



## **Strategies for Successful Anesthetic Management in Patients With Threatened Thyroid Storm: a Systematic Review of Case Reports**

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### **Abstract**

This systematic review aims to identify optimal anesthetic strategies for managing patients with uncontrolled hyperthyroidism undergoing emergency non-thyroid surgery to minimize the risk of thyroid storm (TS). Patients with uncontrolled hyperthyroidism undergoing emergency non-thyroid-related surgeries are at increased risk of perioperative complications, including thyroid storm. Following PRISMA 2020 guidelines, a systematic review of published case reports from 2018 to 2024 was conducted, supplemented by an additional case report from the authors' institution. Cases were analyzed for anesthetic strategies, perioperative complications, and outcomes, with a focus on TS occurrence, survival rates, and risk factors. Five case reports and an additional case were reviewed. The use of beta-blockers, glucocorticoids, antithyroid drugs, and regional anesthesia was found to mitigate perioperative complications. General anesthesia was employed in most cases, with vigilant intraoperative monitoring. TS was reported in one case, emphasizing the need for early recognition and aggressive management. Comprehensive preoperative assessment, intraoperative vigilance, and postoperative monitoring are critical in managing patients with uncontrolled hyperthyroidism undergoing emergency surgery. Beta-blockers, steroids, and regional anesthesia appear to be key in minimizing complications and improving outcomes.

**Keywords:** Hyperthyroidism, Thyroid Storm, Emergency Surgery, Anesthetic Management, Perioperative Care

### **INTRODUCTION**

Hyperthyroidism occurs due to the thyroid gland's excessive activity, which results in the release of an overabundance of thyroid hormones (triiodothyronine (T3) and thyroxine (T4) (Bereda, 2022; Rajalakshmi & Begam, 2021). The most common cause of hyperthyroidism in both adults and children is Graves' disease (GD), an autoimmune disorder (Ferrari et al., 2019; Kyritsi & Kanaka-Gantenbein, 2020). In pediatric cases, GD accounts for 96% of hyperthyroidism instances and is identified by the presence of thyroid-stimulating hormone receptor autoantibodies (TRAbs) that stimulate thyroid hormone production (Bucci et al., 2017; Kravchenko & Zakharchenko, 2023).

Hyperthyroidism presents significant perioperative challenges, especially in emergency surgical settings (Uludag et al., 2024). Thyroid storm, the most severe complication, can be triggered by surgery, stress, or inadequate preoperative control (de Mul et al., 2021; Stefanou et al., 2022). While elective surgeries allow for thyroid optimization, emergency procedures necessitate tailored anesthetic approaches to minimize risks (Jung, 2025). This systematic review synthesizes case reports to provide insights into best anesthetic management practices (Esmaeeli et al., 2021).

Hyperthyroidism affects approximately 1.2% of the global population, with varying prevalence across different regions and demographic groups (Caputo et al., 2020). The condition poses substantial challenges in perioperative care, particularly when patients require emergency surgical intervention (Moparathi et al., 2024). Worldwide, the incidence of thyroid storm (TS), the most life-threatening complication of hyperthyroidism, ranges from 0.2 to 0.4 per 100,000 persons annually, with mortality rates reported between 10% and 30% despite aggressive treatment (Farooqi et al., 2023; Wiersinga et al., 2023). In perioperative settings, the stress of surgery, anesthesia, and underlying acute illness can precipitate TS in inadequately controlled patients, leading to cardiovascular collapse, hyperthermia, and multiorgan failure (Kulkarni et al., 2023).

Emergency surgical scenarios present unique challenges, as they preclude the possibility of achieving euthyroid status preoperatively—a standard recommended for elective procedures (De Hert et al., 2018). Unlike elective surgeries, where thyroid optimization can be achieved over weeks to months, emergency procedures necessitate immediate intervention while managing the hypermetabolic state and heightened sympathetic activity characteristic of hyperthyroidism. This clinical dilemma places anesthesiologists in a critical position, requiring rapid assessment, risk stratification, and implementation of tailored anesthetic strategies to prevent catastrophic complications.

Previous systematic reviews have primarily focused on perioperative management of thyrotoxicosis in elective thyroid surgery or have examined thyroid storm as a general medical emergency (de Mul et al., 2021; Terefe et al., 2022; Zeng et al., 2025). While valuable, these reviews do not specifically address the constellation of challenges inherent to emergency non-thyroid surgery in hyperthyroid patients. A recent systematic review by de Mul (2021) examined the risk of perioperative thyroid storm in hyperthyroid patients but included predominantly elective procedures and lacked specific guidance on anesthetic technique selection for emergency contexts. Similarly, Terefe (2022) provided general perioperative management principles but did not synthesize case-based evidence from emergency surgical scenarios where preoperative optimization is not feasible.

To date, there exists a critical gap in the literature: a lack of consolidated,

evidence-based anesthetic guidance specifically tailored for emergency surgery in patients with poorly controlled or undiagnosed hyperthyroidism (Lincango et al., 2025). The heterogeneity of emergency surgical presentations, combined with the rarity of thyroid storm, makes randomized controlled trials infeasible. Consequently, case reports and case series represent the primary sources of evidence for this clinical scenario, yet these have not been systematically compiled and analyzed to inform best practices.

This systematic review addresses this gap by synthesizing published case reports of emergency non-thyroid surgery in hyperthyroid patients and integrating an additional case from the authors' institution (Zeng et al., 2025). The novelty of this work lies in its focused examination of anesthetic decision-making in time-critical situations where conventional preoperative thyroid control cannot be achieved. By analyzing anesthetic techniques, pharmacologic interventions, monitoring strategies, and outcomes across multiple cases, this review provides practical, evidence-informed guidance for anesthesiologists and perioperative teams.

The primary aim of this systematic review is to identify optimal anesthetic strategies and perioperative management approaches for patients with uncontrolled hyperthyroidism requiring emergency non-thyroid surgery. Secondary objectives include: (1) determining the incidence and predictors of intraoperative and postoperative thyroid storm; (2) evaluating the effectiveness of different anesthetic techniques (general versus regional anesthesia); (3) assessing the role of pharmacologic adjuncts (beta-blockers, glucocorticoids, antithyroid drugs) in preventing TS; and (4) analyzing perioperative outcomes and survival rates.

The clinical implications of this review are significant. By providing a comprehensive synthesis of available case evidence, this work will enable clinicians to make more informed decisions regarding anesthetic technique selection, pharmacologic preparation, and monitoring intensity in emergency settings. Furthermore, the findings may inform the development of institutional protocols and clinical guidelines for managing this high-risk patient population. Ultimately, improved perioperative management of hyperthyroid patients undergoing emergency surgery has the potential to reduce morbidity and mortality, shorten intensive care unit stays, and optimize resource utilization in acute care settings.

## METHOD

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. The review protocol was developed a priori to ensure methodological rigor and transparency. Systematic review of case reports, including one additional case report by the authors from the Department of Anesthesiology and Intensive Care, [Institution Name], conducted between January 2024 and March 2024.

### 1. **Inclusion Criteria**

Case reports of patients with uncontrolled hyperthyroidism undergoing emergency non-thyroid-related surgery published between January 2018 and December 2024, reported in English, and providing sufficient detail on anesthetic management and perioperative outcomes..

### 2. **Exclusion Criteria**

Elective surgeries and cases with well-controlled hyperthyroidism, cases involving thyroid surgery, conference abstracts without full-text availability, duplicate publications, and retracted articles..

### 3. **Search Strategy**

A comprehensive literature search was conducted using PubMed, PubMed Central, and Google Scholar databases from January 2018 to December 2024. The following search keywords were used: ((emergency OR urgent OR acute) AND (hyperthyroid OR hyperthyroidism OR thyrotoxicosis)) AND (anesthesia OR anesthetic OR anesthetic management) AND (non-thyroid surgery OR non-thyroidal surgery OR extra-thyroidal surgery) AND (case report OR case study). The search was completed in March 2024, with no language restrictions applied initially, though only English-language reports were ultimately included. Reference lists of included studies were hand-searched to identify additional relevant cases..

Two independent reviewers (initials) screened titles and abstracts against inclusion criteria. Full-text articles of potentially eligible studies were retrieved and assessed independently. Disagreements were resolved through discussion or consultation with a third reviewer when necessary. A standardized data extraction form was developed to collect the following information from each case: patient demographics (age, sex), hyperthyroid etiology and severity (thyroid function test results, Wayne Index, Burch-Wartofsky Point Scale scores), type and urgency of surgery, preoperative management strategies, anesthetic technique (general vs. regional), intraoperative pharmacologic interventions (beta-blockers, glucocorticoids, antithyroid drugs), monitoring parameters, intraoperative complications, occurrence of thyroid storm (defined by BWPS  $\geq 45$  or clinical diagnosis), postoperative management, and patient outcomes (survival, length of stay, complications). The authors' institutional case was integrated using the same standardized extraction template to ensure consistency and comparability with published reports.

The risk of bias was assessed using a modified version of the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Case Reports. Each case report was evaluated for: (1) clear description of patient demographics and clinical characteristics; (2) detailed reporting of interventions and outcomes; (3) adequacy of follow-up assessment; and (4) clarity of conclusions drawn from the case. Potential sources of bias, including selective reporting of positive outcomes, incomplete case details that might obscure complications, and publication bias

favoring unusual or severe presentations, were explicitly considered in data interpretation. Potential sources of bias, including selective reporting, incomplete case details, and publication bias, were considered in data interpretation.

Descriptive synthesis of reported cases to identify common management strategies and outcomes. Given the heterogeneity of case reports and the small sample size, meta-analysis was not feasible. Instead, a narrative synthesis approach was employed to identify patterns in anesthetic management, pharmacologic interventions, and outcomes across cases. Frequencies and proportions were calculated for categorical variables (e.g., use of specific anesthetic techniques or drugs). Qualitative themes related to successful management strategies and risk factors for complications were identified through iterative review of case narratives..

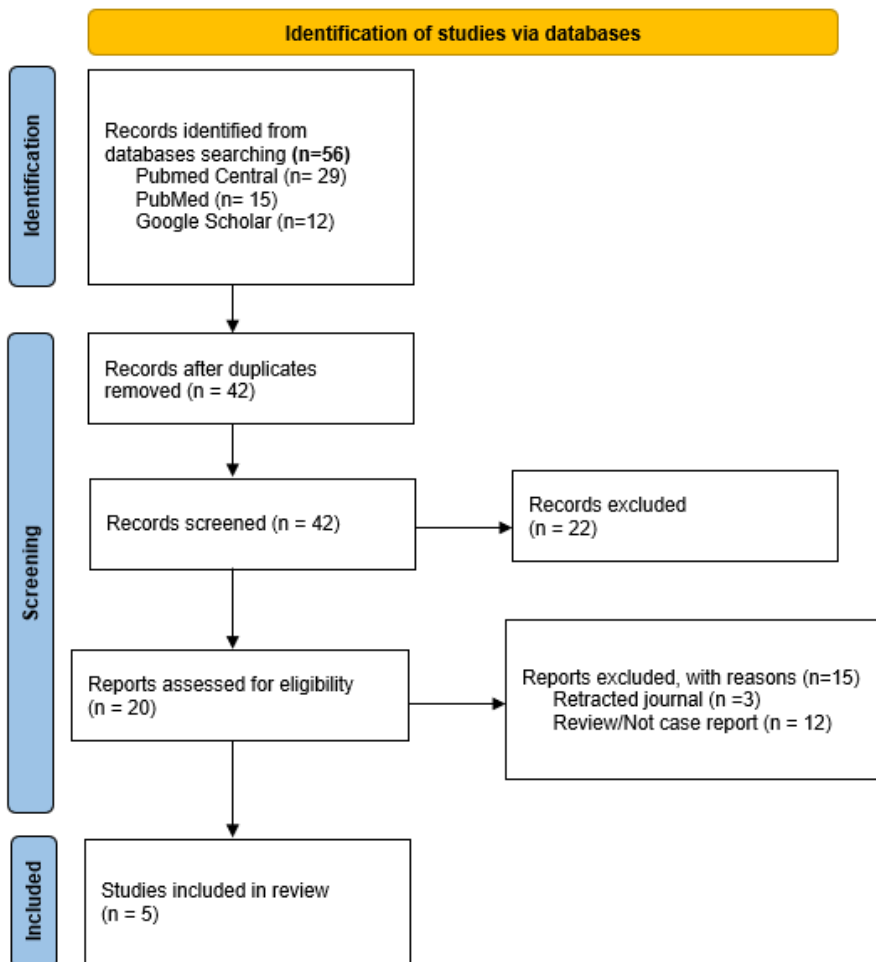


Figure 1 PRISMA 2020 Flowchart

### Case Presentation

Here's a 15 years-old male referred from a secondary hospital to ER with persisting head pain after hit by a car while patient was sitting on a stationary motorbike 18 hours ago. The patient fell and hit his head on a hard object. The

patient felt nauseous, already vomited 4 times, had seizures, and often felt hot. Patient has no history of allergy, asthma, or previous surgeries. The results of the physical examination found blood pressure were 135/80 mmHg and heart rates were 146x beats/minute. There were bulging eyes, goiter, tremors, and heart palpitations. Laboratory results (15/1/25) showed hemoglobin 11.2 g/dl, leukocytes 18,010/mm<sup>3</sup>.

The patient has a history of hyperthyroidism for the past year and has been prescribed propylthiouracil (PTU), although the treatment adherence has been inconsistent. Hence, he presented with the following levels: TSH 0.001  $\mu$ U/mL and FT4 39.4 ng/dL. CT scan findings in secondary hospital showed Epidural Hematoma (EDH) in the left temporoparietal region, with volume of 39.6 cc and no skull fracture noted. The results of the chest x-ray at our center showed a fracture in the proximal 1/3 of the left clavicle bone, completely displaced (Figure 1). Patient was admitted for emergency craniotomy for evacuation of EDH.

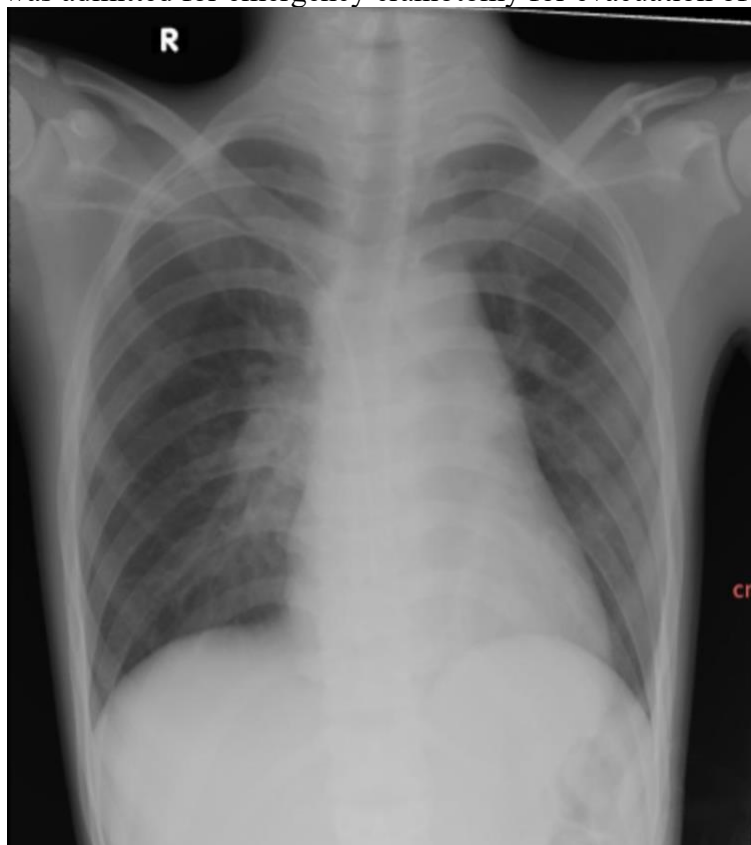


Figure 2 Chest X-Ray Findings showed a fracture of left clavicle bone

### **Preoperative Management**

The patient was admitted as a neurosurgical inpatient and his head was elevated to 30 degrees. Prior to the surgical procedure, PTU was administered to

the patient. Oxygen was administered at a rate of 15 liters per minute using a non-rebreather mask (NRM). The patient received intravenous fluid therapy with an RL drip, alongside intravenous medications that included ceftriaxone 1g every 12 hours, ketorolac 30 mg every 8 hours, and omeprazole 40 mg every 24 hours. Blood was prepared for surgery, and an orthopedic consultation was conducted. The patient was advised to fast preoperatively for 6 hours. The patient had a Wayne Index score of 17, which means equivocal. In addition, the Burch-Wartosky Point Scale (BWPS) assessment obtained a score of 35 which means impending storm; hence the emergency surgical procedure was proceeded with. Patient has physical status ASA IIe.

### Intraoperative Management

The patient was immediately taken to the operating room for emergency craniotomy with general anesthesia technique with endotracheal tube (ETT). For induction, the patient was given fentanyl 200 mcg, thiopental 500 mg, and rocuronium 30 mg. The operation went smoothly with a duration of 2.5 hours. Intraoperatively, the patient's hemodynamics were stable (Figure 2). Input during the operation was 1000 ml of crystalloid, while output was 250 ml of bleeding and 500 ml of urine. Due to the potential for cardiopulmonary complications in the postoperative period, intensive care management is essential. Therefore, the patient was transferred to the pediatric intensive care unit (PICU) for 48 h close monitoring after surgery.



Figure 3 Intraoperative Hemodynamic Monitoring

### Post-operative Management:

Postoperatively, the patient received intravenous fluid therapy with D5 1/2 NS at a rate of 80 mL/hour. Antibiotic coverage was continued with intravenous

ceftriaxone 1g once daily. For pain management, intravenous paracetamol 1g was administered four times daily, along with intravenous ketorolac 25 mg twice daily. Seizure prophylaxis was provided with intravenous phenytoin at an initial dose of 250 mg twice daily, later tapered to 125 mg twice daily. Mannitol therapy was administered to manage intracranial pressure, initially given as 250 mL every 8 hours and later adjusted to 200 mL three times daily. Endocrinology consultation was obtained, and three days postoperatively, the patient was initiated on thyrozol 10 mg three times daily and propranolol 10 mg twice daily to manage hyperthyroidism. The patient’s postoperative course was uneventful, and he remained hemodynamically stable throughout recovery.

**Outcome and Follow-up:**

Post-operatively, the patient showed significant improvement, where there was no more headache, nausea or vomiting. The patient was conscious and could talk. No hemodynamic abnormalities were found.

**RESULTS AND DISCUSSION**

Table 1 Summary of the Study Characteristics

| No | Author              | Country   | Title                                                                                                                   | Design study                      | Result                                                                                                                                                                                                                                                                                                                                                            |
|----|---------------------|-----------|-------------------------------------------------------------------------------------------------------------------------|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | Shao et al., 2024   | China     | Thyroid storm in a patient with unknown hyperthyroidism during nonthyroidal surgery—a case report and literature review | Case report and literature review | This case highlights the risk of thyroid storm (TS) in non-thyroidal surgeries, particularly when hyperthyroidism is undiagnosed preoperatively. The study emphasizes the need for comprehensive preoperative assessment, early recognition of abnormal intraoperative signs (e.g., tachycardia), and prompt initiation of supportive and antithyroid treatments. |
| 2. | Perera et al., 2020 | Sri Lanka | Urgent surgery in a poorly controlled hyperthyroid patient                                                              | Case history                      | This case underscores the importance of a multimodal pharmacologic approach in managing hyperthyroidism perioperatively, particularly in emergency surgeries where preoperative euthyroid status cannot be achieved. Beta-blockers, glucocorticoids, and magnesium sulfate played key roles in stabilizing the patient and preventing TS.                         |
| 3. | Okubuiro & Okoli    | Nigeria   | Anaesthesia for emergency                                                                                               | Case Report                       | The study highlights that undiagnosed hyperthyroidism                                                                                                                                                                                                                                                                                                             |

| No | Author               | Country   | Title                                                                                                                               | Design study | Result                                                                                                                                                                                                                                                                                                                                                                                         |
|----|----------------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | &, 2018              |           | exploratory Laparotomy in a Patient with undiagnosed Thyrotoxicosis: A Case Report                                                  |              | can present significant anesthetic challenges, with symptoms such as tachycardia and hypertension. Preoperative administration of beta-blockers effectively controlled the patient's cardiovascular symptoms, allowing for successful anesthetic management and a positive postoperative outcome.                                                                                              |
| 4  | Shah et al., 2022    | India     | Anesthesia Consideration of an Impending Thyroid Storm Patient undergoing Emergency Suction Evacuation for Bleeding Molar Pregnancy | Case Report  | This case demonstrates that thyrotoxicosis related to molar pregnancy presents unique challenges, requiring both endocrine and obstetric management. Preoperative stabilization with beta-blockers and steroids, along with the use of low-dose spinal anesthesia, successfully mitigated perioperative risks, suggesting that regional anesthesia may be a safer alternative when applicable. |
| 5  | Ryalino et al., 2018 | Indonesia | Anestesi regional dalam pembedahan darurat non tiroid pada pasien dengan tirotoksikosis                                             | Case Report  | The study reinforces the critical role of pain and anxiety control in hyperthyroid patients undergoing emergency surgery. Regional anesthesia was found to be a preferable option in mitigating sympathetic overactivity. Postoperative monitoring remains essential, as TS can develop even after a seemingly uneventful intraoperative period.                                               |

A total of 56 records were initially identified from three databases: PubMed Central (29), PubMed (15), and Google Scholar (12). After removing 14 duplicate records, 42 unique studies remained for screening. Following title and abstract screening, 22 records were excluded for not meeting the inclusion criteria. The full text of the remaining 20 studies was assessed for eligibility, leading to the exclusion of 15 studies due to reasons such as being retracted (3) or not being case reports (12). Ultimately, five case reports met the inclusion criteria and were included in this systematic review.

## **Case Characteristics**

Six cases, including the author's case, were reviewed.

### **1. Anesthetic Approaches:**

- a) Beta-blockers (used in 6/6 cases)
- b) Glucocorticoids (used in 4/6 cases)
- c) Antithyroid drugs (used in 3/6 cases)
- d) Regional anesthesia (used in 2/6 cases)
- e) General anesthesia (used in 4/6 cases)

### **2. Primary Outcome**

TS occurred in one case (study 1), reinforcing the importance of preemptive measures.

### **3. Secondary Outcomes:**

#### **a) Survival Rate**

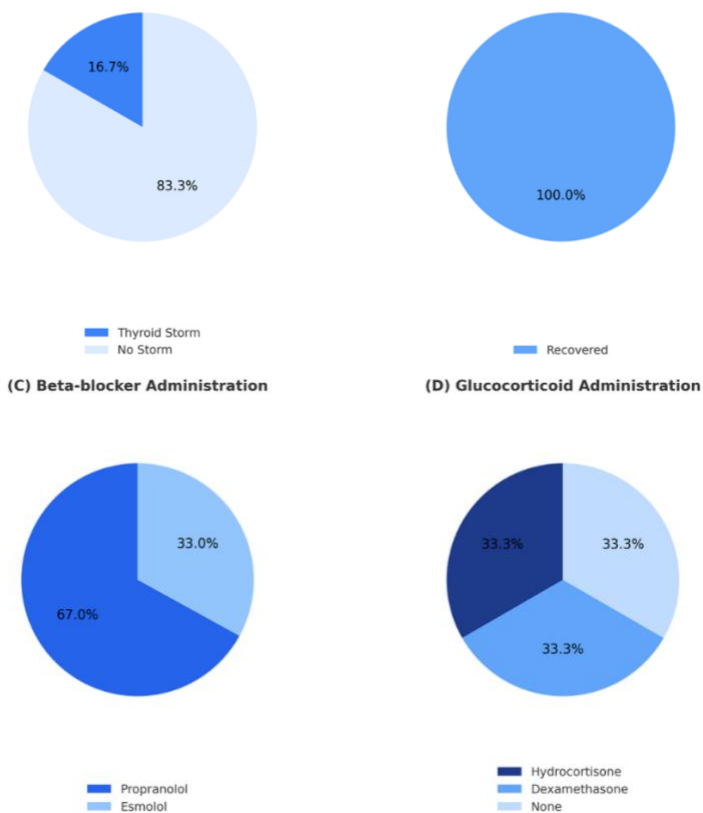
100% (all patients recovered postoperatively).

#### **b) TS Risk Factors**

Surgery type, preoperative thyroid status, and anesthetic choice.

#### **c) Thyroid Levels and TS**

Elevated thyroid hormone levels correlated with TS risk, though not all hyperthyroid patients developed TS.

**(A) Thyroid Storm Occurred in 1 of 6 Cases (16.7%) (B) All Patients Recovered Postoperatively (100%)****Figure 4 Distribution of clinical characteristics and pharmacologic management across reported cases.**

The greatest risk in surgery of patients with hyperthyroidism is the presence of thyroid storm during surgery. While the precise pathophysiological mechanism behind a thyroid storm remains unclear, sudden changes in physical stress, such as those caused by trauma or surgery, can trigger this condition. A comprehensive and thorough assessment of the patient to ensure the patient is euthyroid before surgery is mandatory in these patients. One of the preventions that can be done is by assessing the BWPS, where a score  $> 45$  indicates thyroid storm. In this patient, BWPS score was 35 which means impending storm, therefore anesthesiologist and surgeon were agreed to undergoing immediate emergency craniotomy.

Patients with hyperthyroidism might need anesthetic care during surgery to address the primary disease, treat conditions resulting from hyperthyroidism, or for unrelated issues. Regardless of the reason for surgery, this group faces a higher risk of complications and mortality due to the hyperthyroid state and the possibility of a thyroid storm (TS). Since TS can lead to cardiovascular collapse and death, it is crucial to identify hyperthyroidism preoperatively, implement management strategies beforehand, and follow perioperative protocols. However,

a recent study indicated that thyroid storm can occur regardless of the preoperative treatment received, and interestingly, it can affect both euthyroid and hyperthyroid patients. Given the severity of this complication and the inability to identify patients at higher risk, preoperative treatment remains warranted.

The findings emphasize the necessity of thorough preoperative assessment and intraoperative vigilance. Beta-blockers and glucocorticoids are crucial in managing sympathetic overactivity and inflammation. Regional anesthesia, when feasible, minimizes stress response, while general anesthesia requires careful hemodynamic control. Postoperative monitoring is essential, as TS may manifest hours after surgery.

## CONCLUSION

Patients with uncontrolled hyperthyroidism undergoing emergency surgery require individualized anesthetic strategies. Beta-blockers, glucocorticoids, and regional anesthesia appear to play protective roles. Future studies should explore standardized protocols to further mitigate TS risk in this high-risk population.

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