Thyroid Storm in the ICU: A Retrospective Multicenter Study

Simon Bourcier, MD[1]; Maxime Coutrot, MD[1]; Antoine Kimmoun, MD, PhD[2]; Romain Sonneville, MD, PhD[3]; Etienne de Montmollin, MD[4]; Romain Persichini, MD[5]; David Schnell, MD[6]; Julien Charpentier, MD[7]; Cécile Aubron, MD, PhD[8]; Elise Morawiec, MD, PhD[9]; Naïke Bigé, MD, PhD[10]; Saad Nseir, MD, PhD[11]; Nicolas Terzi, MD, PhD[12]; Keyvan Razazi, MD[13]; Elie Azoulay, MD, PhD[14]; Alexis Ferré, MD[15]; Yacine Tandjaoui-Lambiotte, MD[16]; Olivier Ellrodt, MD[17]; Sami Hraiech, MD, PhD[18]; Clément Delmas, MD[19]; François Barbier, MD, PhD[20]; Alexandre Lautrette, MD, PhD[21]; Nadia Aissaoui, MD, PhD[22]; Xavier Repessé, MD[23]; Claire Pichereau, MD[24]; Yoann Zerbib, MD[25]; Jean-Baptiste Lascarrou, MD[26]; Serge Carreira, MD[27]; Danielle Reuter, MD[28]; Aurélien Frérou, MD[29]; Vincent Peigne, MD[30,31]; Pierre Fillatre, MD[32]; Bruno Megarbane, MD, PhD[33]; Guillaume Voiriot, MD, PhD[34]; Alain Combes, MD, PhD[1,35]; Matthieu Schmidt, MD, PhD[1,35]

[1]Assistance Publique-Hôpitaux de Paris (APHP), Pitié-Salpêtrière Hospital, Medical Intensive Care Unit, 75651 Paris Cedex 13, Paris, France.

[2]Service de Réanimation Médicale Brabois, Pole Cardiovasculaire et Réanimation Médicale, Hôpital Brabois, Vandoeuvre-les-Nancy, France.

[3]Medical and Infectious Diseases Intensive Care Unit, Bichat Hospital, APHP, Paris, France.

[4]Medical-Surgical Intensive Care Unit, Delafontaine Hospital, Saint-Denis, France.

[5]Medical-Surgical Intensive Care Unit, Centre Hospitalier Universitaire (CHU) de La Réunion, Felix-Guyon Hospital, Saint-Denis, La Réunion, France.

[6]Service de Réanimation Polyvalente, CH d'Angoulême, Angoulême, France.

[7]Medical Intensive Care Unit, Cochin Hospital, Hôpitaux Universitaire Paris Centre, APHP, Paris, France.

[8]Department of Critical Care, Brest University Hospital, Brest, France.

[9]Service de Pneumologie et Réanimation Médicale (Département "R3S"), Hôpital de la Pitié-Salpêtrière, APHP, Paris, France.

[10]Medical Intensive Care Unit, Hôpital Saint-Antoine, APHP, Paris, France.

[11]Critical Care Center, University Hospital of Lille, Lille University, Lille, France.

[12]Department of Medical Intensive Care, CHU de Grenoble Alpes, Grenoble, France.

[13]Medical Intensive Care Unit, CHU Henri-Mondor, APHP, Créteil, France.

[14]Medical Intensive Care Unit, Saint-Louis Hospital, APHP, Paris, France.

[15]Medical-Surgical Intensive Carre Unit, CH de Versailles, Le Chesnay, France.

[16]Medical Intensive Care Unit, Avicenne University Hospital, APHP, Bobigny, France.

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[17]Département de Médecine Intensive, Groupe Hospitalier Sud Île-de-France, Hôpital de Melun, Melun, France.

[18]Assistance Publique, Hôpitaux de Marseille, Hôpital Nord, Réanimation des Détresses Respiratoires et des Infections Sévères, Marseille, France.

[19]Intensive Care Unit, Anesthesia and Critical Care Department, Institut des Maladies Métaboliques et Cardiovasculaires, Rangueil University Hospital, Toulouse, France.

[20]Medical Intensive Care Unit, CH Regional d'Orléans, Orléans, France.

[21]Medical Intensive Care Unit, CHU Clermont-Ferrand, Clermont-Ferrand, France.

[22]Department of Critical Care Unit, Hôpital Européen Georges-Pompidou (HEGP), APHP, Paris, France.

[23]Intensive Care Unit, University Hospital Ambroise-Paré, APHP, Boulogne-Billancourt, France.

[24]Intensive Care Unit, Poissy Saint-Germain-en-Laye Hospital, Poissy, France.

[25]Department of Medical Intensive Care, Amiens University Hospital, Amiens, France.

[26]Médecine Intensive Réanimation, CHU de Nantes, Nantes, France.

[27]Medical-Surgical Intensive Care Unit, Saint-Camille Hospital, Bry-sur-Marne, France.

[28]Medical-Surgical Intensive Care Unit, CH Sud Francilien, Corbeil, France.

[29]Medical Intensive Care Unit, Hôpital Pontchaillou, CHU de Rennes, France.

[30]Haute-Savoie Fire Department, Meythet, France.

[31]Intensive Care Unit Metropole-Savoie Hospital, Chambery, France.

[32]Medical-Surgical Intensive Care Unit, CH de Saint-Brieuc, Saint-Brieuc, France.

[33]Department of Medical Intensive Care, Lariboisière Hospital, APHP, Paris, France.

[34]Service de Pneumologie et Réanimation, Hôpital Tenon, APHP, Paris, France.

[35]Sorbonne Universités, UPMC Univ Paris 06, INSERM, UMRS_1166-ICAN, Institute of Cardiometabolism and Nutrition, Paris, France.

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Address requests for reprints to: Matthieu Schmidt, MD, PhD, Service de Réanimation Médicale, iCAN, Institute of Cardiometabolism and Nutrition, Hôpital de la Pitié-Salpêtrière, 47, bd de l'Hôpital, 75651 Paris Cedex 13, France. E-mail: matthieu.schmidt@aphp.fr.

Objectives: Thyroid storm represents a rare but life-threatening endocrine emergency. Only rare data are available on its management and the outcome of the most severe forms requiring ICU admission. We aimed to describe the clinical manifestations, management and in-ICU and 6-month survival rates of patients with those most severe thyroid storm forms requiring ICU admission.

Design: Retrospective, multicenter, national study over an 18-year period (2000–2017).

Setting: Thirty-one French ICUs.

Patients: The local medical records of patients from each participating ICU were screened using the *International Classification of Diseases*, 10th Revision. Inclusion criteria were "definite thyroid storm," as defined by the Japanese Thyroid Association criteria, and at least one thyroid storm-related organ failure.

Measurements and Main Results: Ninety-two patients were included in the study. Amiodarone-associated thyrotoxicosis and Graves' disease represented the main thyroid storm etiologies (30 [33%] and 24 [26%] patients, respectively), while hyperthyroidism was unknown in 29 patients (32%) before ICU admission. Amiodarone use (24 patients [26%]) and antithyroid-drug discontinuation (13 patients [14%]) were the main thyroid storm-triggering factors. No triggering factor was identified for 30 patients (33%). Thirty-five patients (38%) developed cardiogenic shock within the first 48 hours after ICU admission. In-ICU and 6-month postadmission mortality rates were 17% and 22%, respectively. ICU nonsurvivors more frequently required vasopressors, extracorporeal membrane of oxygenation, renal replacement therapy, mechanical ventilation, and/or therapeutic plasmapheresis. Multivariable analyses retained Sequential Organ Failure Assessment score without cardiovascular component (odds ratio, 1.22; 95% CI, 1.03–1.46; $p = 0.025$) and cardiogenic shock within 48 hours post-ICU admission (odds ratio, 9.43; 1.77–50.12; $p = 0.008$) as being independently associated with in-ICU mortality.

Conclusions: Thyroid storm requiring ICU admission causes high in-ICU mortality. Multiple organ failure and early cardiogenic shock seem to markedly impact the prognosis, suggesting a prompt identification and an aggressive management. (*Crit Care Med* 2019; XX:00–00)

Key Words: cardiogenic shock; critical care; extracorporeal membrane oxygenation; hyperthyroidism; thyroid crisis; thyrotoxicosis

Hyperthyroidism is a pathology resulting from excessive circulating thyroid-hormone concentrations (1). Its main etiologies are Graves' disease, toxic multinodular goiter, and iodine overload (1, 2). Although hyperthyroidism prevalence is estimated at 1% of the general population, severe forms, so-called "thyroid storm" (TS), are rare. This life-threatening event requires prompt diagnosis and specific management (3, 4).

First described in 1928 as the "crisis of exophthalmic goiter" in patients too critically ill to undergo surgery (5), the TS incidence was recently estimated to be two cases per million hospitalized patients, representing an overall incidence of 0.2% of all patients with thyrotoxicosis in a Japanese prospective nationwide survey (6). These rare forms are associated with poor outcomes, with mortality reaching 40% of small cohorts (6–9). Due to the ubiquitous impact of thyroid hormones, TS clinical features are variable, with manifestations ranging from thermoregulatory system dysfunction to gastrointestinal and hepatic disorders, CNS impairment, and cardiothyreosis. This last one is considered as the most severe TS symptom, which may be atrial and/or ventricular arrhythmias, heart failure, and/or cardiac arrest (6, 10–12).

The various clinical manifestations and rarity of severe TS forms make the diagnosis challenging, which may delay ICU admission and specific treatment initiation. Recently, the Japanese Thyroid Association (JTA) published TS criteria based on combinations of clinical features (10, 13). The current American Thyroid Association (ATA) guidelines recommend aggressive therapeutic management, including treatment(s) directed against thyroid-hormone secretion and synthesis, blockade of the peripheral thyroid-hormone actions and the precipitating event, and systemic decompensation management (3). Last, venoarterial extracorporeal membrane oxygenation (ECMO) support (14) and/or plasmapheresis have been proposed to manage the most severe TS forms with cardiothyreosis (15–18).

To date, although intensivists may encounter TS and actively participate in its management, extensive data on this rare disease are lacking, with most information derived from small retrospective cohorts and not ICU patients (7, 19). Therefore, we undertook this study to describe clinical characteristics, management, and outcomes of a large cohort of TS patients treated in French ICUs.

MATERIALS AND METHODS

Studied Population

This study retrospectively included TS patients hospitalized in 31 ICUs between 2000 and 2017 (**Fig. 1**). All consecutive patients with at least one of the following *International Classification of Diseases* 10 diagnoses: E05 (thyrotoxicosis), E05.0 (thyrotoxicosis with diffuse goiter), E05.2 (thyrotoxicosis with toxic multinodular goiter), E05.4 (thyrotoxicosis factitia), E05.8 (other thyrotoxicosis), E05.9 (thyrotoxicosis, unspecified), E06.3 (autoimmune thyroiditis), E06.4 (drug-induced thyroiditis) were screened by the local investigator in each participating ICU. Then, ICU

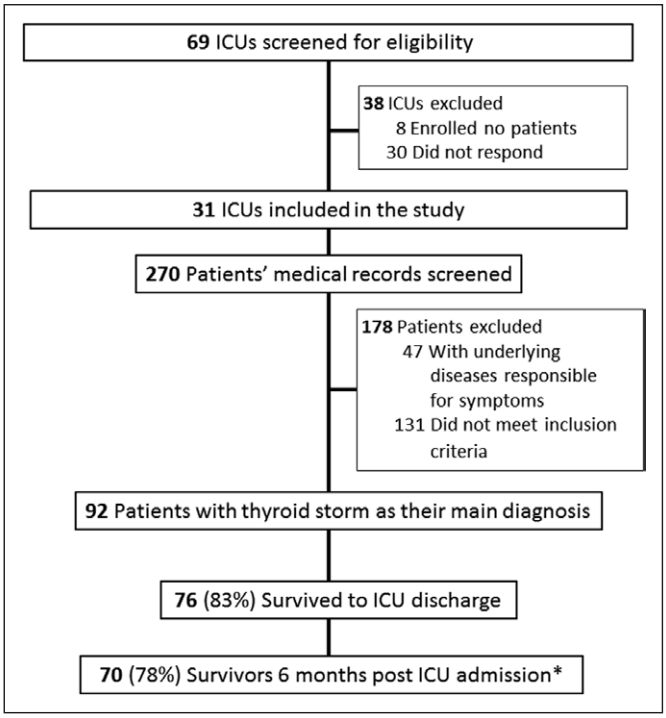

Figure 1. Flowchart of patient selection from participating ICUs. *Available for 90 of 92 patients.

reports were anonymously sent to two investigators (S.B., M.C.), who independently selected patients satisfying inclusion criteria. Disagreements were resolved by consensus after discussion with a third investigator (M.S.). Inclusion criteria were adults greater than 18 years old admitted to the ICU for TS with at least one organ failure and/or a Sequential Organ Failure Assessment (SOFA) score greater than or equal to 1 (20). The latter organ failure had to be a direct consequence of TS for patients with a potential etiological underlying disease.

TS diagnosis was defined by a combination of the following criteria 1, 2, and/or 3, as defined previously by Akamizu et al (6): 1) elevated free triiodothyronine (FT3) or free thyroxine (FT4) levels; 2) one or more CNS manifestation(s) (restlessness, delirium, mental aberration/psychosis, somnolence/lethargy, Glasgow Coma Scale < 15), combined with at least one of the following signs: fever greater than or equal to 38°C, tachycardia (heart rate ≥ 130 beats/min), congestive heart failure (CHF) manifestations (pulmonary edema, cardiogenic shock, class IV of the New York Heart Association scale, or ≥ class III of the Killip classification), or digestive manifestations (nausea, vomiting, diarrhea or total bilirubin ≥ 3.0 mg/dL); and 3) at least three clinical signs among: fever, tachycardia, CHF or digestive manifestations (6, 21).

Patients were excluded when TS was not the primary reason for ICU admission and another underlying disease could explain the presence of criteria 2 and 3, even when criterion 1 was met.

Data Collection

Data were collected from the individual local ICU reports. French ICU reports universally include the following detailed sections: reason for admission, past medical history, present medical history leading to hospital and ICU admission, clinical examination at admission, severity and comorbidity scores, laboratory and imaging results at admission and during the ICU stay, ICU clinical course with organ support data, specific therapeutic management, and clinical status and outcome at ICU discharge.

Baseline information, recorded at ICU admission, included demographic data, severity and comorbidity scores (modified Charlson score [22], Simplified Acute Physiology Score [SAPS] II [23], SOFA score), underlying thyroid disease, triggering factors, clinical signs, and laboratory findings. Follow-up parameters recorded were use of vasopressors, inotropic drugs, mechanical ventilation, renal replacement therapy, or veno-arterial ECMO. In addition, specific thyroid management, including anti-thyroid drugs, β-blockers, corticosteroids, potassium iodide, plasmapheresis, thyroidectomy, or radioactive iodine therapy, was recorded.

Cardiogenic shock was defined as clinical evidence of hypotension (systolic blood pressure < 90 mm Hg), despite adequate filling status, with signs of hypoperfusion occurring within the first 48 hours of the ICU stay, and associated with decreased left ventricular ejection fraction (LVEF) requiring inotropic support and/or venoarterial ECMO (14). Last, ICU and 6-month postadmission survival were noted.

To obtain 6-month mortality and the core missing data, local investigators were contacted to look for these informations into the patient's full medical data files.

Ethical Considerations

This study was approved by the Ethics Committee of the French Intensive Care Society (Société de Réanimation de Langue Francaise CE number 17–26) and complied with French Research Methodology MR003 regarding health-data privacy, in accordance with the French National Commission on Informatics and Liberty.

Statistical Analyses

This study followed the STrengthening the Reporting of OBservational studies in Epidemiology statement recommendations for reporting cohort studies. Continuous variables (expressed as median [interquartile range]) were compared with Student *t* test or the Wilcoxon test, as appropriate. Categorical variables (expressed as *n* [%]) were compared with chi-square tests. Patients' demographic, clinical and management characteristics, and laboratory results were tested in bivariate analyses for association with in-ICU mortality and cardiogenic shock. Factors achieving *p* value of less than or equal to 0.10 in bivariate analyses and with less than 20% missing values were entered into a multivariable model. No assumptions were made for missing data. A list of the rate of missing data within 24 hours in ICU is provided in **Supplemental Table 1** (Supplemental Digital Content 1, http://links.lww.com/CCM/F29). Multicollinearity was assessed calculating a variance inflation factor of each variable and ruled out if the variance inflation was lower than 4 and greater than 0.2. Then, variables associated with one another were not included in the multivariate

model. Thereafter, multiple backward-stepwise logistic-regression analyses eliminated variables with an exit threshold set at *p* value of greater than 0.05. Last, Kaplan-Meier survival curves were computed for cardiogenic shock- or SOFA score without cardiovascular section associated in-ICU mortality, and compared with Mantel-Cox log-rank tests. A *p* value of less than 0.05 defined significance. Analyses were computed with R 3.3.0 (R Foundation for Statistical Computing, Vienna, Austria) software.

RESULTS

Study Population and Clinical TS Spectrum in the ICU

During the 18-year study period, 270 patients admitted to 31 ICUs and meeting at least criteria one were screened (Fig. 1). TS diagnosis was confirmed for 92 of them (age 57 yr [44–69 yr], 58% male, SAPS II 44 [34–56]) (**Table 1**). Based on the number of patients admitted to ICUs during the study period, TS estimated incidence was 6.3 per 100,000 patients admitted. The main causes of hyperthyroidism were amiodarone-associated thyrotoxicosis, Graves' disease, or autoimmune thyroiditis; however, no cause was found for 15 patients (16%). De novo diagnosis of hyperthyroidism was made in 29 patients (32%) during their ICU stay. The most frequent TS triggers were amiodarone, discontinuation of antithyroid drugs, infection, or excess exogenous thyroid hormone, while no triggering factor was identified for a third of the patients (**Supplemental Table 2**, Supplemental Digital Content 2, http://links.lww.com/CCM/F30).

The most frequent TS clinical manifestations were CHF present for 66 patients (72%), CNS impairment for 58 patients (63%), and gastrointestinal or hepatic manifestations for 48 patients (52%). Fourteen patients (15%) had suffered cardiac arrest before ICU admission. Fifty-five (60%) and 12 (13%) patients had supraventricular tachycardia and ventricular fibrillation, respectively. At ICU admission, median FT3, FT4, and thyroid-stimulating hormone (TSH) levels were 9.3 mIU/L (6.0–22.6 mIU/L), 45.0 pmol/L (31.0–77.0 pmol/L), and 0 pmol/L (0.0–0.0 pmol/L), respectively. Except for FT3, which was significantly higher for ICU nonsurvivors ($p = 0.05$), no difference was found for FT4 and TSH at ICU admission.

In-ICU Organ Support and Specific Hyperthyroidism Management

Table 2 reports the ICU management of these patients. ICU nonsurvivors more frequently received vasopressors than ICU survivors (15 [94%] vs 26 [34%] patients; $p < 0.01$), with mechanical ventilation or renal replacement therapy requirements following the same trend. Last, it is worth noting that 13 (14%) of TS patients required venoarterial ECMO support for refractory cardiogenic shock. Targeted hyperthyroidism management frequently combined antithyroid drugs (74 patients [80%]) (i.e., propylthiouracil or carbimazole), β-blockers, glucocorticoids, potassium iodide, or plasmapheresis. Notably, only eight patients (9%) were thyroidectomized during their ICU stays but all survived ($p = 0.34$).

Patient Outcomes

Seventy-six patients (83%) survived in ICU, with 22% 6-month post-ICU admission mortality (available for 90/92 patients). The causes of death are listed in **Supplemental Table 3** (Supplemental Digital Content 3, http://links.lww.com/CCM/F31). As expected, nonsurvivors' SAPS II and SOFA scores were higher (Table 1; and **Fig. 2**). Similarly, ICU nonsurvivors had higher heart rates, aspartate transaminase and alanine transaminase concentrations, lower prothrombin time, and lower arterial pH at ICU admission (Supplemental Table 2, Supplemental Digital Content 2, http://links.lww.com/CCM/F30). ICU survivors received β-blockers more frequently (58 [76%] vs 7 [44%] patients; $p = 0.01$). Last, it is worth highlighting that cardiogenic shock occurred within 48 hours of ICU admission more frequently in ICU nonsurvivors (14 [88%] vs 21 [28%] patients, $p < 0.01$; odds ratio [OR], 18.3; 95% CI, 3.8–87.7). Indeed, 6-month mortality of patients with cardiogenic shock (median LVEF 17% [10–29%]) was higher than that of patients without cardiogenic shock (14 [40%] vs 2 [4%] patients, respectively; $p < 0.01$) (Fig. 2; and **Supplemental Table 4**, Supplemental Digital Content 4, http://links.lww.com/CCM/F32). Nonsurvivors more frequently required mechanical ventilation and renal replacement therapy. Notably, thyroid-hormone levels, and TS etiology and triggers did not differ between patients with or without cardiogenic shock.

Factors Associated With In-ICU Mortality

The following variables were included in the final multivariate model: SOFA score without cardiovascular component, cardiac arrest prior to ICU admission, cardiogenic shock within the first 48 hours after ICU admission, aspartate transaminase, and pH. Multivariable analyses revealed SOFA score without cardiovascular component (OR, 1.22; 1.03–1.46; $p = 0.025$) and cardiogenic shock within 48 hours after ICU admission (OR, 9.43; 1.77–50.12; $p = 0.002$) as being independently associated with in-ICU mortality.

DISCUSSION

To the best of our knowledge, this study reports the largest cohort of TS patients admitted to ICUs. TS estimated incidence is low and associated with high in-ICU and 6-month postadmission mortality, 17% and 22%, respectively. Notably, cardiogenic shock within 48 hours after ICU admission was independently associated with a more dismal prognosis. Specific hyperthyroidism management was heterogeneous among centers, frequently combining several therapeutic agents.

Although Graves' disease remains by far the leading cause of hyperthyroidism worldwide (2), amiodarone-associated thyrotoxicosis was the most frequent TS etiology herein. In addition, amiodarone use was previously found to be the most frequent TS-triggering factor (6), followed by antithyroid-drug discontinuation and infection. In light of the high amiodarone use worldwide, our results emphasize and support the current recommendations that thyroid-hormone levels be monitored regularly after amiodarone prescription (24, 25). Identifying TS-triggering factors is not always simple, as suggested by the

TABLE 1. Included Patients' General Characteristics According to ICU Survival Status

Characteristic	Total ($n = 92$)	ICU Nonsurvivors ($n = 16$)	ICU Survivors ($n = 76$)	p	OR (95% CI)
At ICU admission					
Age (yr)	57 (44–69)	60 (53–69)	57 (42–69)	0.29	
Simplified Acute Physiology Score II	44 (34–56)	56 (46–86)	41 (32–50)	< 0.01	
Charlson score	3 (2–4)	3 (0–5)	1 (0–4)	0.39	
Males	53 (58)	8 (50)	45 (59)	0.69	
Body mass index (kg/m^2)	24 (21–27)	25 (24–29)	24 (21–27)	0.33	
SOFA	6 (3–10)	12 (9–16)	5 (2–8)	< 0.01	
SOFA without cardiovascular section	4 (2–7)	9 (6–13)	4 (2–6)	< 0.01	
De novo hyperthyroidism	29 (32)	3 (19)	26 (34)	0.37	
Etiology				0.25	
Amiodarone-induced thyroiditis	30 (33)	7 (44)	23 (30)		
Graves' disease	24 (26)	3 (19)	21 (28)		
Toxic solitary adenoma	6 (6)	2 (13)	4 (5)		
Toxic multinodular goiter	8 (9)	0 (0)	8 (11)		
Autoimmune thyroiditis	9 (10)	0 (0)	9 (12)		
None	15 (16)	4 (25)	11 (15)		
Clinical medical history					
Weight loss	27 (29)	6 (37)	21 (28)	0.55	
Goiter	26 (28)	4 (25)	22 (29)	1	
Temperature ≥ 38°C	43 (47)	9 (56)	34 (45)	0.57	
Cardiac arrest before ICU	14 (15)	6 (38)	8 (11)	0.01	5.1 (1.5–17.8)
Ventricular fibrillation or tachycardia	12 (13)	2 (13)	10 (13)	0.94	
Supraventricular tachycardia	55 (60)	12 (75)	43 (57)	0.28	
Heart rate ≥ 130 beats/min	24 (26)	4 (25)	20 (26)	1	
Pulmonary edema	55 (60)	13 (81)	42 (55)	0.09	
Diarrhea	26 (28)	3 (19)	23 (30)	0.54	
Vomiting	22 (24)	4 (25)	18 (24)	1	
Coma (Glasgow < 9)	22 (24)	6 (38)	16 (21)	0.28	
Somnolence (9 ≤ Glasgow ≤ 14)	21 (23)	4 (25)	17 (22)	0.75	
Seizure	5 (5)	0 (0)	5 (7)	0.58	
Tremor	12 (13)	2 (13)	10 (13)	1	
Restlessness	25 (27)	5 (31)	20 (26)	0.76	
Thyroid-stimulating hormone (mIU/L)	0 (0–0)	0 (0–0)	0 (0–0.01)	0.30	
Free triiodothyronine (pmol/L)	9.3 (6.0–22.6)	20.0 (9.0–36.0)	8.6 (4.8–17.3)	0.05	
Free thyroxine (pmol/L)	45.0 (31.0–77.0)	64.0 (35.0–100.0)	45.0 (30.7–67.0)	0.29	
Japan Thyroid Association criteria					
Congestive heart failure	66 (72)	13 (83)	53 (70)	0.54	
CNS manifestations	58 (63)	12 (75)	46 (61)	0.42	
Gastrointestinal/hepatic manifestations	48 (52)	9 (56)	39 (51)	0.93	
Cardiogenic shock within 48 hr	35 (38)	14 (88)	21 (28)	< 0.01	18.3 (3.8–87.7)
Left ventricular ejection fraction (%) at admission	30 (15–50)	10 (5–25)	30 (20–50)	0.02	

OR = odds ratio, SOFA = Sequential Organ Failure Assessment.
Results are expressed as median (interquartile range) or *n* (%).
CNS manifestations: restlessness, delirium, mental aberration/psychosis, somnolence/lethargy, and/or coma.
Gastrointestinal/hepatic symptoms: nausea, vomiting, diarrhea, and/or a total bilirubin level ≥ 51 µmol/L (3 mg/dL).

TABLE 2. Therapeutic Management

Therapeutic Management	Total ($n = 92$)	ICU Nonsurvivors ($n = 16$)	ICU Survivors ($n = 76$)	p	OR (95% CI)
Specific hyperthyroidism treatment					
Anti-thyroid drug	74 (80)	12 (75)	62 (82)	0.51	
Carbimazole	39 (42)	6 (38)	33 (43)	0.87	
β-Blocker	65 (71)	7 (44)	58 (76)	0.01	0.25 (0.07–0.86)
Glucocorticoids	45 (49)	7 (44)	38 (50)	0.86	
Propylthiouracil	43 (47)	7 (44)	36 (47)	1	
Plasmapheresis	12 (13)	5 (31)	7 (9)	0.05	4.5 (1.2–16.7)
Potassium iodide	10 (11)	3 (19)	7 (9)	0.37	
Thyroidectomy	8 (9)	0 (0)	8 (11)	0.34	
Cholestyramine	5 (5)	2 (13)	3 (4)	0.20	
IV immunoglobulins	2 (2)	0 (0)	2 (3)	1	
Tacrolimus	1 (1)	0 (0)	1 (1)	1	
Radioactive iodine therapy	1 (1)	0 (0)	1 (1)	1	
None specific	5 (5)	2 (13)	3 (4)	0.21	
No. of patients with 1 specific therapy	8 (9)	2 (13)	6 (8)	0.62	
2 combined therapies	8 (9)	2 (13)	6 (8)	0.62	
≥ 3 therapies	71 (77)	10 (63)	61 (80)	0.13	
Thyroid hormones[a]					
Follow-up thyroid hormone (~day 15)	15 (8–34)	7 (5–13)	25 (10–37)	0.09	
Thyroid-stimulating hormone (mIU/L)	0.01 (0.0–1.38)	0.01 (0.0–0.03)	0.01 (0.0–1.65)	0.75	
Free triiodothyronine (pmol/L)	4.19 (3.0–5.95)	3.4 (2.8–4.8)	4.33 (3.15–6.2)	0.23	
Free thyroxine (pmol/L)	22.2 (11.38–33.6)	26.9 (22.9–39.5)	20.6 (10.7–33.65)	0.26	
Organ support					
Mechanical ventilation	52 (57)	14 (88)	38 (50)	0.01	7.0 (1.5–32.8)
Duration (d)	9 (4–17)	6 (3–9)	10 (6–23)	0.02	
Dobutamine	25 (27)	5 (31)	20 (26)	0.93	
Vasopressors[b]	41 (45)	15 (94)	26 (34)	< 0.01	28.9 (3.6–230.8)
Venoarterial extracorporeal membrane oxygenation	13 (14)	8 (50)	5 (7)	< 0.01	14.2 (3.7–54.0)
Duration (d)	8 (7–13)	11 (6–15)	7 (7–8)	0.60	
Renal replacement therapy	18 (20)	10 (63)	8 (11)	< 0.01	13.5 (3.4–59.7)
Duration (d)	3 (1–6)	3 (2–5)	4 (1–10)	0.75	
ICU length of stay (d)	8 (3–16)	5 (2–9)	9 (3–18)	0.06	

OR = odds ratio.

[a]Thyroid-hormone levels at the end of the ICU stay were available for 52 patients (57%).

[b]Including epinephrine and norepinephrine.

Results are expressed as median (interquartile range) or *n* (%) of patients.

absence of evident triggering factors in 31% of our cohort patients, which agrees with previous reports (6).

A high frequency of CHF at TS onset was observed in our severely ill cohort, compared with previously reported less severely ill patients (6, 8). CHF has a major impact on outcome, with cardiogenic shock being independently associated with higher mortality, and the death rate was also high for patients with refractory cardiogenic shock (i.e., requiring venoarterial

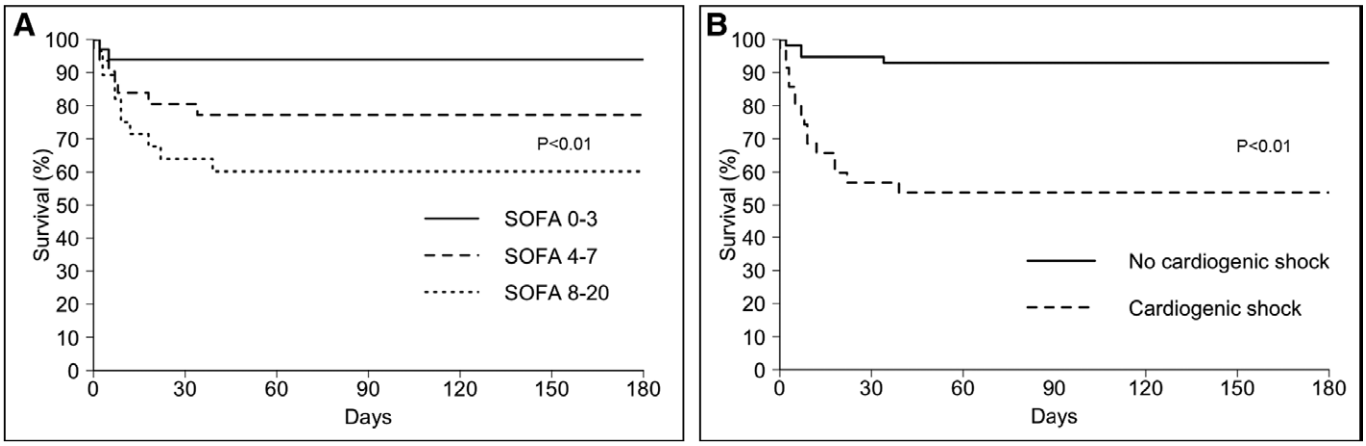

Figure 2. Six-month survival according to Sequential Organ Failure Assessment (SOFA) score tertile without cardiovascular section (**A**) and cardiogenic shock status within 48 hr after ICU admission (**B**).

ECMO). Indeed, that frequent CHF might explain our cohort's higher mortality. Pertinently, severe left ventricular dysfunction was reported to be a strong predictor of death in a single-center study on 60 patients with amiodarone-associated thyrotoxicosis (26), while most deaths occurred subsequent to cardiogenic shock or cardiac arrest in a small cohort of 28 TS patients (7). Notably, the ICU nonsurvivors received significantly more vasopressors in our study. Because these data mixed epinephrine and norepinephrine infusions, we were not able to thoroughly examine how these patients were hemodynamically managed. Last, additional organ failures, illustrated by higher extra cardiovascular SOFA scores, were independently associated with worse outcomes.

Those important findings emphasize the need for early identification of cardiac failure by thorough echocardiographic assessment before irreversible multiple organ dysfunction occurs. For such patients, venoarterial ECMO could provide hemodynamic stabilization, enabling decrease of circulating thyroid hormone levels and, hence, their noxious effects. To date, the JTA and ATA guidelines for TS considered β-blockers to be one of the first-line treatments of thyrotoxicosis and TS (3, 21). Considering the high CHF frequency and poor outcomes associated with cardiogenic shock in our population, β-blockers should be used very cautiously and maybe not suitable for the most severe TS forms. Considering that 99.5% of circulating thyroid hormones are bound to serum proteins, plasmapheresis has been proposed as a promising therapy to rapidly reduce thyroid-hormone levels in patients with the most severe TS manifestations (9, 17, 27). However, because only free thyroid hormones exert an active effect, the usefulness of plasmapheresis could be questionable (28). Once the patient is euthyroid, radical treatment, such as thyroidectomy or radioactive iodine therapy, might be considered after ICU discharge.

Our study's strengths include the large cohort investigated and characterized in detail, and its multicenter design, with 6-month post-ICU–admission follow-up. However, it also has limitations. The first is inherent to its retrospective design. Missing follow-up thyroid-hormone dosages precluded analysis of any potential relationship between clinical evolution and thyroid-hormone–level kinetics. In addition, we did not take into account for residual confounding factors, which might have biased our results. Second, data collection spanned 18 years. ATA guidelines were published in 2011 and updated in 2016 (3), and JTA guidelines for TS (21) were published in 2016. Therefore, it is highly likely that global management of TS patients may have changed during the study period. Third, TS diagnosis is challenging and TS incidence in our study might have been underestimated. However, similar incidence rates were reported from a previous cohort (6).

CONCLUSIONS

In conclusion, TS is a rare but life-threatening endocrine emergency that intensivists should be aware of to assure early recognition. Based on 92 TS patients admitted to ICUs, overall ICU and 6-month postadmission mortality rates were 17% and 22%, respectively. Cardiogenic shock appears to be strongly associated with fatal outcomes, suggesting the need for prompt and regular cardiac monitoring with the use of venoarterial ECMO in the most severe cases. At present, multiple therapies, including antithyroid drugs and plasmapheresis, aiming to rapidly reduce circulating thyroid-hormone concentrations, should be considered for these patients. However, further studies are warranted to determine which combination and which timing offer the best efficacy to treat severe TS. In particular, the place of venoarterial ECMO and thyroidectomy in the time management of these patients should be better defined.

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