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Impact of triage-to-admission time on patient outcome in European intensive care units: A prospective, multi-national study

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ABSTRACT

Purpose: Ubiquitous bed shortages lead to delays in intensive care unit (ICU) admissions worldwide. Assessing the impact of delayed admission must account for illness severity. This study examined both the relationship between triage-to-admission time and 28-day mortality and the impact of controlling for Simplified Acute Physiology Score (SAPS) II scores on that relationship.
Methods: Prospective cross-sectional analysis of referrals to eleven ICUs in seven European countries between 2003 and 2005. Outcomes among patients admitted within versus after 4 h were compared using a Chi-square test. Triage-to-admission time was also analyzed as a continuous variable; outcomes were assessed using a non-parametric Kruskal-Wallis test.
Results: Among 3175 patients analyzed, triage-to-admission time was 2.1 ± 3.9 h. Patients admitted within 4 h had higher SAPS II scores (33.6 versus 30.6, Pearson correlation coefficient −0.07, $p < 0.0001$). 28-day mortality was surprisingly higher among patients admitted earlier (29.6 vs 25.2%, OR 1.25, 95% CI 0.99–1.58, $p = 0.06$). Even after adjusting for SAPS II scores, delayed admission was not associated with higher mortality (OR 1.08, CI 0.83–1.41, $p = 0.58$).
Conclusions: Even after accounting for quantifiable parameters of illness severity, delayed admission did not negatively impact outcome. Triage practices likely influence outcomes. Severity scores may not fully reflect illness acuity or trajectory.

1. Introduction

For critically ill patients, care in an ICU affords a survival advantage over non-ICU settings [1-8]. High staff-to-patient ratios, provider expertise, and specialized equipment furnish ICUs with a unique mix of resources for treating the critically ill [5,6,9-12]. However, demand for intensive care frequently outpaces ICU bed availability, forcing rationing of beds and delays in ICU admission [1-9,13-28]. Depending on the definition of 'delay', as many as three of every four critically ill patients may wait for an ICU bed; wait times extend from hours to days [1,2,8,14].

Prompt treatment of many acute conditions favorably impacts outcomes, and the 'golden hour' concept guides contemporary approaches to trauma, sepsis, acute coronary syndrome, ischemic stroke, and other emergencies [29-34]. Common sense, clinical experience, and published data all suggest that the 'golden hour' concept applies to critical illness as well. Specifically, delayed ICU admission may increase the likelihood of mechanical ventilation [9,21], the duration of mechanical ventilation [16,21], length of ICU stay [9,16,27], length of hospital stay [9,16,27], ICU mortality [9,13,14], in-hospital mortality [9,15,17,27], and 28-day [22], 60-day [22], and 90-day mortality [18]. Two studies demonstrated an incremental rise in mortality for each hour spent waiting for an ICU bed [14,17]. The greatest mortality benefit from intensive care manifests during the first 72 h of critical illness [5].

We present a large, prospective, multi-national investigation into the association between lag time to ICU admission and outcome. As

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admission of sicker patients is routinely prioritized over that of more stable patients, assessing the effect of timely versus delayed admission must account for illness severity. We hypothesized that (1) delayed ICU admission adversely affects patient outcome, (2) some patient sub-populations are more vulnerable than others to the detrimental effects of delayed admission, and (3) controlling for Simplified Acute Physiology Score (SAPS) II [35] scores corrects for the bias introduced by the expedited admission of sicker patients.

2. Methods

2.1. Setting & study design

A prospective, cross-sectional study was conducted in 11 closed, university or university-affiliated general and specialty ICUs in seven European countries from September 2003 until March 2005. The selected ICUs treated diverse medical and surgical patients, contended with chronic bed shortages, and had previously participated in collaborative clinical studies. As an observational study that preserved patient anonymity and did not involve interventions or treatment, each institution's investigational review board granted a waiver of informed consent.

2.2. Inclusion & exclusion criteria

All patients eighteen years or more referred for ICU admission were included. Patients evaluated for critical care consultation only without request for an ICU bed were excluded, as were patients admitted to critical care units other than the study ICU. Acceptance for ICU admission was at the discretion of the treating intensivist. Patterns of acceptance and rejection, the development of a triage score, and analysis of triage based on age and cost were published previously [36-38].

The current post hoc analysis was limited to patients admitted to a participating ICU. Patients rejected for ICU admission, accepted but never actually admitted, accepted after more than one triage evaluation, or for whom complete clinical data were unavailable were excluded. Additionally, patients admitted directly from the operating theater were excluded in recognition of both the intense level of care offered in the operating room and the ongoing surgical interventions undertaken between the times of triage and ICU admission. Finally, patients admitted immediately following cardiopulmonary resuscitation were excluded considering their uniquely poor prognosis, and postoperative patients whose admissions had been scheduled in advance of elective surgery were excluded considering their uniquely favorable prognosis.

2.3. Definitions & data collection

Triage denotes evaluation by a critical care provider of a patient referred for ICU admission. Either acceptance or rejection defines a triage decision. Admission denotes the physical arrival of a patient in the ICU. Acceptance without admission refers to accepted patients who either improved or died while waiting for an available ICU bed. Triaging ward identifies the location from which a patient was transferred to the ICU and includes the emergency room, general inpatient ward, ambulance, other ICU, or other hospital.

Methods of data collection and recording were published previously [37]. Demographic, clinical, laboratory, and physiologic data collected included variables used in previously-validated outcome scores: age; sex; triaging ward; if after surgery, whether surgery was elective or emergent; if hospitalized, length of stay prior to ICU triage; acute medical diagnoses; comorbidities; Karnofsky Performance Scale [39]; Glasgow Coma Scale [40]; vital signs; laboratory results, including arterial blood gas. Triage time, triage decision, reason for rejection (no clinical indication, no available bed, too well, too ill or too old, more data needed or accepted to another ICU), and ICU occupancy at triage time were noted for each referral.

For each patient accepted, time elapsed between triage and admission (dubbed 'triage-to-admission time') was recorded. A time of "zero" was recorded when a patient was transported immediately to the ICU. SAPS II [35] was calculated using the worst clinical data from the 24 h before triage.

The primary outcome measure was 28-day mortality. Secondary outcome measures included the need for invasive treatment in the ICU (mechanical ventilation, continuous vasoactive therapy, or renal replacement therapy), ICU length of stay, hospital length of stay, ICU mortality, in-hospital mortality, and mortality at three months.

2.4. Quality assurance

Quality assurance measures were previously described [37]. Participating physician and nursing personnel were trained on data collection to ensure consistency. Monthly reports and biannual investigator meetings were used to review data and resolve problems. Inter-rater reliability was evaluated on the variables from a random sample of 5% of the patients.

2.5. Statistical analysis

The primary sampling unit for analysis was a patient. The impact of triage-to-admission time was assessed by treating triage-to-admission time as a binary variable, operationalized as timely admission (<4 h from triage time, in accordance with recently published guidelines [25]) versus delayed admission (≥4 h from triage time). For the primary outcome measure only, the impact of triage-to-admission time was also separately assessed by treating triage-to-admission time as a continuous variable. Outcome differences were assessed with a Chi-square test for binary variable analysis and with a non-parametric Kruskal-Wallis test for continuous variable analysis. Multivariate logistic regressions included control variables for the effects of age, sex, SAPS II scores, triaging ward, and participating medical center. Results were presented as odds ratios with 95% confidence intervals. Analyses were also stratified by triaging ward and participating medical center.

Statistical analyses were performed using SAS software (Version 9.4).

3. Results

7994 patients underwent 8751 triage evaluations during the study period. 3175 patients were included in the final analysis (Fig. 1). Table 1 lists demographic and clinical data.

The average time from triage to ICU admission was 2.1 h (SD = 3.9, IQR = 0.25–2.5, range 0–72 h). 2754 patients were admitted within 4 h and 421 after ≥4 h. Time elapsed between triage and admission correlated inversely but weakly with SAPS II scores. Patients with higher severity scores were admitted sooner (Pearson correlation coefficient −

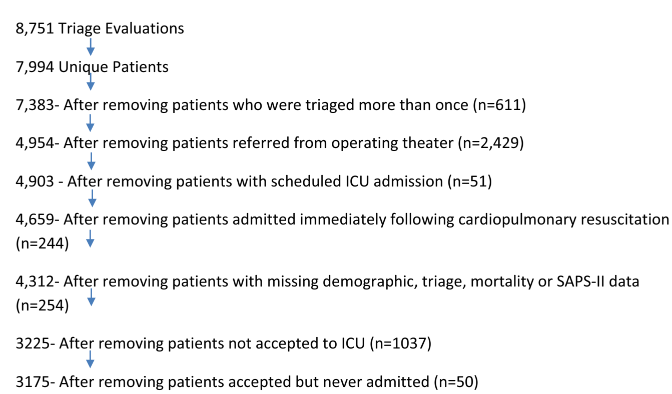

Fig. 1. Selection of study patients.

Table 1
Triage data: Data at time of triage for accepted and admitted, accepted and not admitted, rejected, and total patients. Numerical values represent absolute number (percent) or mean (SD), as indicated.

Parameter	Accepted and admitted (n = 3175)	Admitted within 4 h (n = 2754)	Admitted after ≥4 h (n = 421)	Accepted and Not Admitted (n = 50)	Rejected (n = 1037)	Total (n = 4262)
Age, years (mean ± SD)	57.6 (18.7)	57.7 (18.8)	56.9 (18.4)	61.8 (17.7)	65.4 (17.4)	59.5 (18.7)
Sex, male (%)	1858 (58.5)	1610 (58.5)	248 (58.9)	35 (70.0)	594 (57.3)	2487 (58.4)
Transferred from:						
Emergency department (%)	1320 (40.5)	1178 (42.8)	124 (29.5)	18 (36.0)	525 (50.3)	1863 (42.8)
Ward (%)	1245 (39.2)	1037 (37.7)	208 (49.4)	28 (56.0)	485 (46.8)	1758 (41.3)
Other hospital (%)	425 (13.4)	361 (13.1)	64 (15.2)	3 (6.0)	17 (1.6)	445 (10.4)
Other ICU (%)	117 (3.7)	100 (3.7)	17 (4.0)	0	11 (1.1)	128 (3.0)
Ambulance (%)	86 (2.7)	78 (2.8)	8 (1.9)	1 (2.0)	2 (0.19)	89 (2.1)
Surgical status:						
Elective (%)	286 (9.0)	209 (7.6)	77 (18.3)	9 (18.0)	54 (5.2)	349 (8.2)
Emergency (%)	554 (17.5)	406 (14.7)	148 (35.2)	7 (14.0)	57 (5.5)	618 (14.5)
Non-operative (%)	2235 (73.5)	2139 (77.7)	196 (46.6)	34 (68.0)	926 (89.3)	3295 (77.3)
Simplified Acute Physiology Score II:						
With Age (mean ± SD)	33.2 (15.3)	33.4 (15.2)	30.6 (15.6)	33.3 (16.6)	34.4 (14.9)	33.5 (15.2)
Without Age (mean ± SD)	23.6 (13.7)	23.95 (13.6)	21.3 (14.2)	22.4 (15.1)	22.4 (12.9)	23.3 (13.6)
Prior Karnofsky score (mean ± SD)	77.6 (20.7)	77.9 (20.8)	77.1 (20.0)	80.0 (18.8)	77.9 (20.9)	77.7 (20.7)
Pre-admission mechanical ventilation and/or vasopressors (%)	1355 (42.7)	1174 (42.6)	181 (43.0)	27 (54.0)	475 (45.8)	1857 (43.6)
Primary admission diagnosis:						
Respiratory (%)	918 (28.9)	816 (29.6)	102 (24.3)	10 (20.0)	341 (32.7)	1266 (29.7)
Cardiovascular (%)	380 (12.0)	326 (11.8)	54 (12.8)	6 (12.0)	223 (21.5)	609 (14.3)
Digestive (%)	233 (7.3)	183 (6.6)	50 (11.9)	9 (18.0)	68 (6.6)	310 (7.3)
Trauma (%)	417 (13.1)	369 (13.4)	48 (13.1)	3 (6.0)	45 (4.3)	465 (10.9)
Infectious (%)	307 (9.7)	264 (9.6)	43 (10.2)	2 (4.0)	124 (12.0)	433 (10.2)
Neurologic (%)	519 (16.4)	461 (16.7)	58 (16.4)	8 (16.0)	146 (14.1)	673 (15.6)
Other surgical (%)	43 (1.4)	33 (1.2)	10 (2.4)	4 (8.0)	13 (1.3)	60 (1.4)
Vascular (%)	52 (1.6)	34 (1.2)	18 (4.3)	6 (12.0)	7 (0.7)	65 (1.5)
Metabolic (%)	128 (4.0)	125 (4.5)	3 (0.7)	1 (2.0)	47 (4.5)	176 (4.1)
Renal/genitourinary (%)	80 (2.5)	63 (2.3)	17 (4.0)	1 (2.0)	13 (1.3)	94 (2.2)
Obstetrical-gynecologic (%)	72 (2.3)	62 (2.3)	10 (2.4)	0	6 (0.6)	78 (1.8)
Transplant (%)	9 (0.3)	2 (0.1)	7 (1.7)	0	0	9 (0.21)
Hematologic (%)	17 (0.5)	16 (0.6)	1 (0.2)	0	7 (0.7)	24 (0.6)
Bed Availability:						
2 or more available (%)	1333 (42.0)	1176 (42.7)	156 (37.3)	12 (24.0)	224 (21.6)	1569 (36.8)
1 bed available (%)	997 (31.4)	890 (32.3)	107 (25.4)	8 (16.0)	269 (25.9)	1274 (29.9)
0 beds available (%)	475 (15.0)	393 (14.3)	82 (19.5)	18 (36.0)	429 (41.4)	922 (21.6)
Fewer than 0 beds available (%)	370 (11.7)	295 (10.7)	75 (13.3)	12 (24.0)	115 (11.1)	497 (11.7)

0.07, $p < 0.0001$); the mean SAPS II score was 33.6 among patients admitted within 4 h and 30.6 among those admitted at ≥4 h ($p < 0.0001$). Similarly, time elapsed between triage and admission correlated inversely with ICU bed availability, such that triage-to-admission times were shorter (1.9 ± 3.7 h) when at least one ICU bed was available and longer (mean = 2.5 ± 4.4 h) when ICU occupancy was at or in excess of capacity ($p < 0.001$). The availability of two or more ICU beds at the time of acceptance did not significantly shorten triage-to-admission times as compared with the availability of one bed, nor did occupancy in excess of capacity significantly lengthen triage-to-admission times when compared to full occupancy.

3.1. Primary outcome

Among admitted patients, 28-day mortality was 29%. Using binary variable analysis, 28-day mortality was 29.6% among patients admitted within 4 h and 25.2% among patients admitted after ≥4 h (OR 1.25, 95% CI 0.99–1.58, $p = 0.06$) (Fig. 2). However, after adjusting for age, sex, and SAPS II scores, admission within 4 h was associated with 28-day mortality comparable to that of admission after ≥4 h (OR 1.10, CI 0.85–1.43, $p = 0.45$) (Fig. 3). Adjusting for triaging ward yielded similar results (OR 1.12, CI 0.87–1.45, $p = 0.39$), as did adjusting for participating medical center (OR 1.08, CI 0.83–1.41, $p = 0.58$).

Using six rather than four hours as the cutoff for timely versus delayed admission confirmed the above findings. Similarly, using continuous variable analysis and without adjusting for confounding variables, time elapsed between triage and admission correlated inversely with 28-mortality, such that each added hour of triage-to-admission time reduced mortality by 3% (OR = 0.97, CI 0.95–1.00, $p = 0.02$) (Fig. 4). However, after adjusting for age, sex, and SAPS II scores,

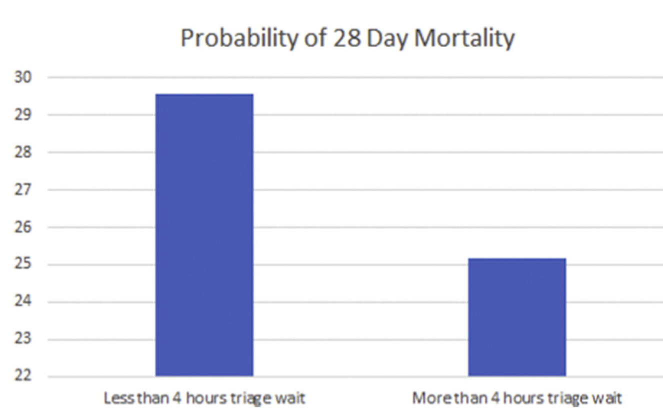

Fig. 2. Unadjusted 28-day mortality, binary analysis. Percent mortality at 28 days among patients admitted within versus after four hours, unadjusted for risk factors.

triage-to-admission time did not significantly impact 28-day mortality (OR 0.99, CI 0.9–1.01, p = 0.37) (Fig. 5).

Analysis of patients with a Karnofsky score of 40 or greater (n = 2956) revealed no difference in 28-day mortality between the timely and delayed admission groups (OR 1.10, CI 0.84–1.43). The same was found among patients with a Karnofsky score of <40 (n = 219; OR 1.08, CI 0.38–3.09). The interaction between triage-to-admission time and Karnofsky score was not significant (p = 0.97).

Analyses of specific diagnoses (trauma, sepsis, drug intoxication, and upper gastrointestinal bleeding) revealed no significant correlation between triage-to-admission time and 28-day mortality.

Analysis of patients receiving mechanical ventilation and/or vasopressors prior to ICU admission (n = 1345) demonstrated no correlation between triage-to-admission time and 28-day mortality (OR 1.07, CI 0.72–1.59, p = 0.75). Patients triaged and accepted when ICU bed vacancy equaled two or more, one, zero, or fewer than zero (i.e. ICU census in excess of capacity) revealed overall mortality rates of 28.7%, 31.5%, 28.2%, and 24.3%, respectively (p = 0.07). Patient ages and SAPS II scores did not differ significantly among these groups. Within each subgroup (2 or more, one, zero, or fewer-than-zero vacancies), triage-to-admission time did not correlate with 28-day mortality.

All aforementioned subgroups were analyzed using the binary variable model after adjusting for age, gender, and SAPS II scores. Adjusting additionally for triaging ward and participating medical center did not influence the results.

Analysis by triaging ward revealed no difference between the timely and delayed admission groups (Table 2). Analysis by medical center revealed no difference between the groups in all but two participating hospitals (Table 3).

3.2. Secondary outcomes

3.2.1. Three-month, in-hospital, and ICU mortality

After adjusting for age, sex, and SAPS II scores, triage ward, and participating medical center, triage-to-admission time did not correlate with three-month mortality (OR 1.07, CI 0.84–1.38, p = 0.58), in-hospital mortality (OR 1.01, CI 0.77–1.32, p = 0.94), or ICU mortality (OR 0.95, CI 0.71–1.26, p = 0.71).

3.2.2. Invasive therapy

43.1% of admitted patients required one or more invasive therapies while in the ICU. After adjusting for confounders, triage-to-admission time did not impact the need for invasive therapy (OR 1.09, CI 0.88–1.34, p = 0.43).

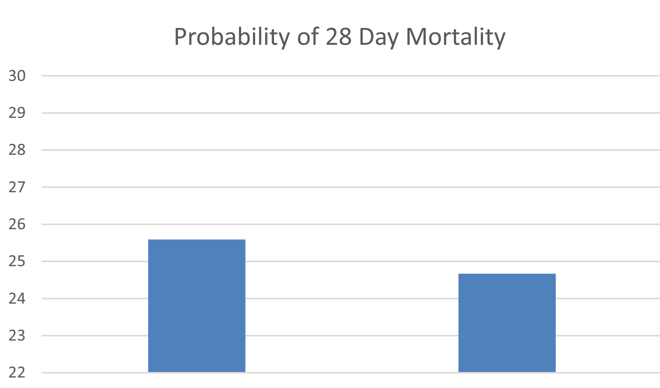

Fig. 3. Predicted 28-day mortality, binary analysis. Predicted mortality at 28 days using logistic regression model; calculated for mean age of 57.6 years and mean SAPS II score of 23.6.

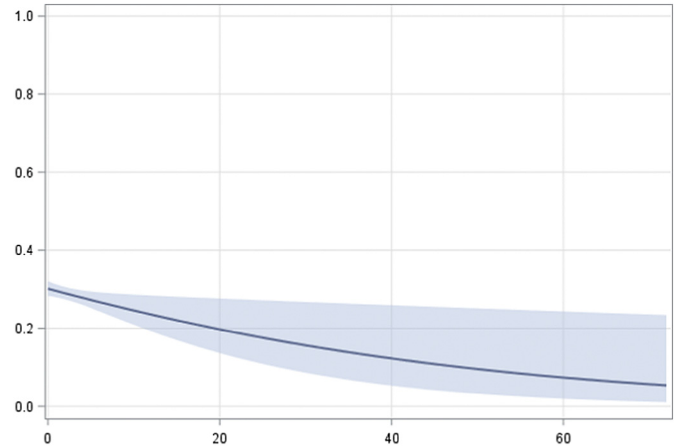

Fig. 4. Unadjusted 28-day mortality, continuous analysis. Probability of mortality at 28-days (y-axis) with 95% confidence intervals (shaded area) as a function of triage-to-admission time in hours (x-axis), unadjusted for risk factors.

3.2.3. Length of ICU and hospital stay

ICU stay lasted 7.1 ± 10.9 (median = 3.4) days among those admitted within four hours of triage and 7.7 ± 12.4 (median = 3.5) days among those admitted later (Wilcoxon p = 0.26). After adjusting for confounders, hospital stay differed between the two groups (mean = 25.4 ± 38.6, median = 14.8 for admission <4 h vs. mean = 26.4 ± 36.0 days, median = 17.2 for admission ≥4 h, p = 0.01).

4. Discussion

This study represents the first prospective, multi-national analysis of the impact of time to ICU admission on patient outcomes. Counterintuitively and counter to previously published data [9,15-18,21,22,27], this study fails to demonstrate a correlation between triage-to-admission time and 28-day mortality, 90-day mortality, in-hospital mortality, ICU mortality, length of ICU stay, and need for invasive ICU therapy. Without adjusting for confounding variables, timely admissions were associated with paradoxically *higher* 28-day mortality than delayed admissions; even after controlling for illness severity, mortality rates remained comparable. This trend persisted among the many subgroups analyzed. Admission within 4 h was associated with shorter duration of hospital stay as compared with delayed admission (25 vs 26 days), although this statistical difference is of questionable clinical significance.

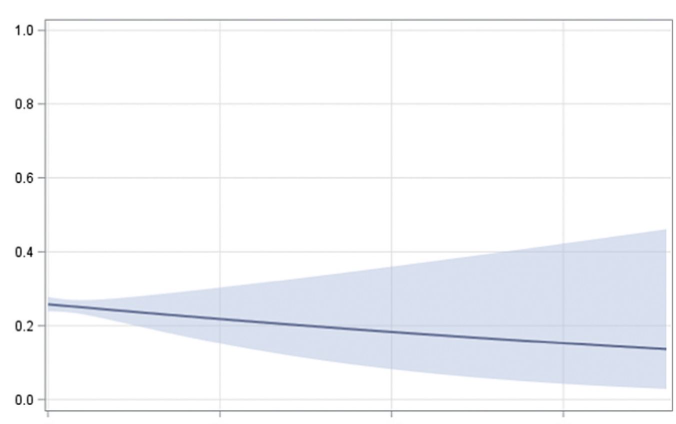

Fig. 5. Predicted 28-day mortality, continuous analysis. Predicted mortality at 28 days (y-axis) with 95% confidence intervals (shaded area) as a function of triage-to-admission time in hours (x-axis) using logistic regression model; calculated for mean age of 57.6 years and mean SAPS II score of 23.6.

Table 2
Primary outcome by triage ward: Comparison of 28-day mortality between patients admitted within 4 h and those admitted after 4 h by triage ward; results adjusted for age, sex, and SAPS II scores.

Triage ward	N	Odds ratio	95% CI	p value
Emergency department	1302	0.79	0.49–1.28	0.34
Ward	1245	1.36	0.94–1.96	0.10
Other hospital	425	1.15	0.60–2.21	0.67
Other ICU	117	1.00	0.30–3.34	0.99
Ambulance	86	2.81	0.24–32.4	0.41

The present study demonstrates unexpectedly an *absence* of the anticipated correlation between triage-to-admission time and patient outcome. This curious phenomenon warrants attention and begs understanding.

The most plausible explanation for this unanticipated finding is that, on average, patients admitted sooner suffer from more rapid clinical decline than those admitted later and that the downward trajectory of these patients prompts clinicians to expedite their transfers to the ICU. Physicians accustomed to grappling with perpetual ICU bed shortages – a characteristic feature of this study's participating centers – are undoubtedly practiced in consistently and efficiently prioritizing admission of the sickest referrals. Indeed, triage-to-admission time was shorter for those with higher SAPS II scores, substantiating the expertise of the Eldicus group. Thus, delayed ICU admission may well adversely impact a patient's clinical course, and yet the observed mortality of patients admitted sooner mirrors that of patients admitted later because the evolution of their conditions portends poorer outcomes. The SAPS II scores used in this study as a surrogate for illness severity, like other formal severity or risk scores, likely overlook unmeasured or unmeasurable elements of illness acuity and cannot account for fluctuating clinical conditions. Seasoned clinicians may be sensitive to nuances not reflected in such quantitative markers.

Harris et al. [18] proposed a statistical method to control for the confounding effects of unmeasured illness severity and the presumption that sicker patients are transferred sooner to the ICU. The method employs ICU occupancy as an instrumental variable and assumes that triage-to-admission time is determined chiefly by bed availability. Indeed, in the present study, triage-to-admission times were shorter when at least one bed was available and longer when occupancy was at or in excess of capacity. However, subgroup analysis of patients accepted at vacancies of each two or more, one, zero, and fewer-than-zero beds demonstrated that, even within each subgroup, delayed admission did not correlate with higher mortality. Moreover, mortality rose progressively as vacancy increased from fewer-than-zero to zero to one bed.

The largest published analysis to reach conclusions at odds with the present findings was based on the Project IMPACT database. Chalfin et al. [9] found that, among over 50,000 patients in the United States referred from emergency rooms to ICUs, admission within six hours was associated with modestly lower ICU (8.4% vs. 10.7%) and in-hospital (12.9% vs. 17.4%) mortality. The present study did not find a significant difference in mortality among patients referred from the emergency department (Table 2). ICU capacity and triage practices among the IMPACT centers may differ from those of the present study's participating centers. It is also conceivable that practices differ between the United States and Europe with respect to treating patients located physically in the emergency department or elsewhere who have been accepted but not yet admitted to an ICU [41-43]. Such differences may involve disparate physician or nursing staffing patterns and variable familiarity with invasive therapies outside of the ICU. The inter-institutional variability observed among our study's participating medical centers supports this contention. Indeed, a recent large retrospective Canadian study found that prolonged stays in the emergency department while awaiting ICU transfer did not impact 90-day mortality [44].

In addition to the contrast between our findings and those of earlier published studies, the inter-institutional variability observed among our study's participating medical centers warrants discussion. Different hospitals and the healthcare providers who staff them may be accustomed to different degrees of overcrowding on inpatient wards, in emergency rooms, and in ICUs. Institution-specific practices evolve to accommodate the measurable and unmeasurable strains, limitations, and realities of each institution and health system. Thus, the level and efficiency of care offered critically ill patients outside of the ICU may differ vastly from one center to another. The intuitive presumption that expedited admission of critically ill patients to the ICU improves outcome may not be true in all hospitals, particularly in those accustomed to severe overcrowding and almost routine administration of ICU-level care outside of a formal ICU. Indeed, this study excluded patients referred from the operating theater precisely because such patients presumably received ICU-level care in the operating or recovery room even as they awaited transfer to an ICU.

The strengths of the present study lie in its prospective nature, its multi-institutional representation, its large sample size, the ability to control for demographic data and illness severity scores in every patient, and the fact that continuous variable analysis confirms the findings gleaned from a binary comparison between those admitted within four hours and those admitted at four hours or more. This study thus overcomes many shortfalls inherent, to varying degrees, in the studies cited above. Additionally, this study's findings call into question the ability of SAPS II scores to accurately reflect the complexity of a patient's condition and trajectory.

Although our data were collected more than a decade ago, the global model of concentrating intensive care resources and expertise in dedicated units has not changed, and this study's findings should inform contemporary practice. Different health systems and different hospitals employ different ICU referral patterns and offer different levels of care outside the ICU. As populations grow and age, as ICU crowding worsens, and as medical interventions become ever more sophisticated, ICU-level care may become increasingly available in referring units [41-43]. As

Table 3
Primary Outcome by participating medical center: 28-day mortality, mean triage-to-admission time, and odds ratio of 28-day mortality among patients admitted within 4 h versus that of patients admitted at 4 h or more by participating medical center; results adjusted for age, sex, and SAPS II scores. Odds ratio and confidence interval could not be estimated for Soroka University Hospital, as 28-day mortality among patients with delayed admission was zero.

Medical center	N	Mortality (%)	Triage-to-admission time (hrs ± SD)	Odds ratio	95% CI	p value
Herlev University Hospital, Copenhagen, Denmark	312	49.0	1.14 (1.83)	0.84	0.29–2.45	0.75
Hospital Lariboisiere, Paris, France	294	17.0	2.98 (3.19)	1.01	0.47–2.17	0.97
Ospedale Azienda San Paolo, Milan, Italy	256	28.5	2.03 (5.43)	0.87	0.32–2.40	0.78
Ospedale San Gerardo, Milan, Italy	215	24.2	0.87 (1.54)	0.22	0.06–0.88	0.03
Soroka University Hospital, Beersheba, Israel	197	35.0	0.43 (3.43)	no estimate	no estimate	0.99
Hadassah University Hospital, Jersualem, Israel	363	11.3	1.95 (2.76)	0.63	0.22–1.179	0.38
Isala Hospital, Zwolle, Netherlands	553	26.0	1.75 (3.30)	3.29	1.36–7.97	0.008
Consorci Hospitalari del Parc Tauli, Barcelona, Spain	249	35.3	1.87 (4.36)	0.69	0.28–1.69	0.42
Royal Hallamshire Hospital, Sheffield, United Kingdom	211	32.2	3.64 (4.49)	1.19	0.58–2.46	0.63
Whittington Hospital, London, United Kingdom	165	38.2	3.36 (3.20)	0.77	0.37–1.62	0.49
University Medical Center, Utrecht, Netherlands	360	33.1	2.88 (5.62)	1.49	0.68–3.24	0.32

that happens, delays in ICU admission may impact not only critically ill patients, but also less severely ill patients who will need to compete with sicker patients for staff attention and other resources in those referring units.

5. Conclusions

Even after accounting for quantifiable parameters of illness severity, delayed admission could not be shown to negatively impact patient outcome among participating European ICUs. The presumption that expeditious admission of critically ill patients lowers mortality may or may not be correct. This study questions this intuitive supposition and highlights two crucial points: one, the outcomes of critically ill patients awaiting ICU admission may vary among different medical centers and systems and may depend as much upon triage patterns as upon provision of intensive care; two, reliance on severity scores, rather than trajectory scores, to quantify illness severity may overlook crucial elements of a patient's acuity, lability, and mortality.

Conflict of interests

All authors participated in the study design and manuscript preparation. No author reports a conflict of interest.

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