Endocrine Emergency
Thyroid Storm and Myxedema Coma

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Outline of the presentation

Thyroid storm:

- **Diagnosis criteria and treatment recommendations.**
- **An original article by LAC-USC endocrine group at JCEM in 2014 (1/2008- 12/2013).**
- **The Japan Thyroid association and Japan Endocrine Society Guidelines on Thyroid Storm.**

Myxedema Coma:

- **ATA guidelines on treatment of hypothyroidism, 2014.**

Definition of Thyroid Storm

- Thyroid storm is a life-threatening manifestation of severe thyrotoxicosis, characterized by a systemic decompensation and - 10% mortality.
- Risk factors include age, comorbidity, rapidity of onset, and a precipitating event.
- Thyroid storm is triggered when these factors surpasses a patient's ability to maintain adequate metabolic, thermoregulatory and cardiovascular and CNS compensatory mechanisms.

Case 1

- **57 yo female with a newly diagnosed Graves' disease 2 months ago presents to the ED with fever, nausea and vomiting, and palpitations occurring 1 week after running out of MMI.**
- **Current medications: MMI 30 mg daily and Atenolol 50 mg daily (ran out of 1 week ago).**
- **PE: Temp 102.7, Pulse 124 bpm, no proptosis and normal extraocular movement. The thyroid has a diffuse goiter with bruit. Her lungs have bibasilar crackles. Hand tremor (+). Her Mini Mental State Examination score 25/30.**
- **Lab tests: fT4 > 7 ng/dl (0.8-1.8), fT3 12.1 (2.0-4.4). TSH 0.001 and total bilirubin 1.5 mg/dl (0.1-1.2).**
- **EKG: sinus tachycardia. Chest x-ray: interstitial edema.**

The diagnostic criteria for Thyroid storm

Table 3 The diagnostic criteria for thyroid storm (TS) of the Japan Thyroid Association

Prerequisite for diagnosis		
Presence of thyrotoxicosis with elevated levels of free triiodothyronine (FT3) or free thyroxine (FT4)		
Symptoms		
1. Central nervous system (CNS) manifestations: Restlessness, delirium, mental aberration/psychosis, somnolence/lethargy, coma (≥1 on the Japan Coma Scale or ≤14 on the Glasgow Coma Scale)		
2. Fever : ≥ 38°C		
3. Tachycardia : ≥ 130 beats per minute or heart rate ≥ 130 in atrial fibrillation		
4. Congestive heart failure (CHF) : Pulmonary edema, moist rales over more than half of the lung field, cardiogenic shock, or Class IV by the New York Heart Asociation or ≥ Class III in the Killip classification		
5. Gastrointestinal (GI)/hepatic manifestations : nausea , vomiting, diarrhea, or a total bilirubin level ≥ 3.0 mg/dL		
Diagnosis		
Grade of TS	Combinations of features	Requirements for diagnosis
TS1	First combination	Thyrotoxicosis and at least one CNS manifestation and fever, tachycardia, CHF, or GI/ hapatic manifestations
TS1	Alternate combination	Thyrotoxicosis and at least three combinations of fever, tachycardia, CHF, or GI/ hapatic manifestations
TS2	First combination	Thyrotoxicosis and a combination of two of the following: fever, tachycardia, CHF, or GI/hepatic manifastations
TS2	Alternate combination	Patients who met the diagnosis of TS1 except that serum FT3 or FT4 level are not available
Exclusion and provisions		
Cases are excluded if other underlying diseases clearly causing any of the following symptoms: fever (*e.g.*, pneumonia and malignant hyperthermia), impaired consciousness (*e.g.*, psychiatric disorders and cerebrovascular disease), heart failure (*e.g.*, acute myocardial infarction), and liver disorders (*e.g.*, viral hepatitis and acute liver failure). Therefore, it is difficult to determine whether the symptom is caused by TS or is simply a manifestation of an undelying disease; the symptom should be regarded as being due to a TS that is caused by these precipitating factors. Clinical judgment in this matter is required.		

TS1, "Definite" TS; TS2, "Suspected" TS.

Table 2 The Burch-Wartofsky Point Scale for diagnosis of thyroid storm

Criteria	Points
Thermoregulatory dysfunction	
Temperature (°C)	
37.2–37.7	5
37.8–38.3	10
38.4–38.8	15
38.9–39.3	20
39.4–39.9	25
≥ 40.0	30
Cardiovascular	
Tachycardia (beats per minute)	
90–109	5
110–119	10
120–129	15
130–139	20
≥ 140	25
Atrial fibrillation	
Absent	0
Present	10
Congestive heart failure	
Absent	0
Mild	5
Moderate	10
Severe	15
Gastrointestinal-hepatic dysfunction	
Manifestation	
Absent	0
Moderate (diarrhea, abdominal pain, nausea/vomiting)	10
Severe (jaundice)	20
Central nervous system disturbance	
Manifestation	
Absent	0
Mild (agitation)	10
Moderate (delirium, psychosis, extreme lethargy)	20
Severe (seizure, come)	30
Precipitating event	
Status	
Absent	0
Present	10
Total score	
≥ 45	Thyroid storm
25–44	Impending storm
< 25	Storm unlikely

Modified from ref. [9].

Endocrine Journal 2016 Guidelines for the management of thyroid storm from The Japan Thyroid Association and Japan Endocrine Society. 2016, 63 (12), 1025-1064

Demographic Characteristics of Study Patients

Table 1. Demographic Characteristics of Study Patients

	All Patients *n* = 150	Thyroid Storm (TS) *n* = 25	Thyrotoxic (CT) *n* = 125	CT BWS ≥45 or AkTS1/2 *n* = 27
Age, mean years ± SD	46 ± 15.7	46 ± 2.2	46 ± 16.4	45.0 ± 19.7
Sex				
M	53 (35.3)	9 (36.0)	44 (35.2)	9 (33.3)
F	97 (64.7)	16 (64.0)	81 (64.8)	18 (66.6)
Diagnosis of thyroid disorder				
New presentation	69 (46.0)	10 (40.0)	59 (47.2)	12 (44.4)
Known diagnosis	71 (47.3)	14 (56.0)	57 (45.6)	13 (48.2)
Unclear	10 (6.7)	1 (4.0)	9 (7.2)	2 (7.4)
Season				
Winter	31 (20.7)	4 (16.0)	27 (21.6)	4 (14.8)
Spring	31 (20.7)	7 (28.0)	24 (19.2)	6 (22.2)
Summer	47 (31.3)	7 (28.0)	40 (32.0)	10 (37.0)
Fall	41 (27.3)	7 (28.0)	34 (27.2)	7 (26.0)
Admitting diagnosis				
Thyroid disorder	34 (22.8)	6 (24.0)	28 (22.6)	4 (14.8)
Cardiovascular	37 (24.8)	2 (8.0)	35 (28.2)	10 (37.0)
Respiratory	8 (5.4)	2 (8.0)	6 (4.8)	0 (0.0)
Gastrointestinal	18 (12.1)	2 (8.0)	16 (12.9)	3 (11.1)
Trauma/Musculoskeletal	10 (6.7)	4 (16.0)	6 (4.8)	1 (3.7)
Infection/Fever	9 (6.0)	2 (8.0)	7 (5.6)	4 (14.8)
Neurologic	14 (9.4)	3 (12.5)	11 (8.9)	1 (3.7)
Malignancy/Other	12 (12.8)	4 (16.0)	15 (12.1)	4 (14.8)

Number of patients (% of group total) are shown for each category, except age, as indicated. Burch Wartofsky Score (BWS), Akamizu (Ak).

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Clinical Features and Lab data for TS and CT

A

	BWS <25 (n = 51)	BWS 25-44 (n = 55)	BWS ≥45 (n = 44)	AkTS0 (n = 109)	AkTS1/2 (n = 41)
CT (n = 125)	51	50	24	104	21
TS (n = 25)	0	5	20	5	20
AkTS0 (n = 109)	51	52	6		
AkTS1/2 (n = 41)	0	3	38		

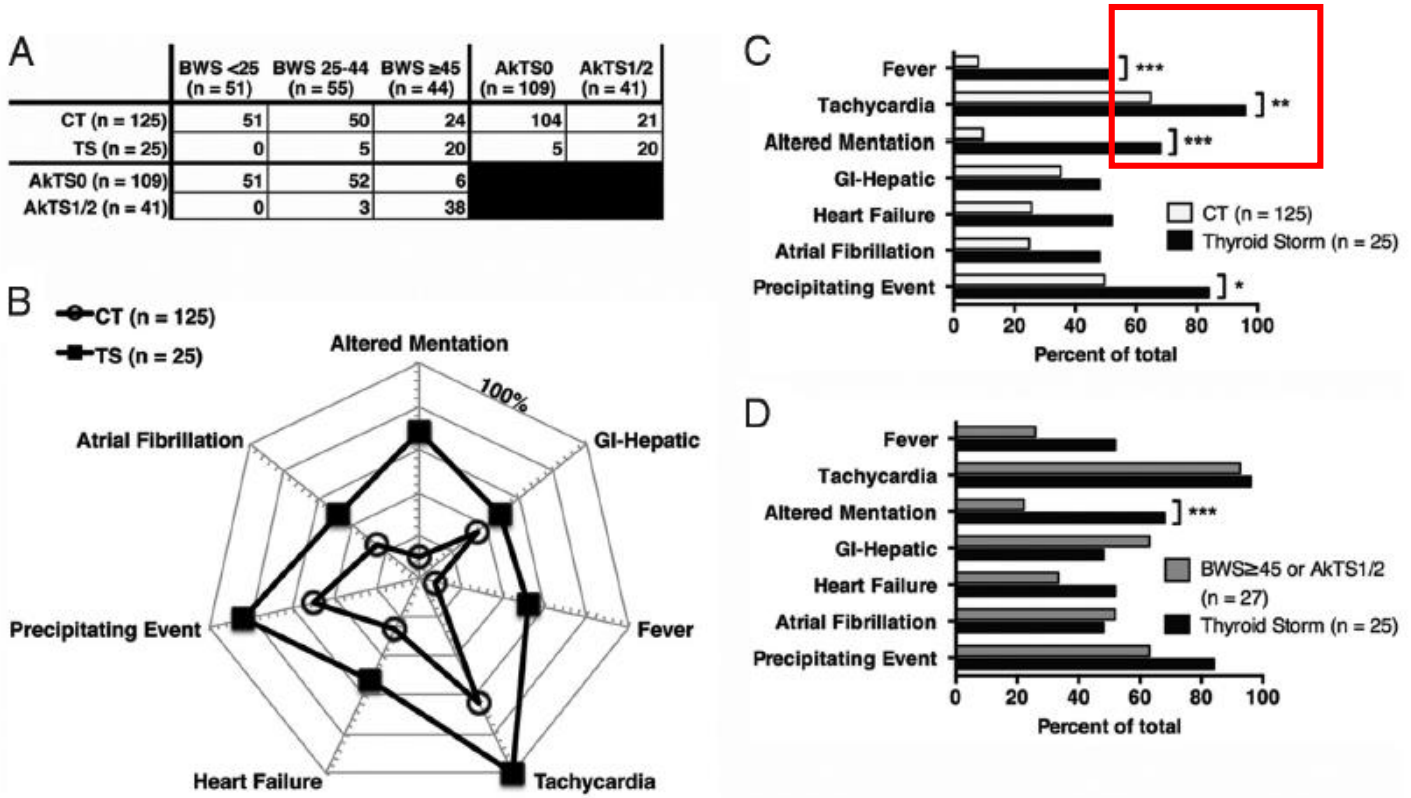

Figure 1. Presenting clinical features and laboratory data for TS and CT patients. A, Study patients stratified by BWSs and Ak criteria. B, Polar chart displaying the frequency of composite presenting clinical features in TS and CT patients. The scale moves from 0% to 100% from center to outer line, with divisions every 20%. All features are reported dichotomously: fever (temperature >100.4°F), tachycardia (heart rate of >100 beats/min), altered mentation (including presence of GCS <15, agitation, delirium, psychosis, lethargy, seizures, or coma), GI-hepatic signs (diarrhea, nausea, emesis, unexplained jaundice, or abdominal pain), signs of CHF (lower-extremity pitting edema, pulmonary edema, jugulovenous distension, or cardiogenic shock) AF, and a identified precipitating stressor. C and D, Frequency of traditional signs and symptoms of TS in TS and CT patients overall (C) or the subgroup of CT patients with BWS ≥45 or AkTS1/2 (D). Significantly different frequencies between TS and CT patients are indicated with asterisks: *, $P < .05$; **, $P < .01$; *** $P < .001$.

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Laboratory Measurements in TS and CT

Table 3. Selected Laboratory Measurements in Thyroid Storm and Compensated Thyrotoxicosis Patients

Laboratory Study	Reference Range	Thyroid Storm (TS) (n = 25)	Thyrotoxic (CT) (n = 125)
Free Thyroxine	0.93–1.83 ng/dL	5.21 (3.53–7.49)	3.93 (2.48–7.77)
Potassium	3.5–5.1 mmol/liter	4.10 (3.75–4.45)	4.00 (3.70–4.30)
Glucose	65–99 mg/dL	111 (100–138)	108 (93.5–130)
Corrected calcium	8.5–10.3 mg/dL	9.28 (8.88–9.80)	9.51 (9.20–9.84)
BUN	8–22 mg/dL	15.0 (12.0–24.8)	14.0 (11.0–18.0)[a]
Creatinine	0.5–1.3 mg/dL	0.57 (0.38–0.71)	0.51 (0.40–0.71)
Alkaline phosphatase	40–130 U/liter	122 (82–170)	119 (86.8–164)
Total bilirubin	0.0–1.0 mg/dL	0.90 (0.50–2.40)	0.60 (0.33–1.00)[b]
INR	0.90–1.10	1.21 (1.10–1.38)	1.14 (1.05–1.26)[b]
WBC count	3.7–10.3 K/uL	9.30 (7.40–15.3)	7.80 (6.33–10.6)[a]
% PMN	42–78%	76.3 (54.2–80.8)	64.2 (54.4–74.9)[b]
Post-hoc analysis			
Sodium	135–145 mmol/liter	137 (135–142)	139 (136–141)
Carbon dioxide	20–30 mmol/liter	22.0 (21.5–25.0)	24.0 (22.0–26.0)
Albumin	3.5–5.0 g/dL	3.30 (2.80–3.80)	3.70 (3.30–4.00)[c]
AST	10–40 U/liter	42.0 (31.8–77.8)	29.0 (23.0–46.3)[c]
ALT	10–55 U/liter	33.0 (22.0–71.0)	31.0 (22.5–47.0)
Direct bilirubin		0.30 (0.20–1.55)	0.30 (0.13–0.40)
Hemoglobin	M: 13.8–16.9 g/dL F: 11.8–14.7 g/dL	12.4 (11.2–14.0)	12.6 (11.4–13.9)
MCV	82.0–99.0 fL	85.2 (78.7–96.0)	83.4 (80.0–87.0)
Platelet count	150–350 K/uL	220 (158–280)	221 (177–275)

Data displayed as Median values (+interquartile range). Blood urea nitrogen (BUN), alanine aminotransferase (ALT), Aspartate aminotransferase (AST), White blood cell count (WBC), Mean corpuscular volume (MCV), Polymorphonuclear cells (PMN), International normalized ratio (INR). Corrected Calcium = {[4 − serum albumin (g/dL)] × 0.8} + serum calcium (mg/dL).

[a] $P < .1$ (trend), [b] $P < .05$, b, [c] $P < .01$.

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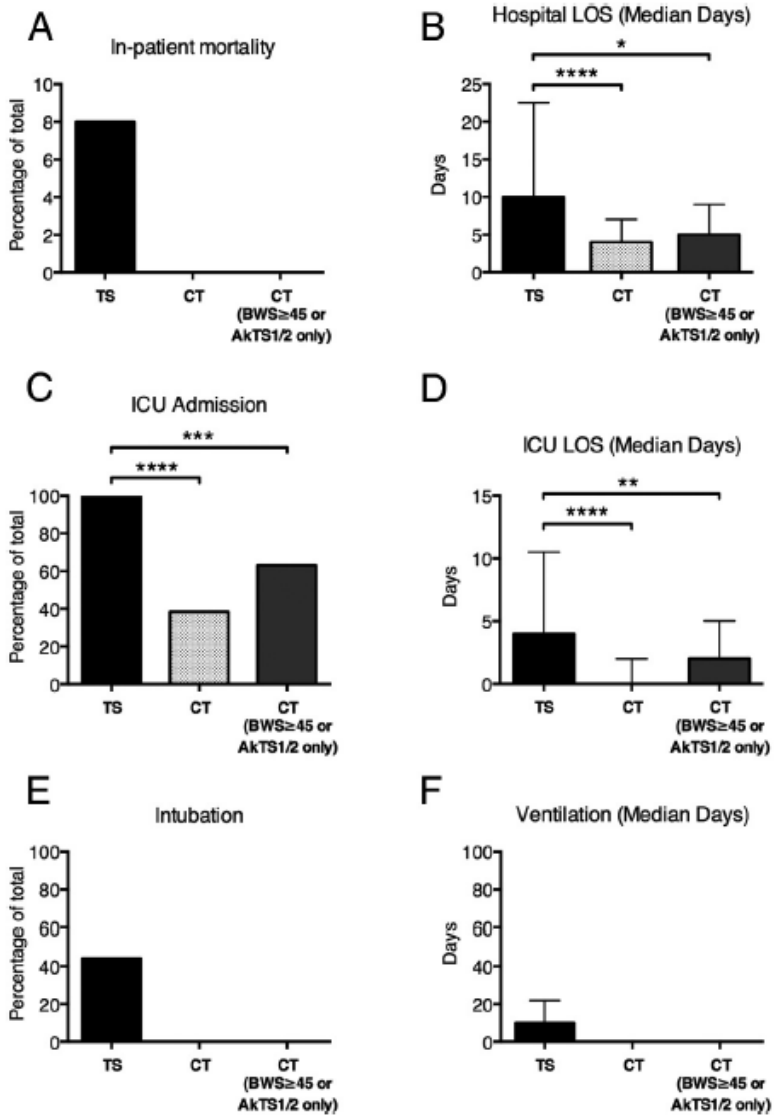
Hospital LOS and BWS



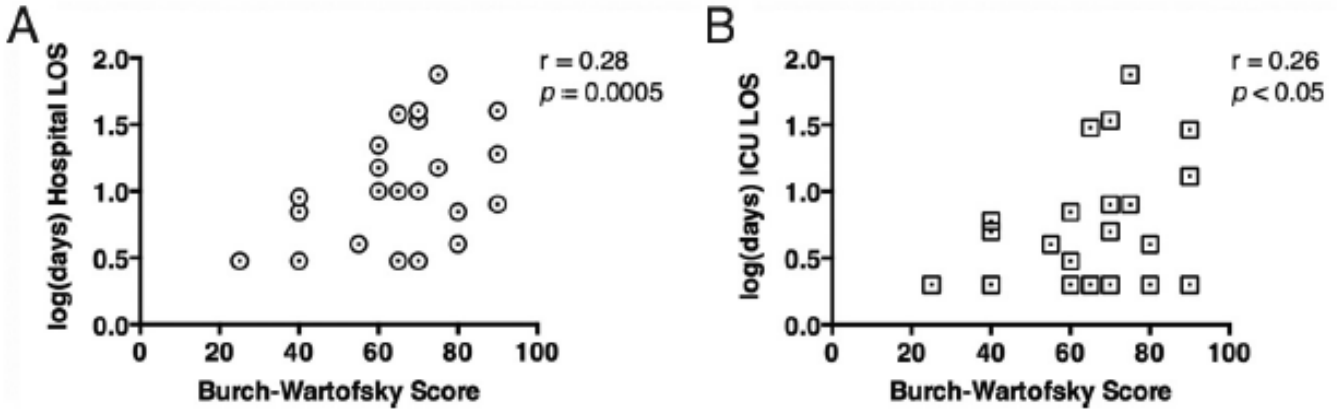


Figure 3. Correlation between BWS and patient outcomes. A and B, The correlation between BWS and log-transformed hospital LOS (A) or log-transformed ICU LOS (B) in days are plotted for individual TS patients. Spearman rank order correlation (*r*) and *P* values are shown with each graph.

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Diagnostic consideration in thyroid storm

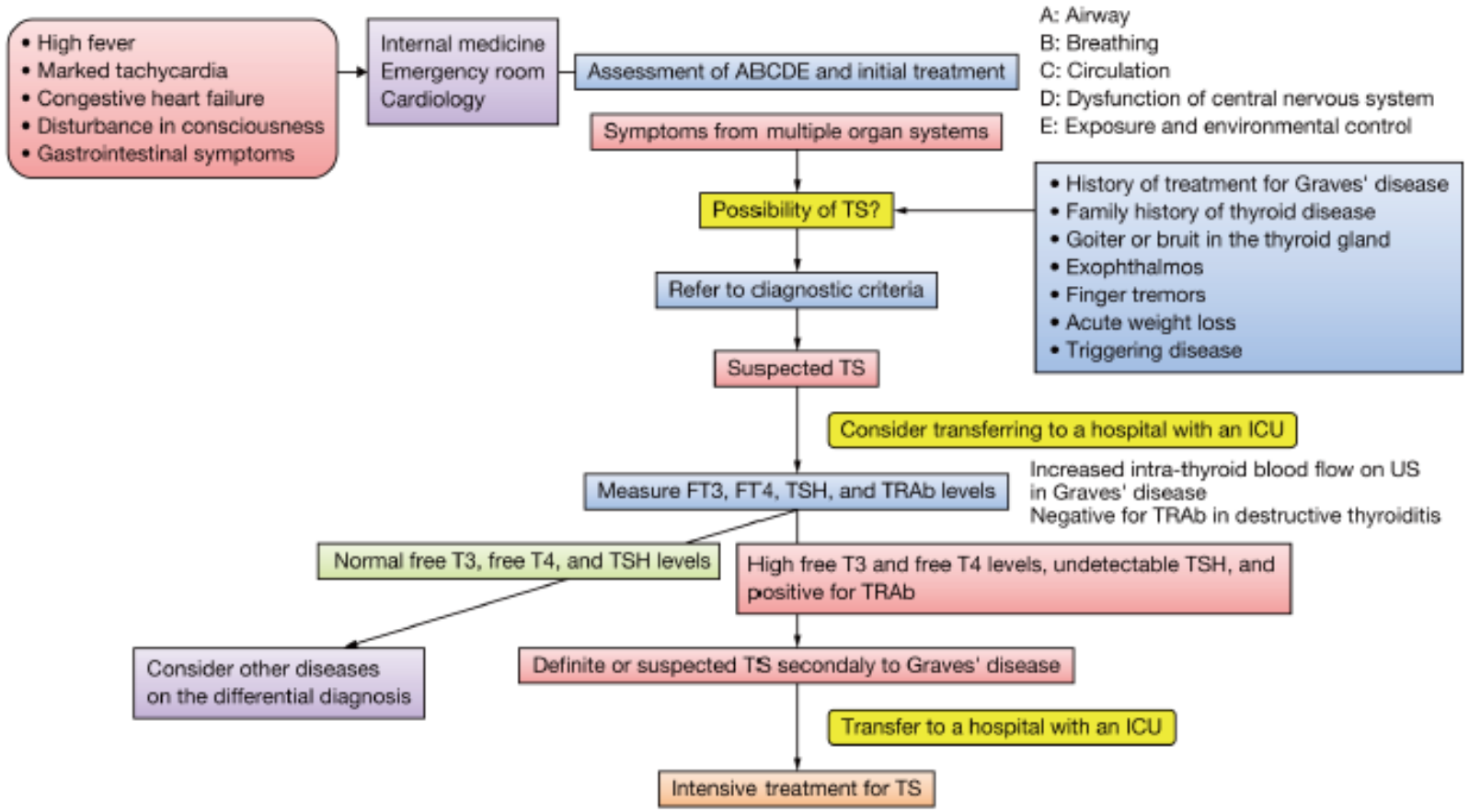
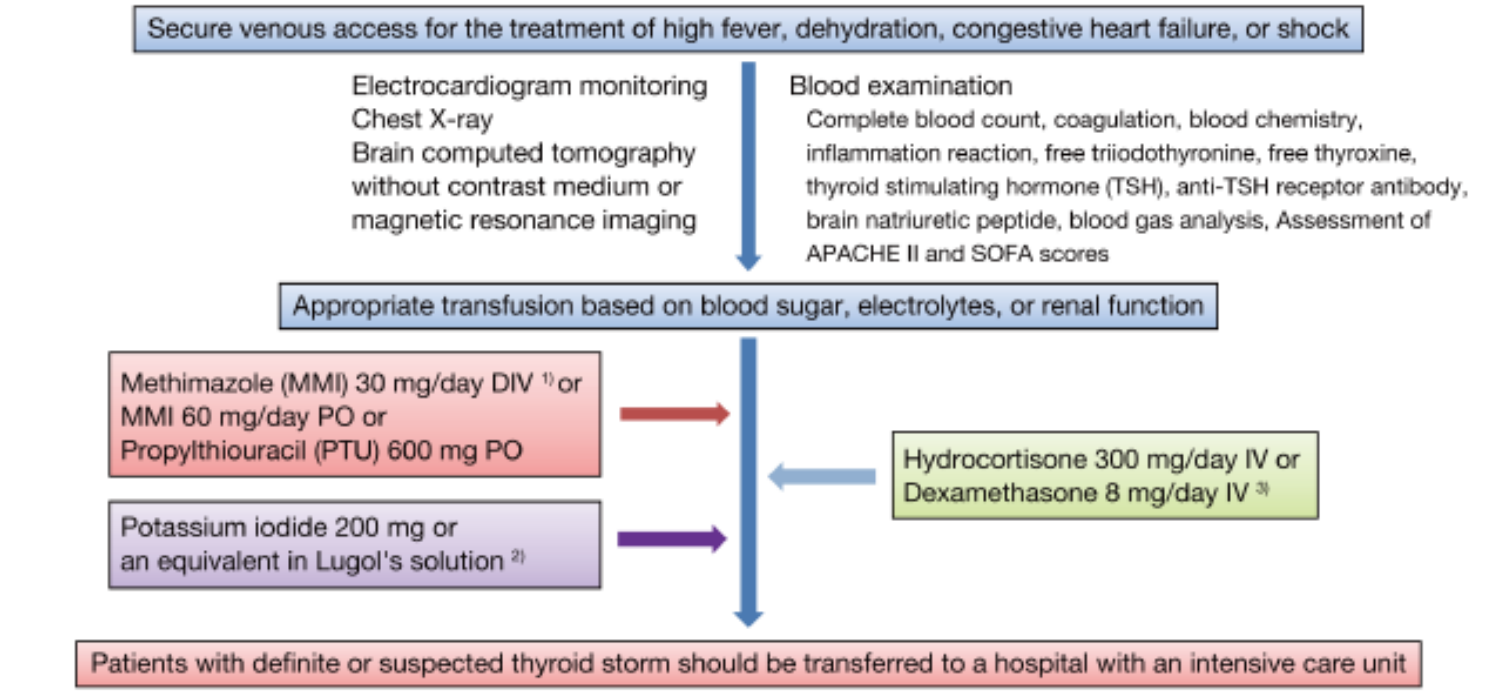


Fig. 4 An algorithm for diagnostic considerations in thyroid storm
TS, thyroid storm; ICU, intensive care unit; T3, triiodothyronine; T4, thyroxine; US, ultrasound examination; TRAb, anti-thyroid stimulating hormone receptor antibody.

Endocrine Journal 2016, 63: 1025-1064. The Japan Thyroid association and Japan Endocrine Society Guidelines on Thyroid Storm

Management of thyroid storm



1) Intravenous administration of MMI is recommended in patients with disturbances of consciousness or non-functioning gastrointestinal tract. If unavailable, MMI or PTU can be administered orally or *via* a nasogastric tube or rectally.
2) Although the amount of inorganic iodide necessary to suppress thyroid hormone secretion is assumed to be 20 mg, a sufficient amount, up to 200 mg/day, is recommended for thyroid storm. The textbook recommends that inorganic iodide be used 1 hour after the administration of antithyroid drug to prevent iodide organification, although large doses of inorganic iodide can inhibit iodide organification and thyroid hormone release.
3) Hydrocortisone 100 mg is recommended every 8 hours. Alternatively, 8 mg dexamethasone can be used.

Fig. 7 Schematic representation of recommended imaging studies and laboratory examination and the initial treatment of thyroid storm

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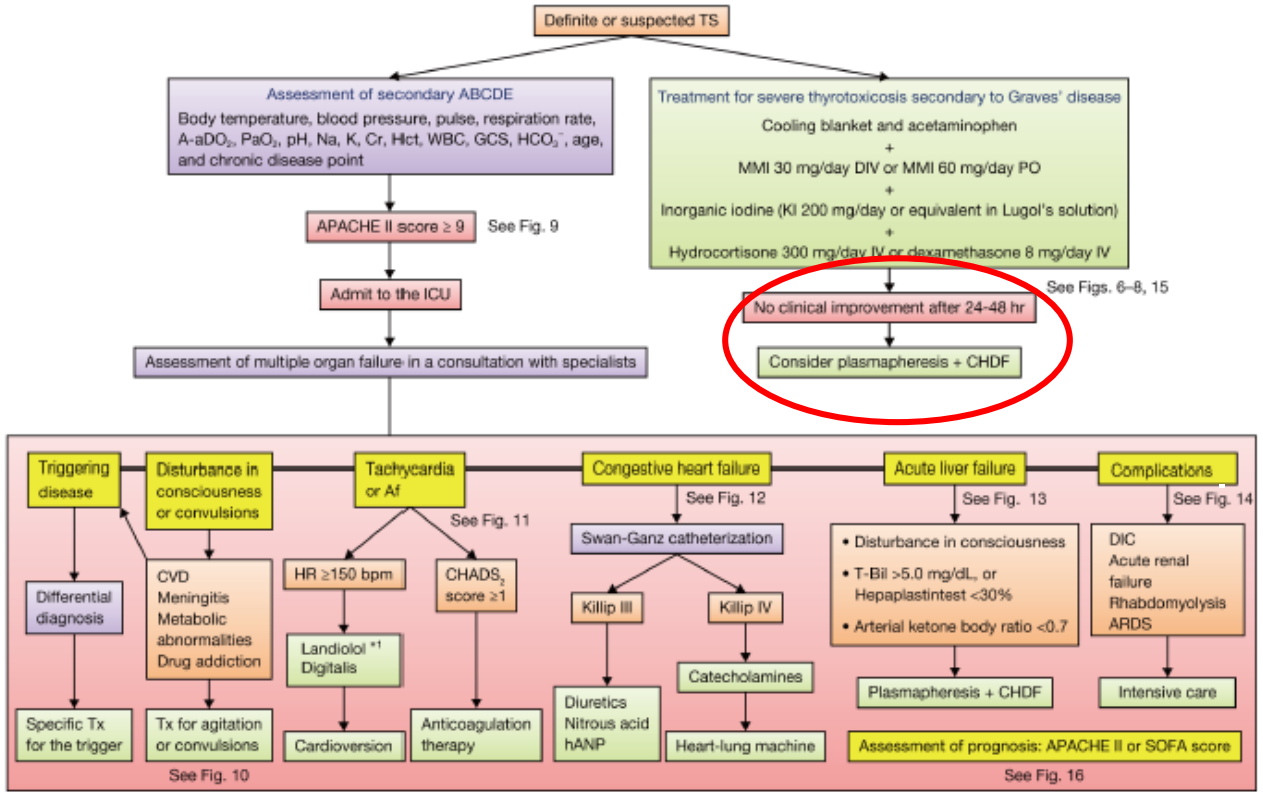
Treatment Algorithm for Thyroid Storm



*1 When the pulse rate ≥150 bpm and Killip classification is III or lower, the infusion of a short-acting beta-blocker is the first choice. A beta-blocker can be administered orally when the pulse rate decreases to <150 bpm. In Killip IV disease, consider the infusion of a short-acting beta-blocker when pulse is ≥150 bpm.

Fig. 5 A treatment algorithm for thyroid storm

Brief comments on the treatment of severe thyrotoxicosis and manifestations in various organs are described in Figs. 6–16. TS, thyroid storm; Hct, hematocrit; WBC, white blood cell count; A-aDO2, alveolar oxygen tension; PaO2, partial pressure of oxygen in arterial blood; Cr, creatinine; ICU, intensive care unit; GCS, Glasgow Coma Scale; APACHE II, acute physiology, and chronic health evaluation II; MMI, methimazole; KI, potassium iodide; HR, heart rate; CHDF, continuous hemodiafiltration; Tx, treatment; CVD, cerebrovascular disease; Af, atrial fibrillation; HR, heart rate; hANP, human atrial natriuretic polypeptide; T-Bil, total bilirubin; DIC, disseminated intravascular coagulation; ARDS, adult respiratory distress syndrome; SOFA, sequential organ failure assessment.

- There is no strong evidence concerning the appropriate doses of anti-thyroid drugs, inorganic iodine, or corticosteroids to treat severe thyrotoxicosis in thyroid storm.
- Based on data from a nationwide survey (8), methimazole (MMI) was equally useful as propylthiouracil (PTU). Intravenous administration of MMI, if available, is recommended in severe cases.
- Inorganic iodine should be administered because its use appears to improve prognosis in thyroid storm.
- Sufficient amounts of corticosteroids should be administered in severe cases.

Fig. 6 Comments on the use of antithyroid drugs, inorganic iodide and corticosteroids

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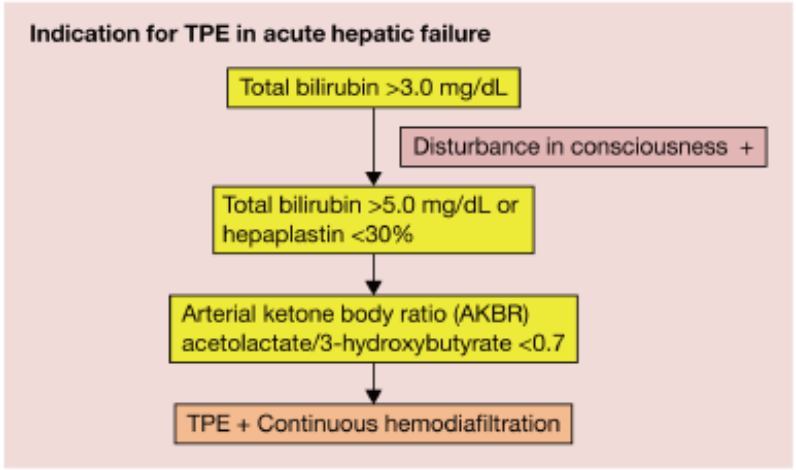
Plasmapheresis in Thyroid storm

- No significant differences were observed in the incidence of liver injury among the drugs used to treat thyroid storm (TS) in the nationwide survey.
- Patients with total bilirubin >3.0 mg/dL had slightly more severe clinical manifestations in the nationwide survey. Bilirubin levels could also be elevated due to multiple organ failure; therefore, the indication of therapeutic plasmapheresis (TPE) cannot be determined only by total bilirubin concentrations.
- Indications for TPE in TS complicated by acute liver failure can be found in the Guidelines from the Japan Society for Apheresis (Apheresis Manual, third edition).



See ref. [165].

Fig. 13 Indication for plasamapheresis in acute hepatic failure in thyroid storm

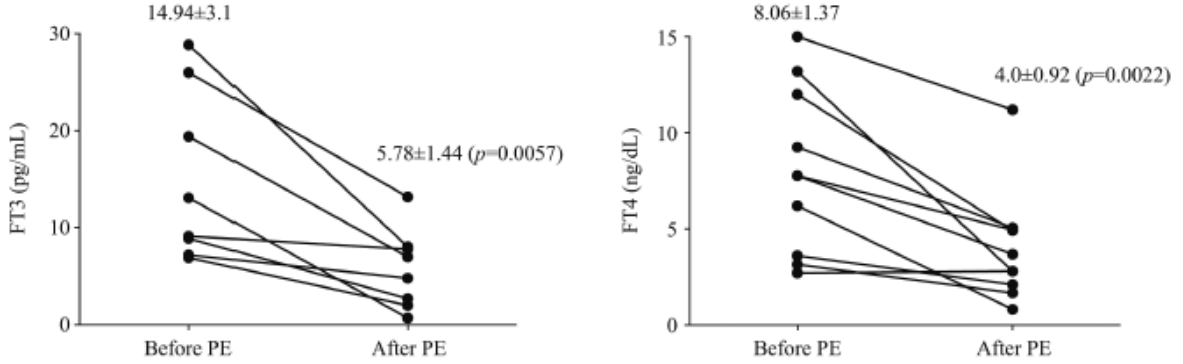


Fig. 1 Significant reduction in thyroid hormone levels before and after plasma exchange (PE) in patients with thyroid storm in the Ichushi database

Changes in free triiodothyronine (FT3) (pg/mL) (n = 8) and free thyroxine (FT4) (ng/dL) (n = 10) levels in patients with thyroid storm after a single session of PE described in case reports between 1983 and 2011 in the Ichushi database were analyzed using the paired *t*-test.

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Plasmapheresis in thyroid storm

- Excess thyroid hormone can be rapidly removed, thyroid hormone binding proteins can be replaced, and catecholamines, cytokines, and anti-thyroid stimulating hormone receptor antibody may also be removed by therapeutic plasmapheresis (TPE).
- The efficacy of TPE has been reported in a recent review that summarized many cases of TS (Ref. [60]); however, a few cases of death were also reported.
- The mortality rate of TPE-treated TS reported in Japan between 1983 and 2015 was 17.4% (11/63).
- The mortality rate of TPE-treated TS in the nationwide survey in Japan was 37.5% (6/16).
- The strength of the recommendation for TPE in TS in the 2010 Guidelines from the American Society for Apheresis is
  Grade 2C: Weak recommendation, low-quality or very low-quality evidence
  Category III: Optimum role of apheresis therapy is not established. Decision-making should be individualized.

1) **Absolute indication for TPE**: TS complicated by acute liver failure (for more details, see Section 7)
2) **Relative indication for TPE**: Uncontrolled thyrotoxicosis 24–48 hours after the initiation of intensive treatment (for more details, see Section 3)

Fig. 15 Comments on the usefulness of and indication for plasmapheresis in thyroid storm

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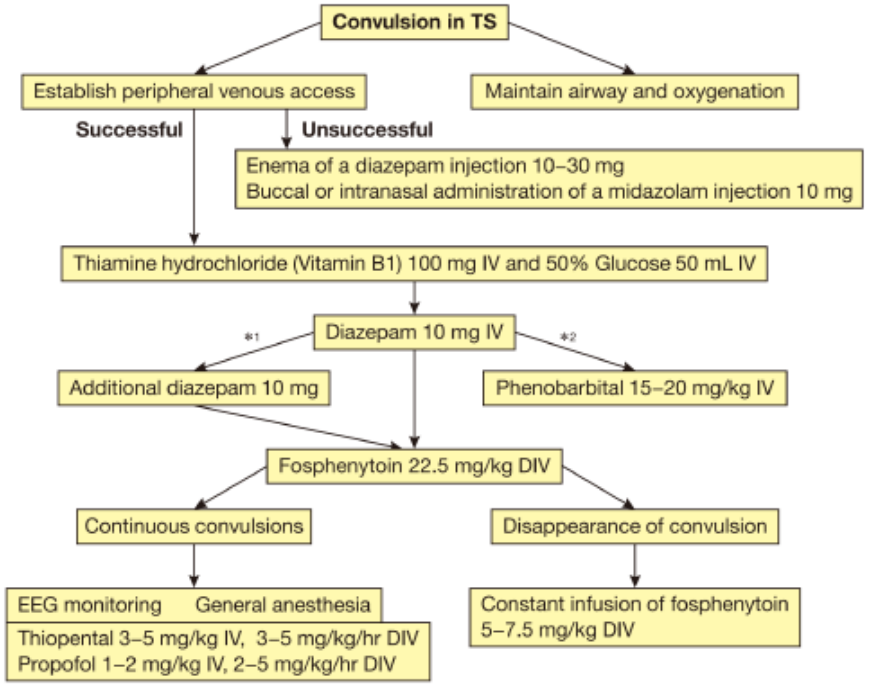
Management of Convulsion in Thyroid Storm



2 Medical treatment for convulsions

A proposed algorithm for the treatment of convulsion in patients with thyroid storm, modified from ref. [121]. *1 Standard therapy, *2 alternative therapy. TS, thyroid storm; EEG, Electroencephalogram.

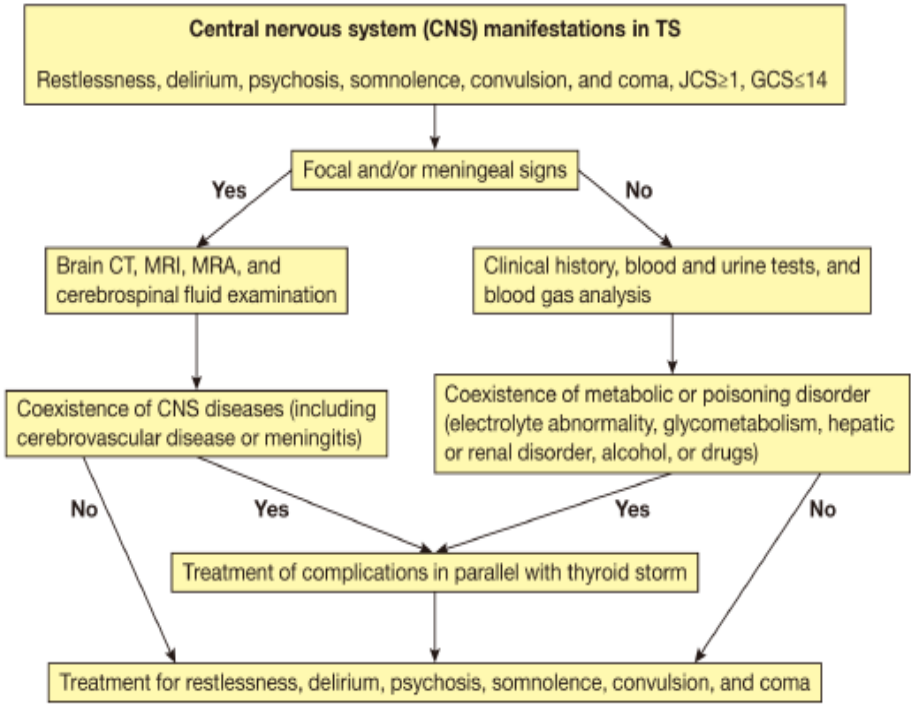


Fig. 3 Differential diagnosis of central nervous system (CNS) manifestations in thyroid storm patients

An algorithm for the differential diagnosis and treatment of CNS manifestations in thyroid storm patients is proposed. TS, thyroid storm; JCS, Japan Coma Scale; GCS, Glasgow Coma Scale; CT, computed tomography; MRI, magnetic resonance imaging; MRA, magnetic resonance angiography.

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Imaging studies and lab examination in TS

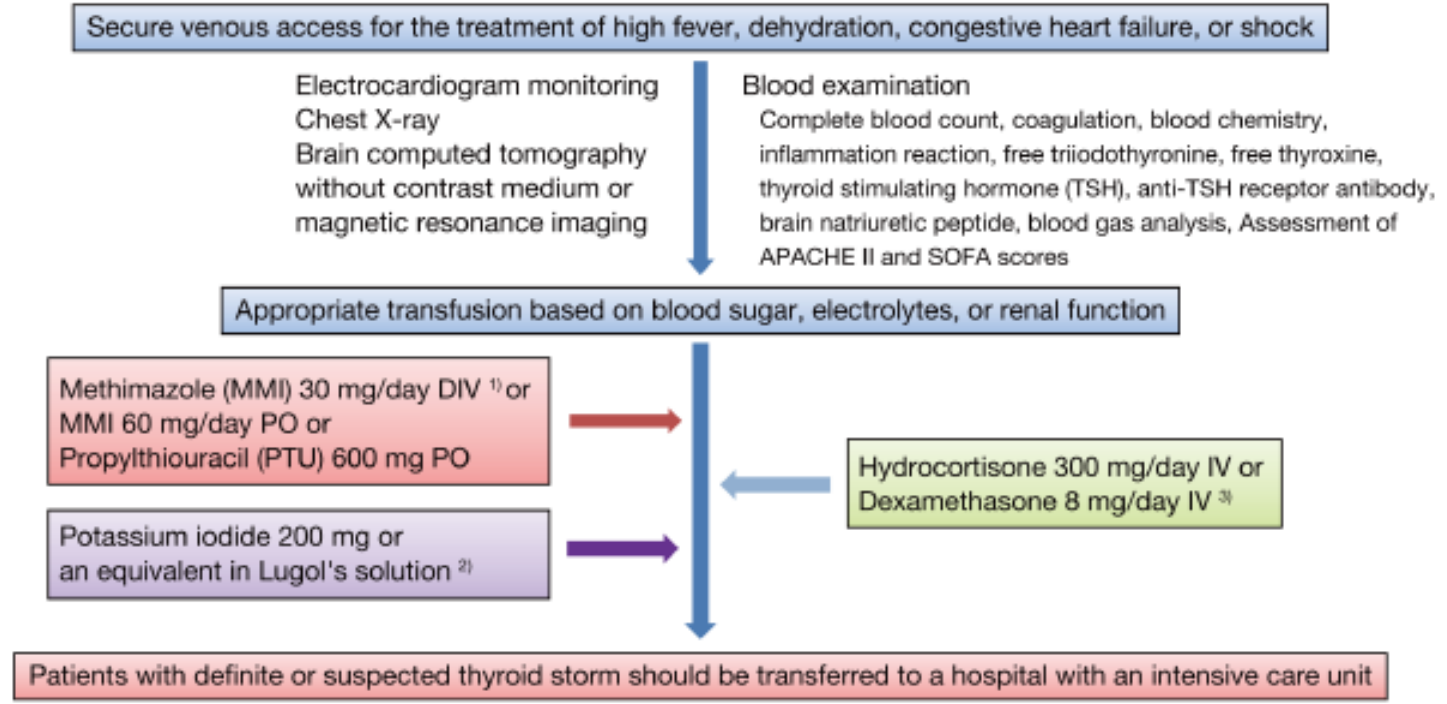

Fig. 7 Schematic representation of recommended imaging studies and laboratory examination and the initial treatment of thyroid storm

Endocrine Journal 2016, 63: 1025-1064. The Japan Thyroid association and Japan Endocrine Society Guidelines on Thyroid Storm.

Prognosis of thyroid storm

- Factors associated with severity, mortality, and irreversible damage were determined by the analysis of nationwide surveys, as shown in the figure below.
- Attention must be paid to central nervous system symptoms, thyroid function, cardiac function (shock), renal function, and disseminated intravascular coagulation (DIC) in thyroid storm.
- Serum creatinine levels were similar between survivors and non-survivors (0.54 ± 0.02 mg/dL *vs.* 0.81 ± 0.09 mg/dL), which may have been due to the abnormal creatinine metabolism in thyrotoxicosis. Therefore, even if serum creatinine is within the normal ranges, it should be carefully monitored during the treatment of TS.

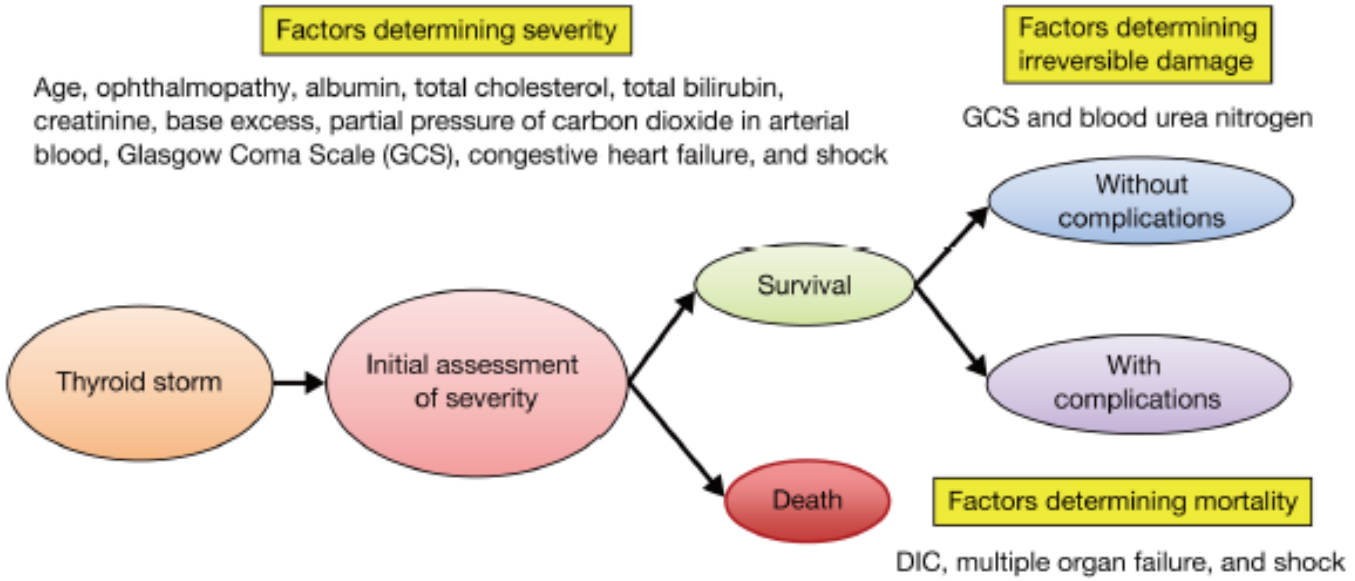

Fig. 16 Comments on the prognosis of thyroid storm in the nationwide surveys

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Treatment of Thyroid Storm

Drug	Dosing	Comment
Propylthiouracil (PTU)	500-1000 mg load, then 250 mg every 4 hours	Inhibits new hormone synthesis Blocks T4 to T3 conversion Alternate drug: Methimazole 60-80 mg daily
Propranolol	60-80 mg every 4 hours	Consider invasive monitoring Blocks T4 to T4 conversion in high doses Alternate drug: Esmolol infusion
Iodine (saturated Solution of potassium Iodide, SSKI)	5 drops (0.25 ml or 250 mg) orally every 6 hours	Start 1 hour after antithyroid drugs Inhibits new hormone synthesis Block thyroid hormone release Alternate drug: Lugol's solution
Hydrocortisone	300 mg IV load, then 100 mg every 8 hours	May block T4 to T3 conversion Prophylaxis against relative adrenal insufficiency Alternate drug: Dexamethasone

Burch H. Thyroid Storm. The Endocrine Society Annual Meeting 2019

Case 2

- **70 yo female presents to the ED with pneumonia, bradycardia with first degree atrioventricular block, and somnolence lasting for past 24 hrs.**
- **PMHx: Graves' disease treated with RAI several years ago, HTN and hyperlipidemia.**
- **Current medications: Lisinopril, HCTZ and Simvastatin.**
- **PE: somnolent, disorientated woman with cold, dry skin. BP 80/50 mmHg, HR 48 bpm, Temp 35C, shallow breathing, crackles in the right lung. Swelling in of the face and lower extremities.**
- **Lab tests: WBC 18,000 with left shift, Hb 11.8 g/dl, platelets 350,000 and Na 122, K 3.8, glucose 60 and Cr 1.6, CPK 10,000 and TSH 35 and fT4 0.4. ABG shows respiratory acidosis.**

Myxedema Coma

- **Myxedema coma is defined as severe hypothyroidism leading to decreased mental status, hypothermia, and other symptoms related to slowing of function in multiple organs. It is a medical emergency with a high mortality rate.**
- **The degree of TSH elevation may not be an accurate indicator of the severity of the hypothyroidism.**
- **The wide range of serum TSH values is seen in myxedema coma patients, possibly due to variable suppression of the hypothalamic-pituitary axis by the illness.**
- **A lesser magnitude of TSH elevation may be seen in older patients, at least in the outpatient setting.**
- **An inappropriate TSH may also be seen if hypothyroidism is caused by TSH deficiency (e.g., secondary hypothyroidism in patients with panhypopituitarism).**

TSH and fT4 in different age groups

TABLE 3. Differences in mean TSH and mean FT_4 values with patients divided into four age groups

Age groups (yr)	Number	TSH				FT_4		
		Mean (mIU/liter)	Log-transformed mean TSH	SD (mIU/liter)	*P* value (for differences between age groups)	Mean (ng/dl)	SD (ng/dl)	*P* value (for differences between age groups using Kruskal-Wallis test)
Spontaneous hypothyroidism								
<35	32	69	1.83	82	0.45[a]	0.82	0.41	0.16[a]
35–49	38	49	1.69	92		0.81	0.31	
50–64	30	43	1.63	39		0.67	0.35	
>64	12	29	1.46	22		0.68	0.30	
Iatrogenic hypothyroidism								
<35	28	156	2.19	98	<0.0001[b]	0.23	0.09	0.94[a]
35–49	40	115	2.06	70		0.24	0.11	
50–64	30	74	1.86	31		0.23	0.07	
>64	14	46	1.66	20		0.22	0.09	

[a] Kruskal-Wallis test.

[b] ANOVA.

Over R, et al. 2010 Age and the thyrotropin response to hypothyroxinemia. J Clin Endocrinol Metab 95:3675–3683.

Clinical Manifestations of Myxedema Coma

System	Manifestations
Thermoregulation	Hypothermia, as low as 80F
CNS and psychiatric manifestations	Altered mentation, unconsciousness, Cerebellar signs, poor memory and recall, seizure, depression, paranoia.
Respiratory	Hypoventilation and partial obstruction of the upper airways
CVS	Cardiogenic shock due to impaired cardiac contractility or cardiac tamponade, arrhythmias.
Renal manifestations	Hyponatremia due to impaired water diuresis, decreased eGFR and renal plasma flow or underlying rhabdomyolysis.
GI system	Gastric atony or paralytic ileus, ascites, GI bleeding due to coagulopathy.
Hematological manifestations	High risk of bleeding due to coagulopathy. Decreased in factors V, VII, VIII, IX and DIC. Infections, anemia, microcytic or macrocytic, B12 deficiency.
Metabolic manifestations	Hypoglycemia, hypercholesterolemia.
Skin	Dry, cold skin, edema.

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Treatment of Patients with Myxedema Coma

Presentation	Treatment
Hypothyroidism	Large initial IV dose of LT4 300-500 mcg. If no response add T3. Initial IV dose of LT4 200-300 mcg Plus T3 10-25 mcg.
Airways and ventilation	Supportive measure. Mechanical ventilation is usually required during first 36-48 hrs.
Hypothermia	Blankets or increased room temperature. No active rewarming.
Hypotension	Hydrocortisone 100 mg Q6-8 hrs. Fluids cautiously with 5% to 10% glucose 0.45% NS if hypoglycemia. Isotonic saline is hyponatremia is present.
Hyponatremia	Severe hyponatremia (105-120) requires hypertonic saline to increase Na by 2-6 mmol/L. Chronic hyponatremia, the correction should not exceed 10-12 mmol/L in 24 hr.
Kidney Failure	Dialysis
General Supportive measures	Underlying problems: Infection, CHF, GI bleeding

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Questions ?

Sequelae of Thyroid Storm

Table 6 Sequelae of thyroid storm

Sequlae	Number of patients
Post-resuscitation encephalopathy	6
Disuse muscle atrophy	5
Cerebrovascular disease	4
Atrial fibrillation	4
Renal insufficiency	2
Psychosis	2
Hypothyroidism	2
Gastric ulcer	1
Others	3
Total	29

Clinical Features TS and CT

Table 2. Clinical Features of Patients With Discordant Thyroid Storm Diagnosis

	Thyroid Storm (TS) BWS <45, AkTS0 (n,%)	Thyrotoxic (CT) BWS ≥45 or AkTS1/2(n,%)
Number of patients	5	27
Sex (F:M)	3:2	18:9
Age, median years (range)	44 (36–58)	40 (21–84)
Fever, Temp >100.4 F (%)	2 (40)	8 (29.6)
CNS dysfunction (%)	4 (80)	6 (22.2)
Tachycardia, HR >100 bpm (%)	5 (100)	25 (92.6)
GI-hepatic dysfunction (%)	0 (0)	17 (63)
Atrial Fibrillation (%)	0 (0)	14 (51.9)
Congestive Heart Failure (%)	0 (0)	9 (33.3)
Precipitating event (%)	2 (40)	17 (63)

Burch Wartofsky Score (BWS), Akamizu (Ak), Central nervous system (CNS), Heart rate (HR), Gastrointestinal (GI).

J Clin Endocrinol Metab Clinical features and hospital outcomes in thyroid storm: a retrospective cohort study. 2015 Feb;100(2):451-9

Diagnostic criteria DIC in thyroid storm

- The mortality rate in patients with disseminated intravascular coagulation (DIC) diagnosed according to guidelines from the Ministry of Welfare of Japan was approximately 60%.
- DIC was comprised 9.27% of patients with thyroid storm (TS) in the nationwide survey, and the mortality rate in these patients was 45.5%. The presence of DIC was correlated with mortality ($p<0.0001$).
- The diagnostic criteria from the Japan Association for Acute Medicine are recommended for rapid diagnosis of DIC in TS. Since TS often fulfills two of the diagnostic criteria (body temperature and heart rate) for systemic inflammatory response syndrome (SIRS), DIC may easily develop in patients with TS.

Diagnostic criteria for DIC (Japanese Association of Acute Medicine) (Ref. [129])

Score	SIRS item *	Platelets (/mm³)	Prothrombin time ratio	Fibrinogen degradation product (μg/mL)
1 point	Positive for more than 3 items	≥80,000 and <120,000 or more than a 30% decrease within 24 hours	≥1.2	≥10 and <25
2 points				
3 points		<80,000 or more than a 50% decrease within 24 hours		≥25

DIC can be diagnosed with a total score ≥ 4 points.

* **Diagnostic criteria for SIRS** (SIRS can be diagnosed when more than 3 items are positive.)

Body temperature >38°C or <36°C
Heart rate >90 bpm
Respiration rate >20/min or $PaCO_2$ <32 mmHg
WBC >12,000/mm³ or <4,000/mm³ or blasts >10%

Fig. 14 Comments on the treatment and diagnostic criteria for disseminated intravascular coagulation

Direct causes of death in thyroid storm

Table 4 Direct causes of death in thyroid storm

Causes	Number of patients
MOF	9
Heart failure	8
Respiratory failure	3
Arrhythmia	3
DIC	2
Gastointestinal perforation	2
Hypoxic brain damages	1
Sepsis	1
Unknown	9
Total	38

MOF, multiple organ failure; DIC, disseminated intravascular coagulation.

Patient characteristics

Table 1
Patient characteristics.

	Overall	Non-survivors	*P*
Total	149 (100)	44 (100)	
Sex			0.27
Male	51 (34.2)	18 (40.9)	
Female	98 (65.8)	26 (59.1)	
Age, years			0.15
≤69	32 (21.5)	4 (9.1)	
70-79	48 (32.2)	16 (36.4)	
80-89	49 (32.9)	16 (36.4)	
≥90	20 (13.4)	8 (18.2)	
Japan Coma Scale score at admission			0.13
0 (alert)	50 (33.6)	13 (29.5)	
1–3 (drowsy)	31 (20.8)	5 (11.4)	
10–30 (somnolence)	41 (27.5)	15 (34.1)	
100–300 (coma)	27 (18.1)	11 (25.0)	
Season at admission			0.86
Spring	30 (20.1)	7 (15.9)	
Summer	23 (15.4)	7 (15.9)	
Autumn	27 (18.1)	9 (20.5)	
Winter	69 (46.3)	21 (47.7)	
Thyroid hormone replacement			0.66
Enteral LT4 alone	120 (80.5)	36 (81.8)	
Enteral LT4 and LT3	11 (7.4)	2 (4.5)	
Others	18 (12.1)	6 (13.6)	
Maximal dosage per day of LT4, μg			0.51
<100	36 (24.2)	12 (27.3)	
100-199	55 (36.9)	13 (29.5)	
≥200	40 (26.8)	13 (29.5)	
Maximal dosage per day of LT3, μg			0.63
<20	4 (2.7)	1 (2.3)	
20-49	4 (2.7)	1 (2.3)	
≥50	3 (2.0)	0 (0)	
Duration of LT3, days			0.66
<7	7 (4.7)	1 (2.3)	
≥7	4 (2.7)	1 (2.3)	
Use of steroids and catecholamines			<0.001
None	49 (32.9)	7 (15.9)	
Steroids alone	50 (33.6)	13 (29.5)	
Catecholamines with or without steroids	50 (33.6)	24 (54.5)	
Duration of steroids, days			0.079
<7	37 (24.8)	19 (43.2)	
7-13	19 (12.8)	4 (9.1)	
≥14	36 (24.2)	13 (29.5)	
Duration of catecholamines, days			0.47
<7	31 (20.8)	17 (38.6)	
7-13	8 (5.4)	3 (6.8)	
≥14	11 (7.4)	4 (9.1)	
Mechanical ventilation			0.008
Yes	39 (26.2)	18 (40.9)	
No	110 (73.8)	26 (59.1)	

Data are shown as n (%). All P values are for chi-square tests.

J Epidemiol. 2017 Mar;27(3):117-122. Clinical characteristics and outcomes of myxedema coma: Analysis of a national inpatient database in Japan.