A study of Thyroid function status and its prognostic value among critically ill patients

Suma Rathod[1], Chethan Kumar K L[2], Anand P Ambali[3]

[1,3]Department of Geriatrics, Shri. B. M. Patil Medical College Hospital and Research Centre, BLDE (DU), Vijayapura, Karnataka, India.

[2]Department of General Medicine, Mandya Institute of Medical Sciences, Mandya, Karnataka, India.

Abstract

Introduction: Thyroid hormones regulate metabolism and reflect the body's response to stress and illness. Abnormal levels, such as in sick euthyroid syndrome, are common in critically ill patients, but their clinical relevance is unclear. Understanding changes, especially in T3 levels, may help improve prognosis and guide emergency care.

Aim: This study aims to evaluate thyroid function status and determine the prognostic significance of sick euthyroid syndrome among critically ill patients.

Materials and Methods: A cross-sectional study was done at the Department of General Medicine, MIMS-Mandya, on 150 ICU patients admitted between July 2021 and June 2022. Thyroid tests were done within 24 hours of admission, and patients were observed until discharge or death to see if thyroid levels could help predict the outcome.

Results: Six of 150 ICU patients were excluded due to existing thyroid conditions, leaving 144 for the analysis (41% women, 59% men). Most were aged 61–70(27.8%). Sick euthyroid syndrome was found in 61.1% of patients, with 48.6% showing low T3 levels. Respiratory issues were the main reason for admission, and sepsis was the leading cause of death. The death rate was higher in patients with low T3 (29.5%) compared to those without the condition (12.5%), showing a significant difference ($p = 0.018$).

Conclusion: This study shows that low T3 syndrome is highly prevalent among acutely ill patients and serves as the most sensitive and independent predictor of ICU mortality.

Keywords: Critically ill; Thyroid status; Sick euthyroid syndrome

Introduction

Thyroid hormones regulate the immune system and metabolism, which are essential for sustaining bodily growth. During the 20th century, researchers identified a link between thyroid dysfunction and increased mortality among patients admitted to intensive care units. Stress causes hypermetabolism, elevated energy expenditure, hyperglycemia, and muscle loss during sepsis and other critical conditions. The first reaction to acute severe disease is to lower the serum triiodothyronine level to combat biochemical catabolism.

Non-thyroidal sickness syndrome, commonly referred to as the low T3 syndrome or sick euthyroid syndrome, is the term used to describe these aberrant circulating Thyroid Hormone (TH) levels when there is no underlying thyroid disease[1].

The typical hormone pattern in sick euthyroid syndrome (SES) is reduced total and free T3 levels (low T3 syndrome), while T4 and TSH levels generally remain within the normal range.

These changes can be partly attributed to decreased levels of thyroid hormone-binding proteins and albumin and reduced binding activity. As a result, more hormones are released from their binding proteins, leading to increased hormone clearance. Additionally, there is an acute change in the peripheral conversion of T4, caused by decreased activity of the enzyme deiodinase type 1 (D1) and increased activity of deiodinase type 3 (D3).

Address for Correspondence:

Dr. Suma Rathod

Department of Geriatrics,
Shri. B. M. Patil Medical College Hospital and Research Centre,
BLDE (DU), Vijayapura, Karnataka, India.
Email: suma.rathod@bldedu.ac.in

Drugs like ketoconazole, rifampicin, and antiepileptics are essential in these changes.

The degree of illness severity is closely associated with the extent of reduction in total serum T3 levels. These hormonal changes are mainly due to the release of cytokines such as IL-6[2].

The level of Triiodothyronine (T3) was substantially lower in non-survivors compared to survivors, according to a study by Bello G et al.[3]. According to a study by Kumar KV et al, Low T3 levels serve as a significant predictor of mortality in critically ill patients. Survivors and non-survivors did not differ in T4 or TSH levels [2] .Triiodothyronine (T3) levels and outcome did not correlate, according to a study by Ray DC et al.[4].

Considering the difference in the prognosis, this study aimed to evaluate the impact of sick euthyroid syndrome on outcomes in critically ill patients.

Material and methods

Critically ill patients admitted to the intensive care unit (ICU) between July 2021 and June 2022 participated in a hospital-based cross-sectional study conducted in the Department of General Medicine, MIMS, Mandya, a tertiary care hospital. The Institutional Ethics Committee (IEC) granted ethical clearance before the trial started (Approval No. MIMS/IEC/690/2021/451, dated 9th September 2021).

A study by Sasi Sekhar TVD et al. found that 59% of severely ill patients admitted to the intensive care unit had low T3[5].

Applying

$$N = Z^2pq/d^2$$

Where,

Z = Standard normal deviate = 1.96

p = Prevalence = 59

q = 100 – 59 = 41

d = Relative error = 15% of 59% prevalence = 8.85

Therefore, by entering the values into the formula above, we obtain the sample size to be 120. Purposive sampling was used to determine the study's sample size of 150 participants. Before the study began, the participants were told of the purpose and design of the study in the language they knew best, and their informed consent was obtained. Each patient's information was gathered using a structured proforma. The standardized proforma was used to interview all patients and/or their family members. Within 24 hours of admission, a clinical examination, history, and demographic information were completed. On the first day, 3 milliliters of an early morning sample of plain clotted blood were taken in the intensive care unit (ICU) and sent for T3, T4, and TSH calculation using the Chemiluminescent Microparticle Immuno Assay (CMIA). For the study, the hormone estimation was completed and gathered. Every patient is monitored until their outcome, such as recovery, discharge or demise. Data was entered in Microsoft Excel and analysed using the SPSS (Statistical Package for the Social Sciences) software. Descriptive statistics, such as percentages and proportions, were used in the analysis to determine the thyroid status and how it related to the results. At 5% ($p<0.05$), the ability of thyroid function tests to independently predict the patients' outcomes was considered.

Inclusion criteria

This study covered all critically sick patients admitted to the intensive care unit who were older than 18 years.

Exclusion criteria

A history of thyroid conditions, including thyroid cancers, hyperthyroidism, hypothyroidism, thyroid nodule, Pregnancy, undergoing any hormonal therapy from past 6 months and patients receiving a massive blood transfusion or having steroid or dopamine therapy and drugs known to interfere with thyroid hormone metabolism, e.g., rifampicin, ketoconazole, antiepileptics.

Results

In this study, 150 samples were collected, of which six patients were excluded—four due to hypothyroidism and two due to hyperthyroidism resulting in a final study population of 144 patients who met the inclusion criteria, and whose biochemical parameters were recorded.

Table 1: Age distribution

Age group (years)	Number	Percentage
≤40	17	11.8
41-50	20	13.8
51-60	34	23.6
61-70	40	27.8
71-80	25	17.4
≥80	8	5.6
Total	144	100

Out of 144 patients studied, 40 (27.8%) were between 61 and 70 years old, while 8 (5.6%) were older than 80 years. Of these, 41% were female, and 59% were male.

Table 2: Common causes for ICU admission

System	Patients (n)
Respiratory system	43
Cardiovascular system	35
Central nervous system	23
Abdominal causes	18
Others*	25

*Others include tetanus (1), diabetic ketoacidosis (8), near drowning (2), snake Bite (2), severe anemia (2), neuroglycopenia (3), surgical sepsis (3), metabolic encephalopathy (3), and partial hanging (1). Sepsis was the most frequent reason for ICU admission (58 patients), followed by ischemic heart disease (25 patients).

The respiratory system (43 patients) and cardiovascular system (35 patients) were the most frequently implicated systems in intensive care unit admissions.

Table 3: Mean value of thyroid function

Parameters	Category	Patients (n)	%
T3	Low	70	48.6
	High	02	1.4
	Normal	72	50
T4	Low	14	9.7
	High	2	1.4
	Normal	128	88.9
TSH	Low	8	5.6
	High	2	1.4
	Normal	134	93

Of the 144 patients, 134 had normal TSH levels and 70 had low T3 levels.

Table 4: Association between Outcome and Thyroid status

Outcome	Thyroid Status			P-value
	Normal	SES*	Total	
Death	7(12.5%)	26(29.5%)	33(22.9%)	0.018
Discharge	49(87.5%)	62(70.5%)	111(77.1%)	
Total	56	88	144	

*SES-sick euthyroid syndrome

Of the 144 individuals, 88 (61.1%) had a sick euthyroid syndrome profile, and 56 (31.9%) had a normal thyroid profile. Among 56 patients with normal thyroid function, 49 (87.5%) recovered and were discharged, while 7 (12.5%) died. Out of the 88 patients with sick euthyroid syndrome, 62 (70.5%) recovered and were discharged, and 26 (29.5%) passed away.

Sepsis was the primary cause of death in this study, resulting in 18 deaths (69.23%), followed by pulmonary edema from acute coronary syndrome and chronic renal disease (6 deaths, 23.07%), and one death each from neuroglycopenia and tetanus. Overall, patients with sick euthyroid syndrome had a considerably higher cumulative mortality rate of 26 cases (29.5%) than those without the condition (7 cases, 12.5%), with statistical significance seen (p=0.018).

Discussion

Evidence suggests that sick euthyroid syndrome (SES) may contribute to wasting of muscles in patients in critical care and lead to adverse outcomes, including a higher mortality rate, even though it was originally thought to be an adaptive response meant to conserve energy during times of physiological stress by reducing thyroid hormone production. Poor prognoses for several organ dysfunctions, including cardiovascular disease, acute neurological conditions, and renal insufficiency, have been linked to sick euthyroid syndrome[6]. Low blood fT3 levels have also been connected to negative outcomes, such as decreased lung compliance, respiratory muscle weakness, and cognitive impairment in patients in intensive care. These findings underscore the multifaceted impact of thyroid hormone imbalances in critically ill patients, highlighting the importance of early identification and proper management of sick euthyroid syndrome to enhance clinical outcomes.

Over time, the role of thyroid function tests (TFTs) has evolved from merely diagnosing thyroid dysfunction to serving as a tool for assessing the severity and prognosis of critical illness.

The majority of patients in the emergency room in this study were middle-aged and older, which is in line with research by Wang S et al.[7].

The distribution of males to females was 59% and 41%, respectively. This aligns with the findings reported by Raghaveni A et al. (60% vs. 37.5%) and Hambhire D et al. (61.7% vs. 38.3%)[8,9]. 61.1% of patients had abnormal thyroid function tests, which is consistent with the findings of Agrawal V et al. (55%) and Bhat K et al. (59.1%)[10,11].

In 48.6% of patients, the most common anomaly was low FT3, which was comparable to findings of Bhat K et al. (50%), Agrawal V et al. (60%), and Hambhire D et al. 60%)[8,10,11].

Our study's 61.1% prevalence of sick euthyroid syndrome (ESS) closely matched those from Wang, S et al. (62.29%)[7], Elmas D et al. (66.7%)[12], and Deng X et al. (57.8%)[13], while contrasted with Guo J et al. (38.7%)[14] study.

These results support earlier findings that individuals in severe condition frequently have aberrant thyroid hormone levels. The primary cause of low FT3 levels, which are observed in 48.6% of patients, is deiodinase activity inhibition. Since free T4 typically stays within the normal range unless the illness is severe and lasts long, low FT4 levels were rare.

Similar to the study by Wang S et al[7], the leading prevalence of sick euthyroid syndrome was linked to sepsis and reduced organ function. In contrast, non-infectious cases showed a lower, non-significant reduction.

Twenty-six patients (29.5%) died overall, with sick euthyroid syndrome patients having a much higher cumulative mortality rate than those without (12.5%). Similarly, Guo J et al. reported mortality rates of 19.5% in sick euthyroid syndrome patients versus 6.4% in non-sick euthyroid syndrome patients (p<0.001) (14), and Sripad DV et al. found higher mortality in low T3 patients (18%) compared to those without[15], According to Elmas D. et al, low FT3 levels were significantly associated with NIV failure in univariate analysis (p = 0.002), but were not identified as an independent prognostic factor[12].

Table 5: Comparative analysis of various scientific studies with the present study

Sl. No.	Study	Age Group	Gender Distribution	TFT Abnormality	LowT3 Levels	SES Prevalence	Mortality
1	Present study [N S Suma et al]	Middle-aged & elderly	59% male, 41% female	61.1%	48.6%	61.1%	29.5% mortality in Low T3 vs 12.5% in non-Low T3 (P-0.018)
2	Wang S, et al.[7]	Middle-aged & elderly				62.29%	
3	Hambhire D, et al.[8]	-	61.7% male, 38.3% female		60%		
4	Raghaveni A, et al.[9]	-					
5	Agrawal V, et al.[10]	-		55%	60%		
6	Bhat K, et al.[11]	-		59.1%	50%		
7	Elmas D, et al.[12]	-				66.7%	
8	Deng X, et al.[13]	-				57.8%	
9	Guo J, et al.[14]	-				38.7%	19.5% mortality in Low T3 vs 6.4% in non-Low T3 (P<0.001)
10	Sripad DV, et al.[15]	-					18% mortality in Low T3 patients

Limitations of the Study

There are some limitations in this study. First of all, the results did not contradict the T4 levels, which would have revealed more information. Second, the results may have been interpreted differently since the impact of other known prognostic factors, like greater APACHE II and SOFA scores, was not considered.

Conclusion

Thyroid function abnormalities, particularly low FT3, are frequently observed in critically ill patients, with a high prevalence of sick euthyroid syndrome. These changes are more frequent in patients with sepsis and organ dysfunction and are linked to significantly higher mortality. Routine assessment of thyroid function may aid in prognostication and management in this patient population.

References

1. *Docter R, Krenning EP, de Jong M, Hennemann G. The sick euthyroid syndrome: changes in thyroid hormone serum parameters and hormone metabolism. Clin Endocrinol (Oxf). 1993 Nov;39(5):499-518. doi: 10.1111/j.1365-2265.1993.tb02401.x. PMID: 8252737.*
2. *Kumar KV, Kapoor U, Kalia R, Chandra NS, Singh P, Nangia R. Low triiodothyronine predicts mortality in critically ill patients. Indian J Endocrinol Metab. 2013 Mar;17(2):285-8. doi: 10.4103/2230-8210.109715. PMID: 23776904; PMCID: PMC3683206.*
3. *Bello G, Pennisi MA, Montini L, Silva S, Maviglia R, Cavallaro F, et al. Non-thyroidal illness syndrome and prolonged mechanical ventilation in patients admitted to the ICU. Chest. 2009 Jun;135(6):1448-54.*
4. *Ray DC, Macduff A, Drummond GB, Wilkinson E, Adams B, Beckett GJ. Endocrine measurements in survivors and non-survivors from critical illness. Intensive Care Med. 2002 Sep;28(9):1301-8. doi: 10.1007/s00134-002-1427-y. Epub 2002 Aug 9. PMID: 12209281.*
5. *Sasi Sekhar TVD, Appalaneni R, Jada A, Pinnamaneni S. Study of thyroid function in patients admitted to the intensive care unit in a tertiary care centre. Int J Res Med Sci. 2018 Jul 25;6(8):2717-21.*
6. *Schultheiss UT, Steinbrenner I, Nauck M, Schneider MP, Kotsis F, Baid-Agrawal S, et al. GCKD investigators. Thyroid function, renal events and mortality in chronic kidney disease patients: the German Chronic Kidney Disease study. Clin Kidney J. 2020 Jun 4;14(3):959-968.*
7. *Wang, S., Chen, M., Sun, D. et al. Total triiodothyronine level associated with disease severity for patients with emergent status. Sci Rep. 2024;14:17170.*
8. *Hambhire DD. Prevalence of sick euthyroid syndrome in non-thyroidal illness. IJMBS. 2019 Oct 30;3(10):359-61.*
9. *Raghaveni A, Narahari G, Raj Kumar K. A prospective observational study of sick euthyroid syndrome in acute myocardial infarction and its prognostic significance. Int J Toxicol Pharmacol Res. 2024;14(2):144-9.*

10. *Agrawal V, Kshirsagar A, Patil V. Derangements in thyroid hormone status in seriously ill patients: does it matter? Inter J Advan Med. 2019 Jul;6(4):1216.*
11. *Bhat K, Sharma S, Sharma K, Singh RK. Assessment of thyroid function in critically ill patients. Biomed Res. 2016;27(1):449-52.*
12. *Elmas D, Kizilarslanoglu, MC. Non-Thyroidal Illness Syndrome: A Predictor of Non-Invasive Ventilation Failure and Mortality in Critically Ill Patients. Medicina. 2025;61:927.*
13. *Deng X, Yi M, Li W, Ye H, Chen Z, Zhang X. The prevalence, hospitalization outcomes and risk factors of euthyroid sick syndrome in patients with diabetic ketosis/ketoacidosis. BMC Endocr Disord. 2023;23:195.*
14. *Guo J, Hong Y, Wang Z, Li Y. Analysis of the Incidence of Euthyroid Sick Syndrome in Comprehensive Intensive Care Units and Related Risk Factors. Front Endocrinol (Lausanne). 2021 Jun 9;12:656641. doi: 10.3389/fendo.2021.656641. PMID: 34177801; PMCID: PMC8220065.*
15. *Sripad DV, Chowdary NVS, Sivaprabodh V, Shekhar R. Relationship between free T3 and ICU mortality: A prospective observation. Inter J Sci Res Publi. 2015;5(1):1-5.*

Conflict of interest: Nil
Source of funding: Nil

Date received: Aug 30, 2025
Date accepted: Dec 28, 2025