

Pitfall of Thyroid Storm Score

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ABSTRACT

The thyroid storm is an emergency characterized by multiple organ failure due to severe thyrotoxicosis that is often triggered by other diseases. The diagnosis of thyroid storm is made clinically in a severe thyrotoxic patient with evidence of systemic decompensation. The Burch–Wartofsky Point Scale (BWPS) is a score that is widely used to diagnose thyroid storm, introduced by Burch and Wartofsky in 1993. In Burch–Wartofsky Point Scale, the thyroid storm diagnosis is made if there is clinically severe thyrotoxicosis with a score of 45 in a patient that has a previous history of elevated free fT3 (triiodothyronine) or fT4 (free thyroxine). But in a condition it cannot be distinguished whether a condition is caused by the effects of thyrotoxicosis or due to other diseases, then these symptoms are considered as a result of the effects of thyrotoxicosis. In the Burch–Wartofsky Point Scale, there is a pitfall. If we are accustomed to assuming a worsening of the condition in thyroid patients as a result of the effects of thyrotoxicosis, without trying to exclude the condition due to other conditions can lead to a misdiagnosis of thyroid storm. This article aims to remind us to be careful in applying diagnostic tools in diagnosing a thyroid storm.

Keywords: Thyroid storm, Burch–Wartofsky Point Scale, Pitfall

INTRODUCTION

The term “thyroid storm” was introduced in the late 1920s. In 1928, Lahey gave an early description of thyroid storm: “The following remarks concerning thyroid crises and their management are prompted by the fact that so many patients are constantly being brought to the hospital in advanced stages of thyroid crisis and so many of these inoperable patients die despite the employment of every measure with which we are acquainted”.⁽¹⁾

Nowadays, thyroid storm is definitely an emergency characterized by multiple organ failure due to severe thyrotoxicosis that is often triggered by other diseases. The diagnosis of thyroid storm is made clinically in a severe thyrotoxic patient with evidence of systemic decompensation.⁽²⁾

Before 1993, there was no clear diagnostic method for diagnosing thyroid storm. At that time, a history of elevated free triiodothyronine (fT3) or free thyroxine (fT4) accompanied by worsening symptoms caused by thyrotoxicosis



was considered a thyroid storm, thus biasing the diagnosis of thyroid storm.⁽³⁾

The Burch–Wartofsky Point Scale (BWPS) is a score is that widely used for thyroid storm diagnosis, introduced by Burch and Wartofsky in 1993. We can diagnose thyroid storm if there is clinically severe thyrotoxicosis with a score of 45 in a patient that has a previous history of elevated free fT3 (triiodothyronine) or fT4 (free thyroxine). But in a condition, it cannot be distinguished whether a condition is caused by the effects of thyrotoxicosis or due to other diseases, then these symptoms are considered as a result of the effects of thyrotoxicosis.⁽⁴⁾

In the BW score, there is a pitfall. If we are accustomed to assuming a worsening of the condition in thyroid patients as a result of the effects of thyrotoxicosis, without trying to exclude the condition due to other conditions can lead to a misdiagnosis of thyroid storm.⁽⁴⁾

In 2016, the Japan Thyroid Association (JTA) introduced a new thyroid storm diagnostic system known as the JTA Criteria. In the JTA criteria, there are prerequisites condition for establishing a thyroid storm diagnosis. prerequisites condition is an increase in free triiodothyronine (fT3) or free thyroxine (fT4) in that time condition. In the JTA criteria, if there is no evidence of an increase in free triiodothyronine (fT3) or free thyroxine (fT4) but meets the symptoms of a thyroid storm, the patient can be suspected of having a thyroid storm.⁽⁴⁾

DEFINITION

The term thyroid storm (TS) or thyroid crisis was first introduced in 1926.⁽⁵⁾ A thyroid storm (also known as thyroid crisis or thyrotoxicosis crisis) is currently defined as an endocrine emergency characterized by multiple organ failure due to severe thyrotoxicosis, which is often precipitated by another disease.⁽²⁾

Thyroid storm is a life-threatening condition and requires emergency treatment. Thyroid storm is often triggered by physical or mental stress in patients with thyrotoxicosis. Patients will experience multiple organ failures as a result of failed compensatory mechanisms.^(6–8)

EPIDEMIOLOGY

Thyroid storm is more common in women, with a ratio of women to men 2.5:1, the average age of attack is 47 years.^(5,9) The incidence of thyroid storm in Japan is 0.2 cases per 100,000 hospitalizations per year.⁽¹⁰⁾ with a mortality rate of 10.1% of cases.⁽⁵⁾ Even in other literature it is stated that the mortality rate can reach 30%.⁽¹¹⁾

ETIOLOGY

The most common cause of thyroid storm is Grave Disease. However, in some cases, thyroid storm can also occur in hyperthyroidism with other causes, such as toxic multinodular goiter or destructive thyroiditis.^(8,10) Until now, there have been many identified triggering factors for the transition from non-thyroid storm hyperthyroidism to thyroid storm, including infection, surgery, trauma, post-radioiodine therapy, post-use of iodine-based contrast, post-thyroidectomy, childbirth, emotional stress, and even after FNAB.^(12,13)

MANIFESTATION

In the study from Akamizu et al, it is estimated that two-thirds of patients with thyroid storm have a temperature more than 38.0 °C and 76.2% of patients with definitive thyroid storm had tachycardia with heart rate \geq 130 beats per minute. While the appearance of atrial fibrillation (AF) was found in 39.3% of pa-

tients with definitive thyroid storm, the incidence of AF reached 52.6% of all patients who died. The estimated thyroid storm patients who experience CHF reach 40%, even three-quarters of them are severe CHF. In addition, 53.5% of thyroid storm patients experienced a decrease in consciousness and gastrointestinal or hepatic manifestations can appear in 68.3% of thyroid storm patients.⁽⁶⁾ Another study conducted by Freidooni and Forootan (2018) found central nervous manifestations in up to 84% of cases, tachycardia (with HR > 130) in up to 75% of cases, and heart failure in up to 40% of cases and as many as 76% of cases had more than 3 organ failures.⁽¹¹⁾

In a thyroid storm, thyroid hormone is secreted in large quantities and increases myocardial cell Na⁺/K⁺/ATP activity and is followed by an increase in Ca²⁺/ATP level activity in the sarcoplasmic reticulum, triggering an increase in oxygen consumption, and causing hypoxia and ischemia resulting in severe arrhythmias.⁽¹⁴⁾

DIAGNOSIS

Between the period 1926 to 1993, there was no clear diagnostic method for diagnosing thyroid storm. Before 1993, a history of elevated free triiodothyronine (fT3) or free thyroxine (fT4) accompanied by the aggravation of symptoms due to thyrotoxicosis was considered a thyroid storm, thus biasing the diagnosis of thyroid storm.⁽⁴⁾

The Burch–Wartofsky Point Scale (BWPS) is a score that is widely used to diagnose thyroid storm, introduced by Burch and Wartofsky in 1993.⁽³⁾ According to Burch and Wartofsky, a definitive thyroid storm diagnosis can be enforced if there is clinically severe thyrotoxicosis with a score ≥ 45 . In cases where it cannot be distinguished whether a condition is caused by the ef-

fects of thyrotoxicosis or due to another disease, then these symptoms are considered as a result of the effects of thyrotoxicosis.⁽⁴⁾

In 2016, the Japan Thyroid Association (JTA) introduced a new thyroid storm diagnostic system known as the JTA Criteria. In the JTA criteria, there are prerequisites for diagnosis, namely an increase in free triiodothyronine (fT3) or free thyroxine (fT4). In JTA criteria, in the absence of evidence of increased free triiodothyronine (fT3) or free thyroxine (fT4) but fulfills the symptoms of thyroid storm, the patient can be suspected of having a thyroid storm.⁽²⁾

Table 1. Burch-Wartofsky Point Scale

Criteria	Point(s)
Temperature °F (°C)	
<99	0
99 – 99.9 (37.2 – 37.7)	+5
100-100.9 (37.8 – 38.2)	+10
101 – 101.9 (38.3 – 38.8)	+15
102 – 102.9 (38.9 – 39.2)	+20
103 – 103.9 (39.3 – 39.9)	+25
≥ 104.0 (≥ 40.0)	+30
Atrial Fibrillation	
Absent	0
Present	+10
Congestive Heart Failure	
Absent	0
Mild (pedal edema)	+5
Moderate (bibasilar rales)	+10
Severe (pulmonary edema)	+15
Gastrointestinal-hepatic dysfunction	
Absent	0
Mild (agitation)	+10
Moderate (seizure, coma)	+20
Severe (seizure, coma)	+30
Precipitating event	
Absent	0
Present	+10

*Score interpretation: <25: Unlikely to represent thyroid storm, 25-44: Suggestive of impending thyroid storm, ≥ 45 : Highly suggestive of thyroid storm.

There are two main differences between BWPS and JTA criteria, the first difference is that in BWPS clinical thyrotoxicosis (without evidence of fT3 and fT4 hormone levels) is a BWPS criterion, whereas, in JTA criteria, evidence of

thyrotoxicosis (there is an increase in fT3 or fT4 hormone levels) is a prerequisite for diagnosis thyroid storm. While the second difference is that in the JTA criteria, there is no use of a scoring system.⁽⁶⁾

Given the difficulty in distinguishing whether a symptom in a patient is caused by a manifestation of a thyroid storm or a disease that triggers a thyroid storm, both the BWPS and JTA criteria suggest that if you are in doubt whether the symptom is part of a thyroid storm or not, then it should be considered part of a thyroid storm. So that clinical judgment determines whether we include it as part of the symptoms of thyroid storm or not. In addition, as previously described, in the criteria for JTA, the patient still considered as a definitive thyroid storm before evidence of thyrotoxicosis is obtained (there is an increase in fT3 or fT4 hormone levels).⁽²⁾

PITT FALL IN THYROID STORM SCORE

Patients with definitive thyroid storm, suspected thyroid storm, and thyrotoxicosis without thyroid storm can have similar clinical manifestations. Even some patients with thyroid storm may have normal fT3, and elevated

serum fT4 levels accompanied by decreased TSH levels.⁽⁶⁾

Until the 2000s, there were no reviews evaluating the use of the Burch–Wartofsky Point Scale (BWPS). Although this criterion is clearly useful, this scoring system has not been validated. On the other hand, because the incidence of thyroid storm is not high, prospective studies to meet the criteria for thyroid storm are considered to be very difficult and time-consuming.

As previously mentioned, there are two systems for diagnosing thyroid storm, namely BWPS and JTA criteria, both of which have differences in terms of using evidence of thyrotoxicosis (increased levels of fT3 and/or fT4 hormones) as a prerequisite for the diagnosis of thyroid storm on JTA criteria and no JTA criteria. use of a scoring system. According to Akamizu (2018), the use of evidence of increased fT3 and/or fT4 hormone levels is important to reduce false positives, despite the fact that even though fT4 increases and TSH decreases, fT3 can be normal in thyroid storm. In addition, the use of a scoring system in BWPS is difficult to accept because it was produced from a retrospective research review that was not validated.⁽⁶⁾

Table 2. 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: $\geq 38^\circ\text{C}$		
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 Association or \geq Class III in the Killip Classification		
5. Gastrointestinal (GI) / hepatic manifestations: nausea, vomiting, diarrhea, or total bilirubin ≥ 3.0 mg/dL		
Diagnosis		
Grade of TS	Combinations of features	Requirement for diagnosis
TS1	First combination	Thyrotoxicosis and at least one CNS manifestation and fever, tachycardia, CHF, or GI/hepatic manifestations
TS2	Alternate combination	Thyrotoxicosis and at least one CNS manifestation and fever, tachycardia, CHF, or GI/hepatic manifestations
TS3	First combination	Thyrotoxicosis and at least one CNS manifestation and fever, tachycardia, CHF, or GI/hepatic manifestations
TS4	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 disease clearly causing any of the following symptoms: fever (e.g., pneumonia and malignant hyperthermia), impaired consciousness (e.g., psychiatric disorder 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 underlying 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.		

Note: TS, "Definite" TS; TS2, "Suspected" TS

Stumpf et al (2019) reported a patient who had been diagnosed with Grave's thyrotoxicosis but did not take routine treatment, at the time of admission the patient experienced decreased consciousness, hypotension tachycardia (143 x/minute), and fever (40.5 C), the calculated BWPS was 55. However, on further examination, the results of leukocytes were $430 \times 10^6/\text{L}$ with a neutrophil percentage of only 15% (equivalent to $60 \times 10^6/\text{L}$) so it was more suggestive of sepsis. In this case, the patient improved and was discharged after the 7th day of treatment with only non-thyroid storm thyrotoxicosis therapy.⁽¹⁵⁾

Strowd et al (2017) also reported a perioperative case. 2 weeks before surgery, the TSH level $< 0.01 \mu\text{IU}/\text{mL}$ and FT3 $440 \text{ pg}/\text{dL}$. During the operation, an increase in body temperature

(temperature 39.2 C) and tachycardia (frequency $110 \text{ x}/\text{minute}$) was found and the calculated BWPS was 35. The patient was then given phenylephrine $600 \mu\text{g}$ IV in divided doses, tromethamine solution (THAM) 500 mL IV and compresses were applied to the groin and armpits, without receiving thyroid storm therapy. The patient was improved and then did not diagnose with thyroid storm but with Malignant Hyperthermia.⁽¹⁶⁾

Rayner et al (2013) also reported a woman with a history of hyperthyroidism who had a gum abscess, tachycardia $140 \text{ x}/\text{minute}$, and a fever of 38.8 C . The calculated BWPS was 55 (fever +20, tachycardia + 25, and trigger factor +10). However, leukocytes were $7.5 \times 10^3/\mu\text{L}$ with a 0% neutrophil percentage.

On examination the total T3 was 185 ng/dL (upper limit 178 ng/dL), fT4 was 3 ng/dL (upper limit 1.2 ng/dL) and TSH was 0.036 μ IU/mL (lower limit 0.4 μ IU/mL). In this patient it was decided to be treated as febrile neutropenia (methimazole induced) with an odontogenic abscess as the source of infection, the patient then received antibiotic therapy, GCSF (granulocyte colony-stimulating factor) subcutaneously. After that treatment, the patient improved.⁽¹⁷⁾

DISCUSSIONS

Hyperthyroidism, both overt and subclinical, is a risk factor for atrial fibrillation. According to Anderson et al (2020), atrial fibrillation in hyperthyroid cases can even occur at fT4 levels that are still within normal limits, although the risk clearly increases with increased fT4.⁽¹⁸⁾

Akamizu et al (2012) found the fact that a pulse rate >130x/minute could even be found in 7.5% of the hyperthyroid patient population without thyroid storm and a pulse rate >120x/minute even reached a quarter of the hyperthyroid patients without thyroid storm. Meanwhile, the BWPS score related to tachycardia is 20 for a pulse frequency of 130-139x/minute and 15 for a pulse frequency of 120-129x/minute. In addition, body temperature > 38 C can also be found in 3% of hyperthyroid patients without thyroid storm while in BWPS, temperatures > 38 C at least get 10 scores.⁽¹⁹⁾ This proves that the symptoms of a thyroid storm can be found in a non-thyroid storm and it could be that if we misinterpret it, we can fall into a state of overdiagnosis.

Akamizu et al (2012) also found a significant difference in fT3 levels between groups with thyroid storms and those without thyroid storms. In the non-thyroid storm group, the average fT3 level was “only” 16.5 (\pm 8.2) pg/mL,

whereas, in the definitive thyroid storm group, the average fT3 level was 19.7 (\pm 12.7) pg/mL, while fT4 levels were not too different, in the non-thyroid storm group, the average fT4 level was 6.35 (\pm 5.13) pg/mL, and in the definitive storm group, the mean fT4 level was 6.38 (\pm 3.4) pg/mL.⁽¹⁹⁾

Reflecting on that, it makes us realize that we must be wise in using the BWPS as a diagnostic tool for thyroid storm because the BWPS basically only assesses the patient's clinical condition and in fact has not been validated until now. In addition, it is important to measure thyroid hormone levels when a thyroid storm is suspected to prove whether the condition is a thyroid storm or not.

CONCLUSION

Thyroid storm is a life-threatening condition and requires emergency treatment. Until now, 2 kinds of scoring systems have been introduced to diagnose thyroid storm, namely BWPS and JTA criteria. The main difference between BWPS and JTA criteria is that in BWPS the assessment is based solely on clinical thyrotoxicosis and a history of elevated fT3 or fT4 hormone levels, whereas in JTA criteria, evidence of thyrotoxicosis (presence of increased fT3 or fT4 hormone levels) is a prerequisite for the diagnosis of thyroid storm. In addition, the JTA criteria do not use a scoring system.

The BWPS scoring and JTA criteria suggest that if there is doubt about whether a symptom is part of a thyroid storm or not, then it should be considered part of a thyroid storm. However, considering that BWPS does not need evidence of increased fT3 or fT4 hormone levels when symptoms appear, BWPS has the potential for overdiagnosis compared to JTA hormones.

Reflecting on this, we must be wise in diagnosing thyroid storms even in patients with a history of hyperthyroidism. Inappropriate implementation of the diagnostic system can lead to misdiagnosis of thyroid storm.

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