ORIGINAL ARTICLE

# Assessment of the impact of waiting time until admission in the Intensive Care Unit on the clinical outcome of critical patients

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## ABSTRACT

The premise that underpins this study is that the more Intensive Care Unit (ICU) beds available, the shorter the waiting time for ICU admission, resulting in better clinical outcomes, which justifies the relevance of this study. **Objective:** Assess if the waiting time in the Emergency Room until ICU admission influences on the clinical outcome of critical patients. **Methods:** An observational longitudinal retrospective study performed in a public hospital in Joinville/SC in 2019. This study analyzed data from patients admitted to the ICU with up to 72h of waiting time in the Emergency Room. It compares Q4'2017 (phase 1), when there were 14 ICU beds in the hospital vs. Q4'2018 (phase 2), when there were 30 ICU beds. **Results:** 173 medical records were analyzed in 2017-2018. There was a statistically significant difference in the time for ICU admission between 2017 and 2018 (median 22h vs. 15h; p=0.0002). There was also a statistically significant difference for mortality rates up to 24h of admission (9.61% vs. 2.47%; p=0.04). There was no statistically significant difference for hospital mortality rates (34.6% vs. 35.5%; p=0.57). There was also no statistically significant difference between the other parameters analyzed. **Conclusion:** Comparing 2017 and 2018, waiting time for an ICU bed was shorter in 2018, and the mortality rates up to 24 hours of ICU admission were lower. However, waiting time in the Emergency Room until ICU admission did not show association with hospital mortality rates.


**Keywords:** Emergency; Intensive Care Unit; Mortality.

## INTRODUCTION

The demand for intensive care is increasing worldwide. However, there is a wide variation in the supply of Intensive Care Units (ICU) beds among different regions[1]. According to data from 2020 of Health' Ministry, Brazil has 23 thousand ICU beds, adult and pediatric, to assist its population[2]. Yet, due to the progressive increase of critical patients arriving at emergency sectors, overcrowded scenarios, and hectic working environments, doctors and nurses face great trouble to assist the critical patients completely[3]. This chaotic reality in the Emergency Rooms (ER) directly results in delays in the transfer of critical patients to ICU, since doctors take longer to be notified about progressive deteriorations of their patients' clinical conditions, as well as take longer to assess these patients in overcrowded emergency sectors[4].

Therefore, studies suggest that a longer waiting time until ICU admission impacts drastically on the patient's outcome. A cohort study performed at McKay-Dee hospital in Ogden, Utah, in 2003, found that the delay in the admission of patients to the ICU resulted in increased mortality, more costs with hospital resources, and greater morbidity when compared to the group with less than 4 hours until ICU admission. These worse outcomes were associated not only with delays in notifying doctors about the clinical worsening of their patients but also with delays in bedside medical evaluation, implying that slow transfer patients received different medical treatment from those with fast transfer[4]. Similarly, a cross-sectional study from 2007 showed that between 2000 and 2003 patients with 6 hours or more waiting for an ICU bed had longer hospital stays, higher ICU mortality, and greater in-hospital

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mortality in general[3]. Furthermore, interventions, such as mechanical ventilation and central venous access, were more used in the group with more than 6 hours until ICU admission[3]. It is known that the positive impact of ICU admission on patients' survival is most evident during the first 72 hours of critical illness[5].

Late ICU admission may be related not only to the shortage of beds but also to the lack of hospital internal transfer protocols that assist in the management of critical patients[3]. Yet, in a study from 2003, the unfavorable outcomes found in the group with ICU admission time longer than 4 hours were the delay for notifying doctors about the patient's clinical worsening and the delay greater than 3 hours for the medical evaluation after reaching the first physiological severity criterion, even when there is an immediate notification to the doctor[4].

That said, this present study aims to assess if the waiting time in the ER, since the patients' arrival at the hospital until admission to the ICU, influences the outcomes of hospital mortality and mortality up to 24 hours of ICU admission.

## MATERIAL AND METHODS

This is an observational, retrospective, longitudinal study performed in a public hospital in the city of Joinville, Santa Catarina, in 2019. The analyzed data were related to patients admitted to the ICU in the last quarter of 2017 (phase 1), when there were 14 ICU beds in the hospital, and 2018 (phase 2), when there were 30 ICU beds. This project was approved by the Ethics Committee under number 05922819000005362 respecting resolutions 466/12.

All patients admitted to the hospital and directly from the ER were analyzed. In order to be included in this article, it was settled that the maximum length of stay in the ER, since the arrival of the patients to the hospital until ICU admission, would be up to 72 hours. Hence, patients under the age of 18, those in the postoperative period of elective surgeries, patients submitted to inter-hospital transfer or coming from other sectors of the hospital and those with more than 72 hours since hospital admission until ICU admission were excluded from this study. Late admission was considered when more than six hours elapsed from the patient's admission to the hospital's emergency sector until the admission to the ICU.

The following data were collected from each patient: age, sex, diagnosis at ICU admission, Simplified Acute Physiology Score 3 (SAPS3), and waiting time for the ICU bed[6]. The outcome variables analyzed were: hospital mortality and mortality up to 24 hours of ICU admission.

SAPS3 consists of a scoring system with 20 variables that must be evaluated when the patient is admitted to the ICU. By filling in this scale, which has its values between 16 and 217, it is possible to assess the patient's clinical condition before hospitalization, also, it allows to set the extent of the patient's health condition carefully. Therefore, physiological and demographic variables are considered, as well as the reason for admission to the ICU[6].

Continuous variables were analyzed using the Student's T-test and the Mann-Whitney U test, as appropriate. Categorical variables were analyzed using the chi-square test. Logistic regression models were used to examine the variables associated with mortality independently. The data were recorded in Microsoft Excel 2013 (Microsoft, Redmond, Washington, USA) and analyzed using the Statistical Package for Social Sciences (SPSS), version 20.0 (IBM Corp, NY, United States).

## RESULTS

During the study period, there were 381 ICU admissions. A total of 208 (54.5%) patients were excluded from the study, due to the following criteria: 47 (22.5%) patients were postoperative of elective surgery, 6 (2.8%) were under the age of 18, 15 (7.2%) were from other sectors of the hospital, 121 (58.1%) were admitted 72 hours after hospital admission and 19 (9.1%) were transferred from another hospital. Finally, data from 52 (30%) patients in 2017 and 121 (69.9%) patients in 2018 were analyzed (Figure 1).

About the characteristics of the sample, the median age of patients was 51 (IQR 42-59) and 55 (IQR 34-65) in 2017 and 2018, respectively, with a male predominance in both years (59, 6% and 61.1%) (Table 1, page 12). The frequency of late ICU admissions was 81.5%, 96.1% in 2017 and 75.2% in 2018 (Table 1). The median values of SAPS3 found were 56 (IQR 43-66) in 2017 and 66 (IQR 51-80) in 2018 (Table 1). Still, there was a statistically significant difference between the 2017 and 2018 groups regarding the time in hours for ICU admission (median of 22, IQR 18-47 vs. 15, IQR 7-30; p = 0.0002).

Regarding the outcomes (Table 2, page 13), there was a statistically significant difference for mortality within 24 hours after admission to the ICU (9.61% vs. 2.47%; p = 0.040). There was no statistically significant difference in hospital mortality comparing the two years (34.6% vs. 35.5%; p = 0.570).

Based on the analysis of binary logistic regression, there was no association between the waiting time in hours for ICU admission and hospital mortality (OR 1.001, 95% CI [0.982 to 1.021], p = 0.886) (Table 3, page 13) or mortality within 24 hours after admission to the ICU (OR 0.943, 95% CI [0.886 to 1.004], p = 0.068) (Table 4).

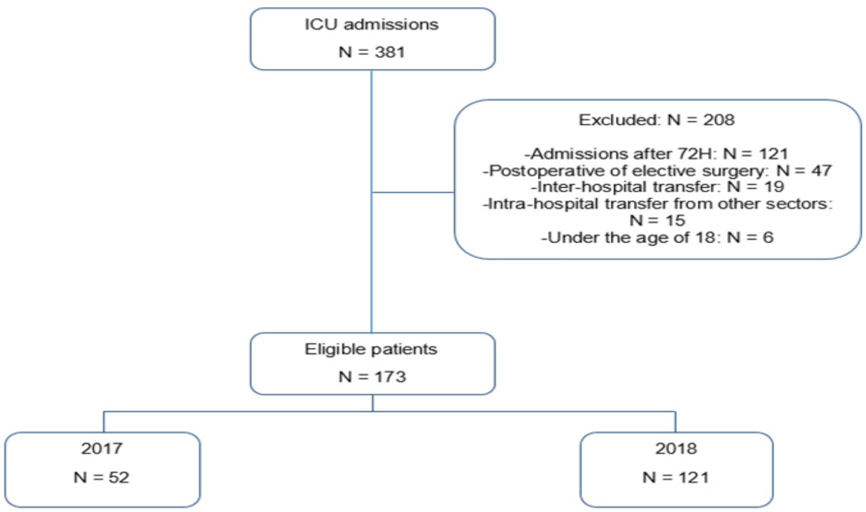


**Figure 01:** Flowchart of patients admitted to the Intensive Care Unit in the last quarter of 2017 and 2018

There was no association between late admission and hospital mortality (OR 1.20, 95% CI [0.475 to 3.071], p = 0.69) (Table 3, page 13). This association also did not occur between late admission and mortality within 24 hours after admission to the ICU (OR 0.136, 95% CI [0.010 to 1,800], P = 0.13) (Table 4, page 13).

Concerning the increase in SAPS 3 values, these were rather associated with higher mortality rates in the first 24 hours of ICU admission (OR 1.129, 95% CI [1.043 to 1.222], p = 0.003) (table 4, page 13), however, they were not associated with higher hospital mortality rates (OR 1.002, 95% CI [0.989 to 1.014], p = 0.788) (Table 3).

**Table 1**

Clinical and demographic features of the patients admitted to the ICU in 2017 and 2018

| Patients' features | 2017 (n=52) | 2018 (n=121) | P value |
|---|---|---|---|
| Male, n (%) | 31 (59,6) | 74 (61,1) | 0,85 |
| Age, years, median (IQR) | 51 (42-59) | 55 (34-65) | 0,44 |
| SAPS 3, median (IQR) | 56 (43-66) | 66 (51-80) | < 0,001 |
| Waiting time for ICU admission, hours, median (IQR) | 22 (18-47) | 15 (7-30) | 0,0002 |
| Late admission, n (%) | 50 (96,15%) | 91 (75,2%) | 0,0011 |

**Table 2**

Outcomes of admissions to the Intensive Care Unit in 2017 and 2018

| Outcomes | 2017 (n=52) | 2018 (n=121) | P value |
|---|---|---|---|
| Hospital mortality, n (%) | 18 (34,6) | 43 (35,5) | 0,57 |
| Hospital mortality within 24 hours after ICU admission, n (%) | 5 (9,61) | 3 (2,47) | 0,04 |

**Table 3**

Binary regression analysis - dependent variable being hospital mortality, n

| Covariates | Odds ratio | 95% CI | P value |
|---|---|---|---|
| Age | 1,015 | 0,996-1,035 | 0,131 |
| Male | 0,710 | 0,371-1,357 | 0,300 |
| SAPS 3 | 1,002 | 0,989-1,014 | 0,788 |
| Late admission | 1,207 | 0,475-3,071 | 0,692 |
| Waiting time for ICU admission | 1,001 | 0,982-1,021 | 0,886 |

**Table 4**

Binary regression analysis – dependent variable being hospital mortality within 24 hours after ICU admission, n

| Covariates | Odds ratio | 95% CI | P value |
|---|---|---|---|
| Age | 0,955 | 0,910-1,003 | 0,065 |
| Male | 1,297 | 0,242-6,942 | 0,761 |
| SAPS 3 | 1,129 | 1,043-1,222 | 0,003 |
| Late admission | 0,136 | 0,010-1,800 | 0,130 |
| Waiting time for ICU admission | 0,943 | 0,886-1,004 | 0,068 |

## DISCUSSION

In 2018, there was a shorter waiting time for admission to the ICU (median hours of 22 in 2017 vs. 15 in 2018, p = 0.0002). This change is understood due to the expansion of the ICU beds in the second year analyzed. As a result of this change, the lowest rate of late admissions was also observed this year (96.1% in 2017 vs. 75.2% in 2018). However, the overall frequency of late admissions in this article was 81.5%, still considered relatively high when compared to data from the literature on late admissions, for example, in regions such as Israel (24%), France (37.6%), England (32.6%) and Hong Kong (37.8%)[7-10].

The retrospective observational study in a university hospital in Boston (USA), with 287 patients with severe sepsis or septic shock, categorized delayed ICU admission as the one that occurs after 6 hours. In this same study, a rate of 52.2% of transfers to the ICU with more than 6 hours of stay in the emergency room was found. All patients underwent strict sepsis treatment and resuscitation protocol. No significant differences were found in the clinical outcomes of the two groups, it is probably imagined that this occurred due to the intense and specialized care provided to the patient already in the emergency department of this university hospital. This reinforces the thesis that "ICU care" can and should be started even in the emergency sectors, in the first hours of care, until access to the specialized bed is available[11].

Thus, late admissions in the present study also reflect the ER workload, which warns of the need for improvements in the admission and internal transfer process for critically ill patients. Based on this, a prospective analysis of an article carried out with 81 patients demonstrated that although the length of stay in the emergency room is very brief compared to the period of hospitalization and with hospitalization in the ICU, the care for critical patients in the emergency sectors impacts significantly, reducing the progression of organ dysfunctions and improving survival[12].

It is considered that this assistance in the emergency sectors is essential for the institution of this study. Since, even with the small number of patients, it was possible to observe an association between the increase in SAPS3 values and the increase in mortality rates in the first 24 hours of ICU admission (OR 1,129, 95% CI [1,043 to 1,222], p = 0.003). Thus, the stabilization of the patient for admission to the ICU and early transfer, which depends essentially on the initial management of the ER, contributing to the reduction of the values of SAPS3 and, therefore, to the best clinical outcome in the first 24 hours.

However, there are difficulties with the unavailability of equipment and supplies to provide complete assistance in the emergency sectors and the shortage of specialized beds. According to data from the 2016 census of the Brazilian Association of Intensive Care Medicine, in Brazil, only 15% of the places have ICU beds[13]. As recommended by the World Health Organization and the Ministry of Health, the ideal number of ICU beds is 1 to 3 beds for every 10,000 inhabitants, with Brazil having a proportion of 2.2 beds, which scattered, it looks satisfactory. However, there is an important discrepancy between the public and private sectors: SUS has an average of 1.4 beds for every 10,000 inhabitants, while the private sector has an average of 4,9[14].

The public hospital in which this study was conducted is a state reference in transplants, traumatology, neurology, oncology, and treatment of burns. Therefore, it presents a high patient flow from several cities in the state, in conditions that are often critical and related to ICU admission, a factor that motivates or increases the number of ICU beds in 2018. Similarly, most public hospitals in Brazil face high rates, especially in large hospitals[15]. When demand exceeds a supply, access becomes limited and the patient's care is postponed. Crossing borders, a study conducted in three Australian hospitals in 2006 has already found a relative increase of 30% in mortality on the second and seventh days in overcrowded hospitals, including in emergency cases, for patients who end hospitalization[16]. Also, regardless of the physical structure, the team's qualification, well-defined service compliance, and experience in the management of critically ill patients by the emergency departments are crucial to improving the clinical outcome after entering intensive care.

Regarding SAPS3, an association was found with mortality within 24 hours after admission to the ICU (OD 1,129, 95% CI [1,043 to 1,222], p = 0.003), but no association with hospital mortality was found (OD 1.002, 95% CI [0.989 to 1.014], p = 0.788). It was observed that in 2018 the median value of SAPS3 was higher (66 in 2018 vs. 56 in 2017), pointing to the admission of patients in more severe conditions to the ICU. However, even in this scenario, there was still a decrease in mortality within 24 hours of admission to the ICU when comparing 2018 to 2017. Therefore, it is questioned whether the shortest waiting time for admission (median of 22 hours in 2017 vs .15 hours in 2018) and the lower late admission rate in 2018 (96.15% in 2017 vs. 75.2% in 2018) could be responsible for the decrease in 24-hour mortality observed in 2018.

About late admission related to hospital mortality, in 2005 a prospective cohort was performed at the University Hospital of Londrina, which evaluated 401 patients from the hospital itself to an ICU, categorizing them into delayed admission or not, with a maximum cut of 72 hours. Of these, 276 patients had delayed access to the ICU (> 72h) and 138 (50%) died, against 47 (37.6%) of those hospitalized without delay in the ICU. Long-term patients in the emergency department had a higher chance of complications due to sepsis: 172 cases (62.3%) in late admissions and 58 cases (46.8%) in immediate ones[5].

As the study cited, this study sought to relate the clinical outcomes of patients to a delay in bed admission to the ICU using a maximum cut-off of 72 hours. Therefore, patients admitted after more than 72 hours of waiting in the emergency department were excluded. This cut-off time was determined because it is the limit beyond which the benefit window would be exceeded since it is in the first 72 hours of the evolution of a severe condition that the greatest results of intensive care are clinically apparent[5]. However, the final data failed to demonstrate an increase in hospital mortality in cases of late admission, with no statistically significant difference between these parameters (OD 1,207, 95% CI [0.475 to 3.071], p = 0.692). There was also no statistically significant difference in hospital mortality between 2017 and 2018 (p = 0.57).

This occurred even with the longest delay for admission to the ICU in 2017 (median of 22 in 2017 vs. 15 in 2018). It is discussed whether the shortest waiting time in 2018 occurred due to the increase in the number of beds this year, impacting the decrease in mortality within 24 hours of admission to the ICU this year. However, due to the small number of patients in the present study, the clinical impact of these interventions may not have been sufficiently significant about hospital mortality.

When analyzing the study data, it is clear that one of the greatest determinants for the outcome of the critical patient would be the immediate intervention to support the organs, which is initiated in the emergency room. This concept of "critical care without walls" is becoming more and more accepted today.

The main limitations of this study were the fact that it was monocentric and the small sample size.

## CONCLUSION

With an increase in the number of ICU beds from 2017 to 2018, there was a reduction in the waiting time for those beds and a lower rate of late admissions, accompanied by a reduction in mortality up to 24h. This points to improved early outcomes when ICU admission occurs in a timely fashion and shows the staff capacity to maintain good initial patient care even with a higher number of beds.

However, these findings were not reflected in hospital mortality, since there was no statistically significant difference in this parameter between the years studied. This raises questions regarding the number of ICU beds to be considered continuously, by managers and even by the general population, in isolation, as the only predictor of the outcome of critical patients. Also, the waiting time in the emergency department for admission to the ICU did not show an association with mortality rates in this study. However, it should be noted that, if other outcomes were evaluated and a larger number of patients were gathered, the association between the waiting time for the ICU bed and hospital mortality in critically ill patients could be found.

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**Conflict of interests**

The authors declare that there is no conflict of interest in this article.

**Authors' contributions**

Deorgelis Rosso: orientation and supervision; Glauco Adrieno Westphal: orientation and supervision; Larissa Fabre: study planning, literature review and writing; Maria Luíza Floriano: data collection, writing and final corrections; Mariana Laís Mendes: data collection, writing and final corrections; Morgana Longo: study planning, literature review and writing; Patricia Tessari: data collection, writing and final correction

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