To keep this page small and fast, questions & discussion about this post can be found on another page here (https://emcrit.org/pulmcrit/thyroid-storm-2/).
Maintain a high index of suspicion for thyroid storm, as this will commonly mimic other conditions (e.g. psychosis, meningitis, hyperthermia, sepsis, cardiogenic shock).

Avoid salicylates or NSAIDs, as these may bind to thyroid-binding globulin, causing increased levels of free thyroid hormone levels.

Be cautious with beta-blockers, because some patients have thyrotoxicosis-induced cardiomyopathy and distributive shock. Aggressive beta-blockade may cause hemodynamic collapse in this situation, because the tachycardia is a compensatory response.

thyroid storm will usually present as a mimic

- **neuro-type presentations**
  - Psychosis mimic
  - Meningitis mimic
  - Hyperthermia mimic

- **cardiac-type presentations**
  - Sepsis mimic (fever, vasodilatory shock)
  - Heart failure (can drop the ejection fraction)
  - AF with intractably elevated heart rate

The Internet Book of Critical Care, by @PalmCrit

5-minute video to review everything (by Anna Pickens)

[5-minute video to review everything](https://emcrit.org/wp-content/uploads/2017/02/mimics2.svg)
Going further:

- **Thyroid storm** (https://emcrit.org/emcrit/thyroid-storm/) (EMCrit podcast 149)
- **Thyroid storm** (https://www.aliem.com/2013/11/thyroid-storm-treatment-strategies/) (Nadia Award, ALIEM)
- **Thyroid storm** (https://first10em.com/thyroid-storm/) (Justin Morgenstern, First 10 in EM)
- **Thyroid storm** (https://coreem.net/core/thyroid-storm/) (Anand Swaminathan, CoreEM)
- **Thyroid storm** (https://lifeinthefastlane.com/ccc/thyroid-storm/) (Chris Nickson, LITFL)
- **Thyroid storm** (https://rst10em.com/thyroid-storm/) (Justin Morgenstern, First 10 in EM)
- **Thyroid storm** (https://coreem.net/core/thyroid-storm/) (Anand Swaminathan, CoreEM)
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Methimazole vs PTU (http://www.lasvegasemr.com/foam-blog/-thyroid-storm-choose-methimazole-over-propothyouracil) (Jeff Hall & David Slattery, Vegas EM)

- Thyroid ultrasonography in Graves disease
  - Radiopaedia (https://radiopaedia.org/articles/graves-disease)
  - University of Virginia (https://www.med-ed.virginia.edu/courses/rad/Thyroid_Ultrasound/02anat/anat-03-04.html)

References


The Internet Book of Critical Care is an online textbook written by Josh Farkas (@PulmCrit), an associate professor of Pulmonary and Critical Care Medicine at the University of Vermont.