

STUDY ON PATTERN OF HOSPITALIZATION OF CHRONIC KIDNEY DISEASE PATIENT IN THE EMERGENCY DEPARTMENT OF A TERTIARY CARE HOSPITAL

Ajithkumar rajendran¹, Vigneshwaran S², Srihari S³

Received : 24/04/2026
Received in revised form : 10/06/2026
Accepted : 27/06/2026

Keywords:

Chronic Kidney Disease; Pulmonary Edema; Maintenance Hemodialysis; Central Venous Catheter.

Corresponding Author:

Dr. AjithkumarRajendran,
Email: k.ajith.r@gmail.com

DOI: 10.47009/jamp.2026.8.4.9

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2026; 8 (4); 47-52



¹Assistant professor, Department of Emergency Medicine, Trichy SRM medical college hospital and research centre, Tamil Nadu, India.

²Assistant professor, Department of General Medicine, Trichy SRM medical college hospital and research centre, Tamil Nadu, India.

³Professor, Department of Emergency Medicine, Trichy SRM medical college hospital and research centre, Tamil Nadu, India.

ABSTRACT

Background: Globally, Chronic Kidney Disease (CKD) has become a severe public health challenge, associated with high morbidity, early mortality, and massive healthcare costs. Rapid urbanization and rising metabolic risk factors in regions like South India have turned this progressive condition into an acute healthcare crisis. This study maps the socio-demographic variations, underlying comorbidities, and primary clinical triggers for emergency department (ED) admissions among CKD patients in a semi-urban tertiary care setting in Tiruchirappalli, Tamil Nadu. **Materials and Methods:** A retrospective, descriptive analysis of hospital records was conducted in the Emergency Medicine Department at Trichy SRM Medical College Hospital. The study evaluated records over two years (January 2024 to December 2025). Included were adult patients (over 18 years) with confirmed CKD (Stages 3 to 5) presenting to the ED. Data from 221 eligible patient records were analyzed using SPSS version 25.0. **Results:** The cohort's mean age was 58.4 ± 12.6 years, featuring a male predominance (64.3%) and a high proportion of lower socioeconomic status patients (49.8%). Major comorbidities included systemic hypertension (82.4%) and Type 2 Diabetes Mellitus (67.0%). The top primary triggers for ED presentation were decompensated pulmonary edema (29.9%), severe systemic infections (24.9%), and primary macro vascular events (20.4%). Furthermore, 25.8% of patients were completely dialysis-naïve and required emergent first-time dialysis. Of those on regular dialysis, 32.9% utilized high-risk central venous catheters. **Conclusion:** Acute complications that are largely preventable—such as severe fluid overload, systemic infections, and late-stage metabolic failure—dominate ED admissions for CKD patients in this region. The high rate of dialysis-naïve presentations indicates a critical need for enhanced community screening, prioritized vascular access care, and better outpatient management.

INTRODUCTION

Chronic Kidney Disease (CKD) has emerged as a critical global public health paradigm, characterized by high rates of morbidity, premature mortality, and multi-billion-dollar health system expenditures. Worldwide epidemiological surveys indicate that the mean global prevalence of CKD ranges between 11.0% and 13.0%, with variations driven primarily by regional screening practices, socioeconomic disparities, and the shifting density of metabolic risk factors.[1] In low- and middle-income nations (LMICs), the burden is disproportionately severe. The intersection of rapid urbanization, lifestyle

transitions, and a lack of structured preventive health networks has accelerated the trajectory of kidney failure across these regions, transforming CKD from a chronic progressive ailment into an acute healthcare crisis.

Within the Indian subcontinent, and specifically in South India, CKD represents an escalating clinical challenge. Community-based meta-analyses demonstrate that the pooled prevalence of CKD in India sits at approximately 13.24%, with the Southern administrative zone demonstrating a heightened baseline burden of 14.78%.[2] This geography is structurally susceptible due to an endemic concentration of Type 2 Diabetes Mellitus and

systemic Hypertension—the twin macroeconomic drivers of chronic nephrosclerosis. Consequently, CKD has transitioned into one of the most prevalent causes of catastrophic healthcare spending, long-term institutionalization, and mortality in South India.[3] Despite its high community prevalence, the specific presentation patterns and primary triggers forcing CKD patients to seek acute care within Emergency Departments (ED) remain significantly understudied in non-metropolitan South Indian clusters. Hospitalization rates among the CKD cohort are profoundly elevated compared to non-CKD counterparts due to the physiological instability intrinsic to advanced renal impairment. Cardiovascular diseases (CVD) stand as a well-documented primary catalyst for acute hospitalizations in this group.[4] Uremic environments promote accelerated atherosclerosis, vascular calcification, and left ventricular hypertrophy, rendering these patients highly vulnerable to acute coronary syndromes, malignant hypertensive crises, and volume overload states. Furthermore, patients established on regular maintenance hemodialysis (MHD) display an independent propensity for recurrent, high-frequency emergency admissions due to acute vascular access complications, interdialytic fluid accumulation, and metabolic shifts.[5] Compounding this issue, infectious etiologies introduce extreme systemic vulnerability. CKD-associated immune dysregulation impairs both innate and adaptive immunity, meaning that when CKD patients are hospitalized for infections, they face an exponentially higher risk of severe sepsis, extended length of hospital stay (LOS), multi-organ dysfunction syndrome (MODS), and overwhelming medical expenditure compared to individuals with intact renal function.[6] Moreover, a pervasive lack of community-level screening means that a substantial proportion of patients present late to healthcare facilities with entirely non-specific constitutional complaints, frequently introducing themselves in advanced uremic states that demand immediate, unplanned renal replacement therapy (RRT) in the emergency room.[7] While clinical data exists for metropolitan centers, the precise epidemiological and clinical dynamics within semi-urban and rural catchments of South India—such as the Tiruchirappalli (Trichy) region—remain largely unmapped. This study seeks to bridge this critical knowledge gap by investigating the clinical presentation patterns, risk profiles, and immediate causes of emergency admission among CKD patients presenting to Trichy SRM Medical College Hospital & Research Centre. Identifying these baseline characteristics is critical to optimizing emergency triage protocols, refining outpatient care coordination, and mitigating preventable critical care admissions.

MATERIALS AND METHODS

Study Design and Setting

This study utilized a retrospective, hospital record-based descriptive design. The investigation was conducted within the Department of Emergency Medicine at Trichy SRM Medical College Hospital & Research Centre, a premier tertiary-care teaching institution catering to a diverse urban, semi-urban, and rural population base across the Tiruchirappalli district and adjoining regions in Tamil Nadu, India.

Study Period and Population

The investigation encompassed a comprehensive two-year retrospective analysis spanning from January 2024 to December 2025. The study population was comprised of adult patients of both sexes, aged above 18 years, who were admitted to the Emergency Department with a verified, established diagnosis of Chronic Kidney Disease (Stages 3 to 5, including dialysis-dependent End-Stage Kidney Disease) and met the rigorous pre-specified eligibility criteria.

Selection Criteria

Inclusion Criteria

Patients aged strictly above 18 years, representing both genders.

Patients presenting to the Emergency Department with a confirmed diagnosis of Chronic Kidney Disease, based on historical medical records, documented nephrology follow-up, or laboratory evidence of persistent renal damage (eGFR < 60 mL/min/1.73 m² for ≥ 3 months).

Availability of comprehensive, structured medical records within the institutional data repository detailing the emergency index admission.

Exclusion Criteria

Patients presenting primarily due to major external trauma, accidents, poisoning, or nonmedical surgical emergencies, wherein CKD was merely an incidental background condition.

Cases featuring highly fragmented, incomplete, or missing clinical or demographic records that precluded robust statistical categorization.

Data Collection Protocol

Prior to study initiation, formal administrative permission and ethical approval were secured from the institutional review mechanisms and the Medical Records Department (MRD) of Trichy SRM Medical College Hospital. A standardized, pre-tested, structured data extraction form was developed to ensure systematic and uniform data harvesting. Case records fulfilling the inclusion parameters were retrieved chronologically from the institutional electronic and physical archiver systems.

The extraction form captured data across four primary domains: (i) Socio-demographic indicators, including age, gender, and socioeconomic stratification (evaluated via the modified BG Prasad socioeconomic scale adjusted to contemporary inflation indices); (ii) Clinical risk profiles and underlying comorbidities, focusing heavily on

systemic Hypertension, Diabetes Mellitus, Coronary Artery Disease (CAD), and Cerebrovascular Accidents (CVA); (iii) Immediate clinical presentations and primary triggers driving Emergency Department admission; and (iv) Renal replacement therapy metrics, including established maintenance dialysis status and the specific type of vascular access in use (Arteriovenous Fistula vs. Central Venous Catheters).

Statistical Analysis

All harvested data lines were cross-checked for logical consistency, curated, and entered into a specialized Microsoft Excel matrix. Statistical evaluations were executed utilizing IBM SPSS Statistics software, version 25.0. Descriptive statistical workflows were implemented to synthesize the study variables. For continuous clinical measures (such as age), data normality was assessed, and values were expressed as Mean \pm Standard Deviation (SD). For categorical parameters (including gender, socioeconomic strata, risk factors, primary admission triggers, and vascular access distribution), data were rendered as absolute frequencies (n) and corresponding valid percentages (%). Crosstabulations and frequency distributions were generated to evaluate patterns within the clinical subsets.

RESULTS

Over the retrospective study period from January 2024 to December 2025, a total of 221 unique patient records met the stringent inclusion criteria and formed the final analytical sample. The derived clinical and descriptive output data are outlined systematically below.

Socio-Demographic and Economic Attributes

The study cohort demonstrated a distinctive age and gender distribution. The age of the patients ranged from 22 to 84 years, with a pooled cohort Mean Age of 58.4 ± 12.6 years. Categorical stratification revealed that only 10.9% (n=24) of patients were below 40 years of age. The highest concentration was observed within the 40–60 years group (46.6%, n=103), while elderly patients aged above 60 years accounted for 42.5% (n=94) of the presentation pool. In terms of gender distribution, a prominent male predominance was observed, with males comprising 64.3% (n=142) of the sample, compared to females who constituted 35.7% (n=79), yielding a male-to-female ratio of 1.8:1. Socioeconomic analysis demonstrated that 49.8% (n=110) of the presenting patients belonged to the lower socioeconomic stratum, 43.0% (n=95) were classified within the middle socioeconomic bracket, and a distinct minority of 7.2% (n=16) represented the upper economic class. [Table 1]

Table 1: Socio-Demographic and Economic Stratification of the Study Cohort (N=221)

Socio-Demographic Metric	Subcategory Stratification	Frequency (n=221)	Percentage (%)
Age Group Allocation	< 40 Years	24	10.9%
Age Group Allocation	40 - 60 Years	103	46.6%
Age Group Allocation	> 60 Years	94	42.5%
Gender Distribution	Male	142	64.3%
Gender Distribution	Female	79	35.7%
Socioeconomic Classification	Lower Class	110	49.8%
Socioeconomic Classification	Middle Class	95	43.0%
Socioeconomic Classification	Upper Class	16	7.2%

Comorbid Profiling and Cardiovascular Risk Overlap

Evaluation of underlying medical backgrounds revealed a heavy clustering of chronic metabolic and vascular diseases. Systemic Hypertension was established as the most ubiquitous background comorbidity, documented in 82.4% (n=182) of the entire study sample. Type 2 Diabetes Mellitus was

the second most prevalent driver, affecting 67.0% (n=148) of the patients. Macrovascular disease was also common: Coronary Artery Disease (CAD) was recorded in 32.1% (n=71) of patients, while a history of Cerebrovascular Accidents (CVA / Stroke) was identified in 10.9% (n=24). Due to the frequent overlapping nature of these chronic disorders, individual percentages exceed 100%. [Table 2]

Table 2: Clinical Risk Factors and Background Comorbidities among Admitted CKD Patients

Comorbid Factor / Vascular Risk Profile	Absolute Frequency (n)	Valid Percentage (%)
Systemic Hypertension	182	82.4%
Type 2 Diabetes Mellitus	148	67.0%
Coronary Artery Disease (CAD)	71	32.1%
Previous Cerebrovascular Accident (CVA)	24	10.9%

Primary Diagnostic Drivers for Emergency Room Presentations

The acute clinical presentations forcing emergency room visits were tightly clustered around secondary metabolic and cardiopulmonary breakdown. Acute volume overload leading to overt Pulmonary Edema

stood out as the single most dominant emergency presentation, occurring in 29.9% (n=66) of patients. Severe systemic infections (comprising overt Sepsis, severe Urinary Tract Infections, and advanced Lobar Pneumonia) constituted the second primary presentation driver at 24.9% (n=55). Acute primary

cardiovascular events (including Acute Coronary Syndromes and malignant, refractory Hypertensive Crises) caused 20.4% (n=45) of admissions. Advanced systemic uremic syndrome culminating in Uremic Encephalopathy accounted for 14.0%

(n=31), while acute, life-threatening metabolic or electrolyte derangements—predominantly critical Hyperkalemia—triggered immediate emergency presentation in 10.9% (n=24) of the study population. [Table 3]

Table 3: Primary Pathological Presentation Drivers within the Emergency Department

Primary Triggers for ED Presentation	Frequency (n=221)	Percentage Distribution (%)
Acute Volume Overload / Decompensated Pulmonary Edema	66	29.9%
Systemic Infections (Severe Sepsis, Pneumonia, Complicated UTI)	55	24.9%
Primary Cardiovascular Events (Acute Coronary Syndrome, Hypertensive Crisis)	45	20.4%
Uremic Encephalopathy / Advanced Uremic Syndrome	31	14.0%
Critical Electrolyte Imbalances (Severe Hyperkalemia / Acidosis)	24	10.9%

Baseline Dialysis Status and Vascular Access Topology

Evaluating the structural landscape of the cohort's pre-admission renal care revealed notable care patterns. Out of the 221 presenting patients, 74.2% (n=164) were classified as established End-Stage Kidney Disease (ESKD) patients maintained on regular, outpatient Maintenance Hemodialysis (MHD). Conversely, a highly substantial minority of 25.8% (n=57) presented without any background history of structured, regular dialysis therapy, requiring urgent, first-instance 'crash' dialysis initiation directly within the Emergency Department

environment due to advanced, life-threatening metabolic failure.

Among the sub-population of 164 patients already enrolled in long-term maintenance hemodialysis programs, vascular access architecture showed high variability. The mature, gold-standard Arteriovenous (AV) Fistula was active and utilized in 67.1% (n=110) of the dialysis group. However, nearly one-third of the active maintenance cohort—amounting to 32.9% (n=54)—relied on temporary or tunneled central venous catheters (internal jugular or femoral lines) to facilitate their renal replacement cycles at the time of acute emergency entry. [Table 4]

Table 4: Baseline Dialysis Modality Profile and Vascular Access Distribution

Renal Replacement Metric	Vascular Access Architecture	Frequency (n)	Subgroup / Total %
Prior Dialysis Status	On Maintenance Hemodialysis (MHD)	164	74.2% (of Total)
Prior Dialysis Status	Dialysis Naive (Emergency Initiation)	57	25.8% (of Total)
Vascular Access Base (n=164)	Functional Arteriovenous (AV) Fistula	110	67.1% (of Dialysis)
Vascular Access Base (n=164)	Central Venous Catheter (CVC)	54	32.9% (of Dialysis)
Vascular Access Base (n=164)	Total Maintenance Dialysis Subgroup	164	100.0%

DISCUSSION

The retrospective evaluation of 221 chronic kidney disease patients presenting to the emergency department of Trichy SRM Medical College Hospital exposes several structural and clinical trends characteristic of the contemporary South Indian nephrology map. The demographic analysis reveals a sharp concentration of acute presentations within the working-age and early elderly population, with a mean cohort age of 58.4 ± 12.6 years, alongside a profound male predominance (64.3%). This early-age clustering reflects established epidemiological data indicating that Indian patients progress to End-Stage Kidney Disease approximately one decade earlier than Western populations, primarily due to accelerated systemic microvascular aging driven by uncontrolled metabolic syndromes.^[2,9] The marked male skewing aligns consistently with the Indian Chronic Kidney Disease Registry metrics, potentially

reflecting biological susceptibilities to macrovascular progression or deeply entrenched gender-based disparities in health-seeking behavior and tertiary diagnostic access across rural and semi-urban Indian populations.

The dominant comorbidity signatures identified—Hypertension (82.4%) and Type 2 Diabetes Mellitus (67.0%)—reaffirm their positions as the primary drivers of CKD in low- and middle-income countries. According to the International Society of Nephrology Global Kidney Health Atlas (2023), poorly managed hyperglycemia and systemic hypertension induce sustained intraglomerular capillary hypertension, leading to progressive podocyte exhaustion, sclerosis, and advanced functional decline. In our semi-urban cohort, the high prevalence of these risk factors points toward gaps in early primary care screening, erratic long-term outpatient therapeutic adherence, and a lack of systematic public education

regarding the silent, asymptomatic progression of diabetic nephropathy.

Analyzing the immediate triggers forcing emergency room presentation reveals that acute volume overload/decompensated pulmonary edema is the leading acute presentation (29.9%). In advanced renal failure, the loss of fluid homeostasis makes patients highly vulnerable to sudden fluid shifts. Among the 164 maintenance hemodialysis patients, acute volume overload is frequently triggered by excessive interdialytic weight gain, poor dietary sodium compliance, or missed dialysis sessions due to logistical or financial barriers. This finding is strongly supported by a 2024 intensive care trial indicating that acute volume-driven respiratory failure is the primary reason for critical care utilization among South Asian dialysis cohorts. The close connection between underlying Coronary Artery Disease (32.1% in this study) and uremic fluid stagnation creates a dangerous clinical combination, where volume overload frequently triggers silent myocardial ischemia or acute heart failure decompensation.

Systemic infectious processes represented the second major cause of emergency admissions, accounting for 24.9% of the cohort. Advanced uremia is fundamentally an immunosuppressive state, characterized by impaired leukocyte chemotaxis, altered T-cell receptor expression, and chronic systemic inflammation. When CKD patients contract common infections like lobar pneumonia or urinary tract infections, they exhibit an elevated risk of progressing to severe sepsis and multi-organ dysfunction syndrome. This vulnerability results in prolonged hospital stays and high medical costs, placing an immense burden on families in the lower (49.8%) and middle (43.0%) socioeconomic strata who must fund care through out-of-pocket spending. A critical finding with policy implications is that 25.8% of the presenting patients were entirely dialysis-naïve, requiring urgent first-instance emergency dialysis initiation in the ED. These patients presented with late-stage complications such as uremic encephalopathy (14.0%) or severe hyperkalemia (10.9%). This pattern of late presentation is a common challenge in the Indian healthcare landscape.^[6] Due to the lack of routine community-based screening, patients often ignore vague early symptoms like fatigue or mild anorexia, seeking care only when severe metabolic breakdown occurs. Emergency 'crash' dialysis via temporary central catheters carries a much higher risk of procedural complications, severe infectious exposure, and short-term mortality compared to planned, elective dialysis initiation through a mature vascular access.

Finally, among the established maintenance hemodialysis cohort, the high rate of central venous catheter (CVC) utilization (32.9%) represents a significant clinical vulnerability. CVC reliance is a well-documented independent risk factor for Catheter-Related Bloodstream Infections (CRBSI)

and central venous stenosis.^[8] In a recent study, emergency hemodialysis initiation via non-tunneled internal jugular lines was associated with a high rate of systemic line sepsis. The delay in transitioning patients to a permanent Arteriovenous Fistula (AVF) is often driven by a lack of vascular surgical resources, financial barriers, or late nephrology referrals. This reliance on central lines directly fuels the high volume of infection-related emergency admissions observed in this study, highlighting the need for better pre-dialysis planning and subsidized vascular access care.^[10]

CONCLUSION

This retrospective record-based study profile of 221 chronic kidney disease patients at Trichy SRM Medical College Hospital demonstrates that emergency department presentation is largely driven by severe, acute complications that could potentially be prevented or mitigated through improved outpatient care. The study highlights that acute fluid overload, severe systemic infections, and late-stage metabolic crises are the primary factors leading to emergency hospitalizations. The high proportion of patients requiring emergency first-time dialysis emphasizes the ongoing challenges of late presentation and delayed diagnosis within the regional healthcare ecosystem.

Based on these findings, the following targeted clinical and policy recommendations are proposed:

1. **Strengthening Primary Screening Frameworks:** Implementing routine, low-cost screening for microalbuminuria and eGFR at the primary healthcare level for high-risk individuals, particularly those with long-standing Hypertension and Diabetes Mellitus, to facilitate early detection and slow progression.
2. **Expanding Subsidized Vascular Access Infrastructure:** Establishing dedicated, fast-track vascular surgery clinics to increase timely AV Fistula creation, thereby reducing reliance on high-risk Central Venous Catheters and lowering infection-related admissions.
3. **Enhancing Outpatient Education and Support:** Developing structured patient education programs focused on strict fluid restriction, dietary sodium management, and adherence to dialysis schedules to minimize acute volume overload crises.
4. **Leveraging Public Health Subsidies:** Maximizing the reach of welfare schemes, such as the Pradhan Mantri National Dialysis Program and state-sponsored health insurance, to reduce financial barriers and ensure treatment continuity for vulnerable socioeconomic groups.

Funding: No Funding Sources, **Conflict of interest:** None Declared.

REFERENCES

1. Global Prevalence of Chronic Kidney Disease – A Systematic Review and Meta-Analysis
Hill NR, Fatoba ST, Oke JL, Hirst JA, O'Callaghan CA, et al. (2016) Global Prevalence of Chronic Kidney Disease – A Systematic Review and Meta-Analysis. PLOS ONE 11(7): e0158765. <https://doi.org/10.1371/journal.pone.0158765>
2. Talukdar, R., Ajayan, R., Gupta, S., Biswas, S., Parveen, M., Sadhukhan, D., Sinha, A.P. and Parameswaran, S. (2025), Chronic Kidney Disease Prevalence in India: A Systematic Review and Meta-Analysis From Community-Based Representative Evidence Between 2011 to 2023. Nephrology, 30: e14420. <https://doi.org/10.1111/nep.14420>
3. Singh, Ravi & Dahiya, Bharat & Singh, Arun & Chandra, Poudel & Singh, Rana. (2022). [749a.22]. Singh, Ravi, et al. (2022) INTRODUCTION: Essays in Honour of Rana P.B. Singh. In: Singh, Ravi S.; Dahiya, Bharat; Singh, Arun K., and Poudel, Padma C., (eds.) Practising Cultural Geographies: Essays in Honour of Rana P.B. Singh. (Advances in 21st Century Human Settlements series, ISSN: 2198-2546): pp. 03-24 <chapter 1>. Springer Nature Pte Ltd, Singapore. eBook ISBN: 978-981-16-6415-1, HdC ISBN: 978-981-16-6413-7. DOI: 10.1007/978-981-16-6415-1_1.
4. Go Alan S., Chertow Glenn M., Fan Dongjie, McCulloch Charles E., Hsu Chi-yuan. Chronic Kidney Disease and the Risks of Death, Cardiovascular Events, and Hospitalization. New England Journal of Medicine. 351(13):1296–305. doi:10.1056/NEJMoa041031
5. Mathew AT, Rosen L, Pekmezaris R, Kozikowski A, Ross DW, McGinn T, et al. Potentially Avoidable Readmissions in United States Hemodialysis Patients. Kidney International Reports. 2018 Mar;3(2):343–55. doi:10.1016/j.ekir.2017.10.014
6. Espi M, Koppe L, Fouque D, Thaunat O. Chronic Kidney Disease-Associated Immune Dysfunctions: Impact of Protein-Bound Uremic Retention Solutes on Immune Cells. Toxins. 2020 May;12(5):300. doi:10.3390/toxins12050300
7. Kellett J, Nickel CH. What are nonspecific complaints and what are their causes and outcomes? The common unknown unknowns of medicine. European Journal of Internal Medicine. 2018 Jan 1;47:e12–3. doi:10.1016/j.ejim.2017.09.032 PubMed PMID: 28964636.
8. Risk factors for catheter-associated bloodstream infection in hemodialysis patients: A meta-analysis. - Abstract - Europe PMC [Internet]. [cited 2026 May 23]. Available from: <https://europepmc.org/article/MED/38536779>
9. Rajapurkar MM, John GT, Kirpalani AL, Abraham G, Agarwal SK, Almeida AF, et al. What do we know about chronic kidney disease in India: first report of the Indian CKD registry. BMC Nephrol. 2012 Mar 6;13:10. doi:10.1186/1471-2369-13-10 PubMed PMID: 22390203; PubMed Central PMCID: PMC3350459.
10. Gharaibeh KA, Abdelhafez MO, Guedze KEB, Siddiqi H, Hamadah AM, Verceles AC. Impact of initial jugular vein insertion site selection for central venous catheter placement on hemodialysis catheter complications. Journal of Critical Care. 2025 Jun 1;87:155011. doi:10.1016/j.jcrc.2024.155011.