BMC Pulmonary Medicine

RESEARCH

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Impact of patient admission source on respiratory intensive care unit outcomes

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Abstract

Background Research is limited in describing the association between admission source and mortality in critically ill patients. Therefore, this study investigated how intensive care units (ICUs) admission source (emergency department (ED) or ward) correlates with mortality rates.

Methods This retrospective observational cross-sectional study was conducted in a tertiary pulmonology teaching hospital's ICU from January 1, 2018, to December 31, 2019. Patients were ICU patients admitted for acute respiratory failure. Demographic, comorbidities, diagnoses, APACHE II score, ICU admission (ED or ward), mechanical breathing support (invasive or noninvasive), length of stay, and mortality were recorded. Comparisons of ICU admission sources and mortality factors were established.

Results A total of 2,173 ICU patients were studied; 1,011 (46%) were admitted from the ED and 1,162 (54%) from the ward. Their mean age was 70 years, and 66% of them were men. Pneumonia was the leading cause of ICU admission at 60% and Chronic Obstructive Pulmonary Disease (COPD) was the most common comorbidity at 54%. When both groups were evaluated in terms of respiratory support, non-invasive mechanical ventilation use was higher in patients admitted from the emergency room (ED: 50% vs. Ward: 35%), invasive mechanical ventilation was more frequently required in patients admitted from the ward compared to those admitted from the emergency department (ED: 17% vs. Ward: 25%). Length of ICU stay (2 vs. 3 days $P<0.001$) and ICU mortality (odds ratio: 1.66, 95% confidence interval 1.297–2.124, $P<0.001$) were higher in patients admitted from the ward than in patients admitted from the emergency department. In addition, pneumonia patients and those with malignancies, interstitial lung disease, or noninvasive mechanical ventilation (NIV) failure were associated with higher mortality.

Conclusion Our study suggests that ward-to-ICU patients had higher mortality rates compared to ED-to-ICU patients. Triage protocols to better identify potentially critically ill patients in the ED may improve outcomes by avoiding delays in care and better assignment of admission location.

Keywords Respiratory failure, Chest diseases ward, Emergency department, Respiratory intensive care, Mortality, Admission source

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Introduction

The majority of patients admitted to respiratory intensive care units (ICU) are cases of respiratory failure that require close support and monitoring despite the treatment given by competent specialists in emergency departments (EDs) or chest diseases wards. However, patients whose clinical and laboratory values are stabilized with treatment in the ED can be transferred to wards for further treatment and follow-up. Especially in EDs with a high density of patients, any increase in the number of severe cases may interrupt the circulation of relevant units. In such moments, even critically ill subjects may have to be transferred to wards after their initial intervention due to the lack of ICU beds and to ensure the ED throughput [1]. n the ward, continuous monitoring and advanced treatment modalities are limited compared to the ICU, which may pose a risk for some patients. In particular, patients with respiratory failure who either might have not been stabilized completely before transfer or might have deteriorated after being transferred. This, in turn, can result in delayed ICU admission and possibly worse outcomes compared to direct admission from the ED. However, there is limited data in the literature on associated adverse outcomes, in particular, mortality. In this study, we aimed to investigate how the admission source of ICU patients interned due to respiratory failure affects mortality and to identify mortality indicators based on admission source.

Materials and methods

This retrospective observational cross-sectional study included all patients admitted to the ICU due to respiratory failure from January 1, 2018, to December 31, 2019, who met the inclusion criteria. Figure 1 shows the flowchart of the study.

The inclusion criteria were as follows:

- Subjects admitted to respiratory ICU due to respiratory failure (from the ward or ED).
- Diagnosis of respiratory failure based on room air blood gas analysis [2].
- $PaO_2 < 60$ mmHg.

or/and.

- $PaCO_2 > 45$ mmHg.

The exclusion criteria were as follows:

- Patients who stayed in the ICU for less than 24 h.
- Patients transferred from step down units.
- Patients admitted during a postoperative period.
- Patients admitted for reasons other than respiratory failure.

The included patients were divided into two groups based on their entry source: those admitted from the ED and those admitted from the general ward (Fig. 1).

Demographic information, admission diagnoses, the origin of admission (ED or ward), APACHE II score, ICU

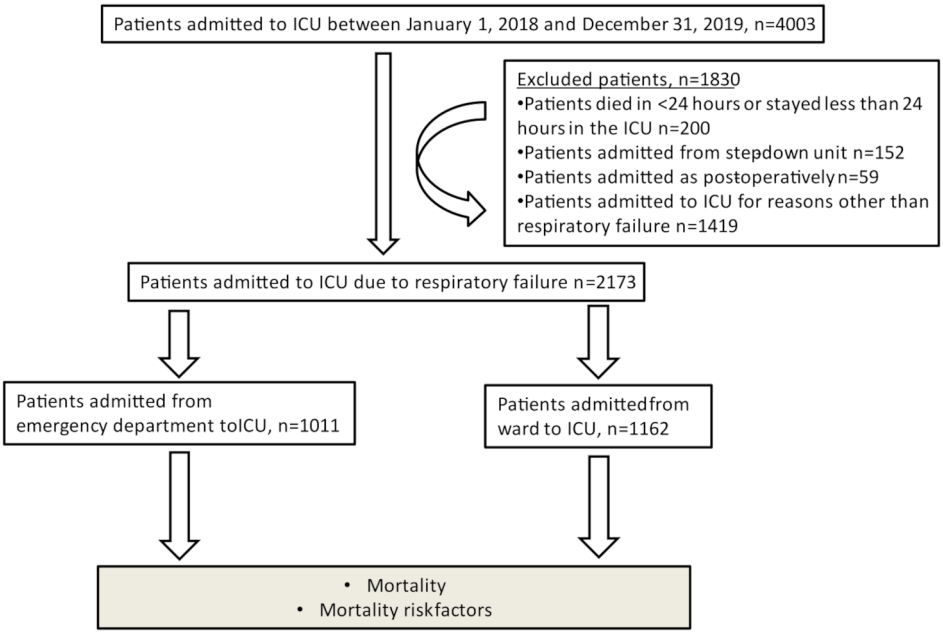

Fig. 1 Flowchart of the study

interventions (oxygen therapy, noninvasive ventilation (NIV), invasive mechanical ventilation (IMV)), duration of respiratory support, ICU length of stay (LOS), and mortality were recorded from the hospital's electronic information management system and ICU records.

Terminal illness/condition definition

An illness or condition was defined as terminal when causing death in 24 months or less [3]. This included advanced, chemotherapy-resistant cancer, end-stage cardiomyopathy or heart failure with ejection fraction below 20%, end-stage interstitial pulmonary fibrosis, COPD and neuromuscular diseases requiring over 16 h of NIV, dementia without spontaneous respiration and self-feeding and hypoxic encephalopathy [4, 5].

Statistical analysis

Statistical analysis was performed using SPSS 20 software (IBM Corporation, Armonk, NY, USA). Normally distributed numerical variables were compared using Student's t-test and presented as mean and standard deviation (SD); for variables that were not normally distributed, the Mann–Whitney U test was used, and the results presented as median with interquartile range (IQR). Categorical variables such as gender and comorbidities were presented as numbers and percentages and compared using the Chi-square test. Group comparisons were made between the two admission source groups. Logistic regression analysis was performed to investigate the factors associated with the risk of mortality, such as the severity of illness, age, admission diagnosis, admission source, need for mechanical ventilation, and ICU LOS.

Sample size estimation was conducted based on a study with a similar design, which investigated mortality in sepsis patients according to admission source [6]. We estimated that 345 completed patients in each group would provide a statistical power of 95% with an α of 0.05.

Table 1 Comparison of characteristics between patients admitted from the emergency department and the general ward

	Emergency Department	General Ward	*P*-value
Gender, Male, n (%)	67(67)	754(65)	0.35
Age (years), mean ± SD	68 ± 13.4	68 ± 14.1	0.46
Terminal condition, n (%)	218 (22)	275 (24)	0.24
APACHE II, median (Q1-Q3)	21 (18–26)	22 (18–27)	0.11
ICU length of stay, median (Q1-Q3)	2 (1–4)	3 (2–6)	**<0.001**
Mortality, n (%)	129 (13)	281 (24)	**<0.001**
Comorbidities, n (%) *			
COPD	627 (62)	544 (47)	<0.001
Hypertension	439 (43)	495 (43)	0.69
Diabetes mellitus	257 (25)	297(26)	0.94
Congestive heart failure	208 (21)	234 (20)	0.80
Coronary artery disease	188 (19)	236 (20)	0.31
Malignancy	169 (17)	435 (38)	<0.001
Atrial fibrillation	59 (6)	84 (7)	0.19
Bronchiectasis	74 (7)	65 (6)	0.10
Chronic kidney disease	45 (4)	75 (6)	0.041
Alzheimer's disease	49 (5)	54 (5)	0.82
Cerebrovascular event	38 (4)	60 (5)	0.11
Asthma	27 (3)	45 (4)	0.11
Interstitial lung disease	14 (1)	38 (3)	0.004

* Multiple diagnoses can exist in one patient

Abbreviations: Q1-Q3: 1st and 3rd quartile values

Results

Of 4,003 patients hospitalized in the respiratory ICU between January 1, 2018, and December 31, 2019, 2,173 met the inclusion criteria and were included in the study. Patients were categorized according to ICU admission source; 1,011 (46%) were admitted from the ED and 1,162 (54%) from the general ward. Their mean age was 70 years, and 66% ($n = 1,429$) were male. Both groups had similar gender and age profiles, number of end-stage patients, and APACHE II scores. However, ICU LOS was increased in patients admitted from the general ward ($P < 0.001$). Regarding comorbidities, COPD and obesity hypoventilation syndrome were significantly higher in patients admitted from the ED, while malignancies, especially lung cancer, chronic kidney disease, and interstitial lung disease, were higher in subjects admitted from the general ward (Table 1).

When comparing the groups based on admission diagnoses, pneumonia, sepsis, acute kidney injury, and pulmonary thromboembolism diagnoses were higher in subjects admitted from general respiratory wards, while exacerbation of COPD diagnosis was higher in patients admitted from the ED. Noninvasive ventilation (NIV) was more commonly utilized in patients admitted from the emergency department, while invasive mechanical ventilation and other forms of respiratory support were more prevalent among patients transferred from the ward (Table 2).

Mortality of subjects was evaluated according to the admission source; it was found that 129 (13%) of 1,011 patients admitted from the ED and 281 (24%) of 1,162 subjects admitted from the general ward died ($P < 0.001$) (Fig. 2). The mortality rate of subjects admitted to the ICU from the general ward was 2.18 times higher than that of those admitted from the ED.

During the follow-up period in the ICU, it was observed that pneumonia, sepsis, acute kidney failure, ARDS, septic shock, and pneumothorax diagnoses were more prevalent in the patients who died than those who survived. Between respiratory support treatments, mortality was higher in patients receiving only IMV or transitioning from NIV to IMV due to NIV failure ($P < 0.001$). Survival rates were significantly higher in patients who

Table 2 Comparison of intensive care unit diagnoses and respiratory support therapies between patients admitted from the emergency department and those admitted from the general ward

	Emergency Department	Ward	*P*-value
Intensive Care Unit admission diagnoses, n (%)			
Pneumonia	559 (55)	746(64)	< 0.001
Sepsis	499 (49)	658 (57)	0.001
COPD exacerbation	126 (13)	64 (6)	< 0.001
Acute renal failure	63 (6)	116 (10)	0.002
Pulmonary thromboembolism	17 (2)	35 (3)	0.043
Acute respiratory distress syndrome	19 (2)	31 (3)	0.22
Septic shock	15 (1)	29 (2)	0.09
Pneumothorax	7 (1)	16 (1)	0.12
Respiratory support therapies, n (%)			
Noninvasive ventilation	510 (50)	412 (35)	< 0.001
Invasive mechanical ventilation	172 (17)	296 (25)	< 0.001
Oxygen therapy	175 (17)	290 (25)	< 0.001
NIV failure	182 (18)	266 (23)	0.005

received only NIV or oxygen therapy ($P < 0.001$). Furthermore, the duration of NIV or both NIV and IMV treatments was longer in subjects who later died. The mean duration of ICU stays and requirement for dialysis were higher in patients who died ($P < 0.001$), whereas there was no difference in APACHE II scores.

Multiple regression analysis was performed to investigate parameters that may be predictors of mortality in patients admitted to the ICU. Patients admitted to the ICU from the ward, those with a diagnosis of malignancy, interstitial lung disease, pneumonia, or pulmonary embolism, and those who required intubation due to NIV failure, were included in the logistic regression model.

Table 3 Multiple regression analysis of parameters included in the model for ICU mortality

	Odds	95% CI for EXP(B)		*P*-value
		Lower	Upper	
Admitted from the ward to ICU	1,660	1,297	2,124	< 0,001
Malignancy	3,687	2,827	4,808	< 0,001
Interstitial lung disease	3,584	1,966	6,533	< 0,001
Intubated with noninvasive ventilation failure	2,188	1,689	2,834	< 0,001
Pneumonia	1,787	1,389	2,298	< 0,001
Pulmonary thromboembolism	1,196	0,572	2,500	0,63

Admission from the ward to ICU (OR: 1.66, %95 Cl 1.2 to 2.1) malignancy (OR: 3.68, %95 Cl 2.8 to 4.8), a diagnosis of interstitial lung disease (OR: 3.68, %95 Cl 1.9 to 6.5), intubation due to NIV failure (OR: 2.18, %95 Cl 1.6 to 2.8), and the presence of pneumonia (OR: 1.78, %95 Cl 1.3 to 2.2) were risk factors for increased ICU mortality. Table 3 summarizes the logistic regression analysis of patient data based on the included parameters.

Discussion

In our study, we evaluated ICU mortality according to admission source and found that patients admitted from the chest diseases ward had higher ICU mortality and longer ICU LOS than those admitted from the ED, despite similar severity of illness. Furthermore, being

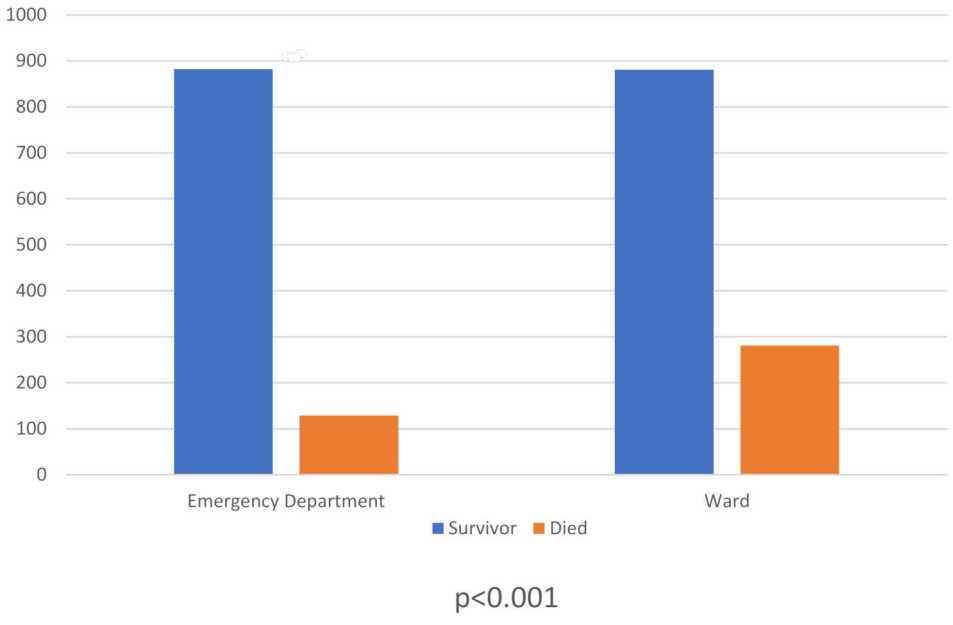

Fig. 2 Mortality numbers based on the admission locations of subjects in the ICU

admitted from the ward to the ICU was identified as a risk factor that increased mortality by 1.66 times.

Outcomes for critically ill patients are often dependent on time-sensitive ICU interventions; delays in transferring patients to the ICU can therefore have a significant impact. Waiting times for ICU bed availability can lead to prolonged stays in the ED [7, 8]. In a study supported by the American Hospital Association, it was found that in large hospitals with overcrowded EDs, the average waiting time for transfer from the ED to an acute or critical care bed was 6 h [9].

Motzkus et al. retrospectively investigated the effect of admission source on mortality in 1,762 patients hospitalized in the ICU due to sepsis and found that the ICU mortality rate in patients admitted from hospital wards (41.1 per 1,000 person-days) was higher than that in those directly admitted from the ED (28.1 per 1,000 person-days) (HRR: 1.35; 95% [CI]: 1.09–1.68); this is consistent with our study [6]. Tripathi et al. also found that mortality was higher in patients who were admitted to ICU from the wards than in those admitted directly from the ED (OR: 1.71, 95% CI 1.5 to 1.9) in their international multicenter study involving 209,645 patients over a 5-year period in pediatric ICUs [10].

In a previous similar study by the same group of authors, there was no difference in mortality between cases directly admitted from the ED and those admitted from wards. The authors attributed this result to the inclusion only of cases that deteriorated within the first 24 h of admission from the wards; the low number of subjects may also mean the study lacked sufficient power to detect a difference in mortality [11].

Patients requiring ICU care in wards can be categorized into two groups: those who were initially inadequately triaged in the ED and those who had a sudden deterioration in their general condition after being stable. In our study, we were not able to make this distinction among patients admitted from the wards. While initial interventions in the ED may have improved the condition of the patients, their stabilization may have not been adequately maintained in the wards due to the lack of continuous monitoring, lower nurse-to-subject ratio compared to ICUs, and the lack of continuous presence of specialized physicians. Although we are located in a developing country, our hospital is a well-established teaching hospital specializing in chest diseases, with sufficient healthcare resources and a highly experienced team in the management of complex pulmonary diseases. Therefore, we considered it feasible to monitor critically ill patients in the ward and made this decision accordingly. However, we acknowledge that in the emergency department setting, intensive care should be the primary consideration for the initial evaluation of critically ill patients. Close monitoring of these patients is safer and more effective under intensive care conditions.

In our study, it was found that the ICU LOS was significantly longer (2 vs. 3 days, respectively) in subjects admitted from the wards than in those directly admitted from the ED. While Mortzkus et al. did not find any difference in LOS according to admission source, Tripathi et al., found a longer duration of hospitalization in pediatric cases coming from the wards (4.9 vs. 3.6 days) [6, 10]. Morina et al. found that the probability of ICU LOS > 1 day increased approximately 2.5 times for those admitted from the ward than for those admitted directly from the ED [12].

When assessing severity by comparing APACHE II scores at the time of ICU admission, our study found similar values between the two groups. In triage assessment, it can be expected that more severe cases would be admitted directly to the ICU and, therefore, severity scores such as APACHE II would be higher for patients coming from the ED. However, it is possible that patients who were admitted to the ward because of a lack of ICU beds, who did not accept ICU admission initially, or whose condition deteriorated in the ward necessitating ICU admission contributed to this similarity.

We also found that the diagnoses of pneumonia and septic shock were higher in patients admitted from the wards than in those directly admitted from the ED. The potential delay in the manifestation of pneumonia, not initially radiologically detected but developing due to initial fluid resuscitation for example, and the inability to detect its progression due to insufficient monitoring after admission to the wards could be considered as reasons for this higher prevalence.

In our study, IMV support was higher in patients admitted from the ward, while NIV support was higher in patients directly admitted from the ED. However, IMV administration was higher in cases with a fatal course, while NIV was higher in survivors. In particular, we found that the mortality of patients who required IMV support after failed NIV administration was approximately two times higher. Patients with these characteristics were more prevalent in the group admitted from the wards. The application of NIV support in the early phase by an experienced team with close monitoring and using powerful devices are factors that increase the chances of success. In patients admitted from the ward, delay in administration, application by an inexperienced team, use of relatively simple devices, and inadequate monitoring are possible explanations for this result.

This study has some limitations. First, as it was a single-center retrospective study, it may not be appropriate to generalize the findings obtained. However, the fact that patients were followed by both chest disease and intensive care physicians with the same protocol suggests that

the study results may be valuable for similar patients; the study provides additional important clinical information due to the large sample size and specific patient group. In our study, the time until admission to the ICU could not be determined for patients admitted from either the ED or the ward. Inevitably, there may be patients who were admitted to the ICU without being admitted to the ward despite waiting for a long time in the ED, as well as patients who recovered in a short time and were initially admitted to the ward and then referred to the ICU upon deterioration. Furthermore, clinical severity scores were calculated after admission to the ICU and could not be determined at the time of ED presentation due to the lack of standardized implementation for all patients. It is possible that changes in these scores in the time until ICU admission may have contributed to the effectiveness of subject follow-up according to the place of arrival.

Conclusion

Patients admitted to the ICU from wards have a worse clinical course than those admitted directly from the ED. We believe that proper triage of patients requiring ICU support in the ED and the close monitoring of ward patients to detect clinical deterioration could have a positive impact on mortality and morbidity.

Abbreviations

COPD	Chronic obstructive pulmonary disease
ED	Emergency department
ICU	Intensıve Care Unit
IMV	Invasive Mechanical Ventilation
LOS	Length of Stay
NIV	Non-invasive Ventilation

Acknowledgements

None.

Author contributions

Literature search- BD, GG, SG, ID, ZKData collection- BD, GG, SG, ID, BY, G-ED, ET, H-GS, O-YM, NA, ZKStudy design- BD, GG, SG, ZKAnalysis of data- GG, SG, ZK Manuscript preparation- BD, GG, SG, ID, BY, G-ED, ET, H-GS, O-YM, NA, ZKReview of manuscript- BD, GG, SG, ID, ZKAll authors read and approved the final manuscript.

Funding

No support has been received.

Data availability

The data of retrospective study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Committee of Sureyyapaşa Chest Diseases and Thoracic Surgery Training and Research Hospital, Health Sciences University, under protocol number 116.2017.193, on August 20, 2020.

Consent for publication

Not applicable.

Clinical trial number

No clinical trial number was applied for this paper.

Competing interests

The authors declare no competing interests.

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Received: 24 September 2024 / Accepted: 6 March 2025
Published online: 18 March 2025

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