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ORIGINAL ARTICLE

Admission patterns, early mortality, and organisational workload in a medical intensive care unit: An eight-year retrospective study at a tertiary care centre

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ABSTRACT

Aim To analyse patient admission patterns, clinical outcomes, and organisational workload in a medical intensive care unit (ICU), with emphasis on early mortality and post-pandemic changes in healthcare demand.
Methods This retrospective, observational, single-centre cohort study included all adult patients admitted to the medical ICU of the Clinic for Internal Medicine at the University Clinical Centre Tuzla between January 1, 2018, and December 31, 2025. Aggregated data were obtained from the hospital information system and internal ICU records. Analysed variables included annual admission volume, admission sources, discharge outcomes, in-hospital and early mortality (within 24-72 hours after ICU admission), estimated length of stay, invasive procedures, and patient age. Temporal trends were assessed across pre-pandemic (2018-2019), pandemic (2020-2021), and post-pandemic (2022-2025) periods.
Results A total of 9,342 ICU hospitalisations were analysed. Admissions remained relatively stable through 2020, declined in 2021, reached their lowest level in 2022, and then increased markedly from 2023 onward. Admissions per bed rose from 67.5 in 2022 to 108.6 in 2025, while the estimated mean ICU length of stay decreased from 5.4 to 3.4 days. Overall, in-hospital mortality was approximately 22%, with 75-80% of deaths occurring between 24 and 72 hours from admission. The patient population was predominantly elderly, with a mean age of approximately 70 years.
Conclusion Medical ICU services operated under increasing organisational strain, reflected by rising admission volume, higher admissions per bed, and reduced estimated length of stay despite fixed bed capacity. Persistently high early mortality remained a prominent feature of this population.

Keywords: intensive care units, patient care pathways, hospital mortality, early mortality, length of stay, healthcare delivery

INTRODUCTION

Intensive care units (ICUs) are a critical component of modern hospital systems, providing advanced monitoring and organ support for patients with severe, potentially reversible medical conditions (1). Owing to limited bed capacity, high resource consumption, and the complexity of care delivery, the organisation and utilisation of ICU services are closely linked to the overall sustainability of healthcare systems (2). In recent years, a continuous increase in demand for intensive care has been reported worldwide, driven primarily by population ageing, a growing burden of chronic diseases, and improved survival of patients who subsequently experience acute clinical deterioration (3). These demographic and epidemiological trends are particularly evident in medical, non-surgical ICUs, where patients are frequently characterised by advanced age, multiple comorbidities, and heterogeneous disease trajectories. Such complexity places substantial pressure on already limited ICU capacities and complicates triage decisions, admission timing, and discharge planning (4). Prior to the COVID-19 pandemic, ICU admission patterns in internal medicine settings were already influenced by increasing patient age, multimorbidity, and the growing burden of chronic non-communicable diseases. Consequently, the efficient organisation of patient care pathways has emerged as a central determinant of both clinical outcomes and meaningful resource utilisation in intensive care medicine (5).

Beyond disease severity alone, organisational factors increasingly influence outcomes among critically ill patients. Admission routes, interdepartmental transfers, timing of escalation

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to the intensive care unit, and discharge processes collectively shape patient flow within hospitals (6). Inefficiencies in these pathways may result in delayed ICU admission, suboptimal utilisation of high-intensity care, length-of-stay patterns driven by capacity constraints rather than clinical need, and an increased proportion of early mortality. These challenges are particularly pronounced in internal medicine ICUs, where diagnostic uncertainty and fluctuating clinical courses are common (7).

Early mortality occurring between 24 and 72 hours after ICU admissionhas been recognised as an important indicator of both clinical severity and healthcare system performance (8). The COVID-19 pandemic further exposed structural vulnerabilities of healthcare systems, particularly within intensive care services (9). During the pandemic, substantial disruptions in patient flow, admission patterns, and discharge processes were observed, often accompanied by temporary organisational restructuring (10). In the post-pandemic period, many healthcare institutions have reported a rebound increase in ICU admissions, especially among older patients with multiple chronic conditions (11).

Despite growing interest in ICU organisation and patient flow, most published studies have focused on surgical or mixed ICUs, short observation periods, or isolated outcome measures (12). Long-term, real-world analyses of medical ICU populations that simultaneously address organisational dynamics and clinical outcomes remain limited (13). Moreover, data from Southeast Europe, including Bosnia and Herzegovina, remain scarce, despite healthcare systems in this region facing pronounced demographic challenges and resource constraints (14,15).

The aim of this study was to analyse patient care pathways, clinical outcomes, and organisational workload in a medical intensive care unit at a tertiary care centre over the period from 2018 to 2025, with particular emphasis on pre-pandemic, pandemic, and post-pandemic trends. We hypothesised that increasing admission volume and persistently high early mortality would coincide with temporal changes in admission patterns and organisational indicators, and that systematic evaluation of these parallel trends could inform evidence-based optimisation of intensive care organisation in routine clinical practice.

MATERIAL AND METHODS

Subjects and study design

This retrospective, observational, single-centre cohort study was conducted in the medical ICU of the Clinic for Internal Medicine at the University Clinical Centre Tuzla over an eight-year period from January 1, 2018, to December 31, 2025.

The ICU of the Clinic for Internal Medicine at the University Clinical Centre Tuzla is a 14-bed unit dedicated exclusively to adult patients with acute internal medicine conditions, most commonly of cardiology, pulmonology, nephrology, endocrinology, gastroenterology, and rheumatology. Surgical and postoperative patients are not managed in this unit.

All hospitalisations of patients aged 18 years or older admitted to the ICU during the study period were eligible for inclusion. Patients were admitted due to acute clinical deterioration requiring continuous haemodynamic or respiratory monitoring, vasoactive support, advanced oxygen therapy, or monitoring not feasible at the ward level. Admissions for short-term elective procedures not requiring intensive treatment, such as planned electrical cardioversion or transoesophageal echocardiography with same-day discharge, were excluded. Admissions with incomplete or missing administrative or clinical records were also excluded.

The study protocol was approved by the Ethical Committee of the University Clinical Centre Tuzla (approval number: 02-09/2-26-3/25). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Methods

Data were collected retrospectively from the hospital information system and internal ICU reports using a structured data collection protocol.

Due to changes in hospital information systems, variable data completeness, and incomplete digitalisation in earlier years, individual patient-level longitudinal data could not be consistently retrieved for the entire study period. Therefore, analyses were primarily performed on aggregated annual datasets derived from routinely collected clinical and administrative records.

For each calendar year, information on admission volume, sources of admission, patient flow patterns, discharge outcomes, in-hospital mortality, early mortality between 24 and 72 hours after ICU admission, and the frequency of invasive and therapeutic procedures was extracted. Patient age and sex were used to describe temporal changes in the ICU population's demographic structure. Because individual patient-level length-of-stay data were not consistently available for the entire study period, ICU length of stay was estimated indirectly as the ratio of the maximum available number of ICU bed-days (14 beds × 365 days) to the total annual number of ICU admissions.

This indicator was used exclusively to assess temporal trends in bed utilisation and patient turnover and should not be interpreted as a clinical measure of individual treatment duration.

Patient inflow was assessed by calculating the mean annual number of ICU admissions. Organisational workload indicators included annual admissions per bed and temporal changes in patient flow patterns across the pre-pandemic (2018-2019), pandemic (2020-2021), and post-pandemic (2022-2025) periods. This temporal stratification was used to analyse changes in admission patterns, patient flow, and clinical outcomes across different phases of the healthcare system. The year 2022 was classified as post-pandemic based on the local cessation of COVID-19-related organisational restructuring of hospital services and a return to standard admission patterns. This temporal categorisation was applied for descriptive analysis of admission trends and patient flow rather than for direct comparison of organisational workload between periods. In this study, organisational workload was operationally defined as admission volume, admissions per available ICU bed, and estimated annual bed turnover, calculated as total admissions relative to the maximum available ICU bed-days.

The frequency of invasive and therapeutic procedures performed in the ICU was analysed, including central venous catheter placement, fibrinolytic therapy, and ultrasound-based diagnostic examinations. Patient age was analysed using year-of-birth data to evaluate longitudinal changes in the age structure of the ICU population.

Statistical analysis

Statistical analyses were based on aggregated annual data from 2018 to 2025. Categorical variables are reported as counts and percentages, and continuous variables as means or estimated annual averages, depending on data availability. Given the absence of consistent individual patient-level data, analyses were limited to descriptive and exploratory trend assessment at the annual level.

Annual ICU admission counts were analysed using Poisson regression with a log link, and results are reported as incidence rate ratios (IRR) with 95% confidence intervals (CI). Trends in annual in-hospital mortality and direct discharge home were evaluated using binomial regression models, with yearly event counts relative to total annual admissions, and results are presented as odds ratios (ORs) and 95% CI.

Comparisons across pre-pandemic, pandemic, and post-pandemic periods were interpreted descriptively because of the small number of yearly observations within each period. All tests were two-sided, and p-values < 0.05 were considered statistically significant. Statistical analyses were performed using IBM SPSS Statistics, version 25.0 (IBM Corp., Armonk, NY, USA).

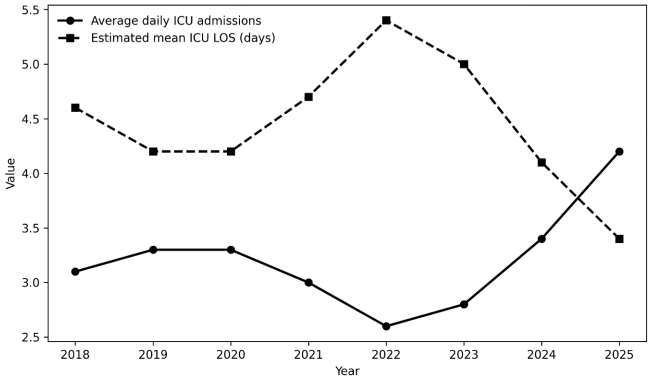


Figure 1. Annual Intensive Care Unit (ICU) patient inflow and estimated mean length of stay (LOS) and average daily ICU admissions between 2018 and 2025

RESULTS

This study included 9,342 adult patients hospitalised in the Clinic for Internal Medicine's ICU between 2018 and 2025. Female patients accounted for 54.0% of admissions (n=5,045), while males comprised 46.0% (n = 4,297). The mean age of the study population was 70 years. Birth-year distribution was predominantly concentrated between 1930 and 1965. In 2025, the mean age increased to 71 years, indicating a progressive shift toward an older ICU population.

Annual ICU admission volume showed temporal variability over the study period, declining during the pandemic years and then increasing markedly post-pandemic (Table 1, Figure 1). Segmented Poisson regression analysis showed no significant temporal trend between 2018 and 2021, whereas admissions increased significantly from 2022 onwards (IRR 1.189, 95% CI 1.133-1.248; p< 0.001).

Annual admissions per bed ranged from 67.5 in 2022 to 108.6 in 2025. The average daily admission rate increased from approximately 2.6 admissions per day during periods of reduced activity to more than four admissions per day in 2025, indicating a substantial acceleration in patient inflow (Table 1, Figure 1). Based on the maximum available 5,110 ICU bed-days per year, the estimated mean ICU length of stay demonstrated an inverse relationship with admission volume, decreasing from approximately 5.4 days in 2022 to 3.4 days in 2025. This estimate reflects accelerated bed turnover under increasing demand and fixed ICU capacity and should be interpreted as an organisational indicator rather than an individual patient-level length-of-stay measure.

Most patients were admitted directly from the emergency department, and the overall distribution of admission sources remained stable throughout the study period (Table 2). Following clinical stabilisation, 45-55% of patients were transferred to specialised internal medicine wards for continued treatment. Transfers to other clinics accounted for 5-12% of admissions, with invasive cardiology representing the most common destination. The proportion of patients discharged directly home declined significantly over time, from 18.5% in 2018 to 10.4%

Table 1. Annual ICU admissions, bed capacity, patient inflow, and estimated length of stay (2018–2025)

Year	Total admissions (n)	ICU beds (n)	Admissions per bed (n/year)	Average daily admissions (n/day)	Estimated mean length of stay (days)
2018	1,119	14	79.9	3.1	4.6
2019	1,204	14	86.0	3.3	4.2
2020	1,211	14	86.5	3.3	4.2
2021	1,095	14	78.2	3.0	4.7
2022	945	14	67.5	2.6	5.4
2023	1,012	14	72.3	2.8	5.0
2024	1,243	14	88.8	3.4	4.1
2025	1,520	14	108.6	4.2	3.4

ICU, intensive care unit.

Table 2. Sources of admission and discharge outcomes of ICU patients (2018–2025)

Variable	Category	Range of annual proportions (%)
Source of admission	Emergency department	75–85
	External transfers (other clinics)	3–8
	Internal medicine wards	4–9
Discharge outcomes	Transfer to internal medicine wards	45–55
	Transfer to other clinics	5–12
	Direct discharge home	10–20
	In-hospital death	19.6–25.1
	Discharge against medical advice	0–2

ICU, intensive care unit.

Table 3. Temporal trends in key organisational outcomes (2018–2025)

Variable	Effect estimate	95% CI	p-value
Admissions (per year)	IRR 1.19	1.13–1.25	< 0.001
Home discharge (per year)	OR 0.89	0.85–0.93	< 0.001
Mortality (per year)	OR 0.99	0.97–1.01	0.54

CI, confidence interval; IRR, incidence rate ratio; OR, odds ratio.

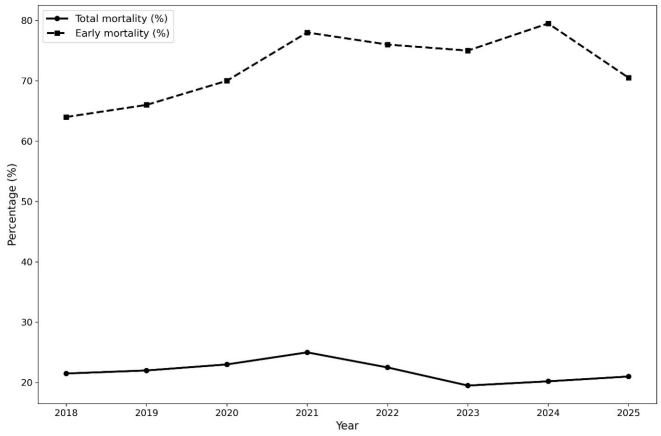


Figure 2. Annual trends in total in-hospital mortality and early mortality among patients treated in the Intensive Care Unit (ICU) between 2018 and 2025

in 2025. Binomial regression demonstrated a progressive reduction in the likelihood of home discharge (OR per year 0.89, 95% CI: 0.85-0.93; p < 0.001), consistent with increasing admission volume and organisational pressure (Table 3). Discharge against medical advice accounted for less than 2% of hospitalisations throughout the study period.

A total of 2,067 in-hospital deaths were recorded, corresponding to an overall mortality rate of approximately 22%. Annual mortality ranged from 19.6% to 25.1%, with the highest rate in 2021 and lower rates in subsequent years (Figure 2). Binomial regression analysis showed no significant temporal trend in overall in-hospital mortality across the study period (OR per year = 0.994, 95% CI: 0.973-1.014; p = 0.535).

Early mortality, defined as death occurring between 24 and 72 hours after ICU admission, accounted for approximately 75-80% of all in-hospital deaths across the study period. This parameter was analysed as the annual proportion of early deaths among all recorded in-hospital deaths and remained relatively stable over time (Figure 2). Given the aggregated structure of the available data, this measure should be interpreted as a descriptive indicator of admission timing and care pathway characteristics rather than as a formal time-to-event survival outcome. In 2021, 58 PCR-confirmed COVID-19 patients with severe clinical presentations were treated in the ICU, although the unit was not primarily designated for COVID-19 care.

DISCUSSION

ICU admission volume increased substantially over the study period despite constant bed capacity, accompanied by an increase in admissions per bed and a reduction in estimated length of stay. Early mortality remained consistently high, with most deaths occurring between 24 and 72 hours after ICU admission. These findings indicate a progressive increase in organisational workload and suggest a shift in the ICU's role toward a high-turnover stabilisation unit within the internal medicine care pathway, rather than a setting primarily dedicated to prolonged intensive treatment.

The increase in ICU admissions should be interpreted within the broader context of systemic changes in healthcare delivery (13,16). Periods of disrupted access to hospital care were followed by a rebound in demand, with patients often presenting later in the course of illness and with higher clinical acuity (14,17). In Bosnia and Herzegovina, this effect is likely compounded by population ageing, sustained outmigration of younger family members, and reduced availability of informal care for older adults, all of which may contribute to delayed recognition of clinical deterioration and delayed hospital referral. Although system-level data on informal caregiving are limited in Bosnia and Herzegovina due to the complexity of the healthcare and social care system, similar challenges related to fragmented long-term care and insufficient integration of informal caregivers into formal health services have been documented in neighbouring Croatia (18).

Within this context, the observed shortening of estimated ICU length of stay is best understood as an organisational response to sustained capacity constraints rather than an indicator of milder disease or improved therapeutic efficiency (19,20). Accelerated bed turnover and earlier transfers to downstream wards appear to represent necessary adaptive strategies to accommodate increasing admission volume and growing need for available beds.

A central finding of this study is the persistently high proportion of early mortality, with most deaths occurring within the first 24-72 hours after ICU admission. Early mortality in intensive care reflects not only disease severity at presentation but also the effectiveness of system-level processes, including timely recognition of clinical deterioration, referral pathways, and escalation of care (21,22). The consistency of this pattern over time suggests that early mortality represents a relatively stable characteristic of the care process rather than a transient phenomenon.

This pattern may partly reflect a broader shift in intensive care practice, whereby ICUs increasingly admit patients in advanced stages of chronic disease, often with limited physiological reserve and reduced likelihood of meaningful recovery (23). Such trends may be influenced by delayed referral, evolving therapeutic goals, and variable availability of structured end-of-life care, rather than solely by unrealistic expectations of reversibility (24,25). Consequently, early death in the ICU may represent not only a clinical outcome but also a potential marker of suboptimal alignment between care intensity and individual disease trajectories (26). The predominance of direct admissions from the emergency department, together with the low proportion of transfers from specialised inpatient wards, suggests a front-loaded admission pattern within the local care pathway. This may indicate limited opportunities for inpatient optimisation prior to ICU admission (27). Following initial stabilisation, most patients were transferred to other internal medicine wards (22). At the same time, direct discharge home remained relatively uncommon, underscoring the ICU's current role as a short-term stabilisation unit embedded within a broader internal medicine care continuum (28).

From a healthcare system perspective, the convergence of rising admission volume, accelerated bed utilisation, reliance on emergency department admissions, and persistently high early mortality indicates that expansion of ICU capacity alone is unlikely to address the underlying challenges identified in

this study. Greater benefit is more likely to be achieved through optimising ward-based escalation pathways, improving early identification of clinical deterioration, clarifying criteria and timing for ICU admission, and integrating early goals-of-care discussions, particularly for elderly and multimorbid patients (24,29). Strengthening intermediate-level care and formalising end-of-life pathways may reduce potentially non-beneficial ICU admissions while preserving intensive care resources for patients most likely to derive meaningful clinical benefit (25,30).

This study has several limitations. It was conducted at a single centre and used retrospective data, which may limit generalisability and introduce information bias due to variable data completeness. Because the analyses were based on aggregated annual data, regression models reflect temporal trends at the population level and should not be interpreted as individual-level associations. ICU length of stay was estimated from fixed annual bed capacity and total admissions and therefore reflects organisational turnover rather than actual patient-level duration of stay.The lack of validated severity scores and detailed clinical data limited the ability to adjust for baseline risk and to interpret early mortality.

CONCLUSION

In conclusion, this long-term analysis demonstrates increasing admission volume and bed utilisation within a fixed ICU capacity, accompanied by persistently high early mortality. The consistently high proportion of early deaths underscores the need for earlier recognition of clinical deterioration, more selective ICU admission, and more precise differentiation between potentially reversible critical illness and end-of-life trajectories. From a healthcare system perspective, these findings may inform local policy development, resource planning, and the optimisation of care pathways in comparable resource-constrained settings.

Strengthening ward-based escalation pathways, improving coordination between intensive care and internal medicine services, and integrating early goals-of-care discussions may help align intensive care utilisation with realistic therapeutic benefit and sustainable service delivery.

FUNDING

No specific funding was received for this study.

CONFLICTS OF INTEREST

None to declare.

ETHICS STATEMENT

The study was approved by the Ethical Committee of the University Clinical Centre Tuzla (approval number: 02-09/2-26-3/25). The study was conducted in accordance with the principles of the Declaration of Helsinki.Due to the retrospective design and the use of anonymised, aggregated data, the ethics committee waived the requirement for individual informed consent.

DATA AVAILABILITY STATEMENT

The datasets generated and analysed during this study are not publicly available due to institutional data protection policies, but are available from the corresponding author on reasonable request, subject to approval by the University Clinical Centre Tuzla.

AUTHOR CONTRIBUTIONS (CRediT)

Conceptualization: E.B.; **Data curation:** M.B., A.S.T.; **Formal analysis:** E.B., A.B.; **Investigation:** E.B., M.B., D.T., A.S.T.; **Methodology:** E.B., M.B., D.T.; **Project administration:** E.B.; **Supervision:** E.B.; **Writing – original draft:** E.B.; **Writing – review & editing:** E.B., M.B., D.T., A.B., A.S.T. All authors have read and agreed to the published version of the manuscript.

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