International Journal of Research and Review
Vol. 10; Issue: 10; October 2023
Website: www.ijrrjournal.com
Original Research Article *E-ISSN: 2349-9788; P-ISSN: 2454-2237*

The Effects of Intensive Care Unit Admission Time on Mortality

Omer Tasargol[1], Elif Bombaci[2], Serkan Tulgar[3], Serhan Colakoglu[2], Zeynep Tasargol[4], Halil Cihan Kose[5], Selin Guven Kose[5], Ibrahim Uzun[6]

[1] Department of Anesthesiology and Reanimation, Dr Burhan Nalbantoglu State Hospital, Nicosia, Cyprus
[2] Department of Anesthesiology and Reanimation, Kartal Dr. Lutfi Kirdar City Hospital, Istanbul, Turkey
[3] Department of Anesthesiology and Reanimation, Samsun University Samsun Training and Research Hospital, Samsun, Turkey
[4] Department of Obstetrics and Gynacology, Elite Hospital, Nicosia, Cyprus
[5] Department of Pain Medicine, Kocaeli City Hospital, Kocaeli, Turkey
[6] Department of Anesthesiology and Reanimation, Findikli State Hospital, Rize, Turkey

Corresponding Author: Halil Cihan Kose

DOI: https://doi.org/10.52403/ijrr.20231021

ABSTRACT

In recent years, there have been notable advancements in the critical care, including significant progress in medical knowledge, technological innovations, and the development of clinical expertise crucial for effectively treating patients. Numerous factors play a role in shaping the admission and discharge decisions made in the context of intensive care units. In this research we aimed to evaluate the effect of the time of the intensive care unit admissions, categorized as either "off hours" or "business hours," on the subsequent death rates among patients. We performed a retrospective investigation of the mortality rates of 1605 patients in intensive care unit between 2007 and 2010. We included all admissions to the intensive care unit without applying any exclusion criteria. The primary outcome measures in our study were the timing of admission, as well as the rates of discharge and mortality. "Business hours" denoted the time frame from 8:00 to 16:59 on weekdays, while "off hours" encompassed the period from 17:00 to 07:59 on weekdays and throughout the weekends. Significantly reduced mortality rates were evident among patients admitted on Mondays and Wednesdays in comparison to those admitted on other days (p=0.037 and p=0.045, respectively). Furthermore, the study revealed an elevated risk of mortality for admissions during weekends when compared with those admission on weekdays (p=0.005). The results found that a significant association was present between admission timing and mortality. Patients admitted on weekends and during off-hours exhibit an increased risk of mortality when compared to those admitted on weekdays during business hours.

Keywords: Intensive care unit, Mortality rate, Time of admission

INTRODUCTION

In recent years, there has been remarkable progress in the field of critical care, encompassing significant advancements in medical knowledge, technology, and clinical expertise essential for the management of critically ill patients. Intensive care, as a specialized discipline within medicine, pertains to the comprehensive assessment, treatment, and subsequent monitoring of patients who are critically ill or have sustained severe injuries. An intensive care unit (ICU) represents a highly specialized and meticulously structured hospital facility. It is expressly configured, staffed, situated, furnished, equipped, and exclusively dedicated to the care and management of individuals afflicted by severe injuries or complex medical conditions that warrant intensive medical intervention and

monitoring vital signs and management responses for 24 hours.

Several factors influence the admission and discharge decisions within the realm of ICUs, encompassing considerations such as the consequences of the underlying medical condition, the availability of specialized treatment resources, the anticipated impact of treatment on the course of the disease, the merits and demerits of therapeutic interventions, and the overarching strategy of the ICU itself [1-3]. Staffing levels tend to diminish during evening, night, weekend, and holiday shifts, collectively termed "off hours," in contrast to the higher staffing levels observed during weekday day shifts. This staffing disparity applies even to ICUs, despite the fact that ICU patients typically necessitate continuous, intensive care spanning 24 hours. Moreover, these time frames may witness constrained accessibility to various medical equipment, potentially resulting in prolonged durations for specific diagnostic and therapeutic procedures, or in some cases, necessitating deferral of such interventions until standard working hours are resumed. Previous studies involving hospitalized acutely ill patients have indicated that disparities in mortality rates between admissions that occur on weekdays and weekends may be most pronounced among individuals suffering from intricate medical conditions associated with elevated mortality risks. Moreover, several investigations exploring the association between the time of admission to the ICU and mortality have identified an association between ICU admissions occurring during weekends or during non-standard hours, often referred to as "off hours," and heightened mortality rates [4-6]. However, no previous studies investigated this topic in Turkey whether the risk of mortality within the ICU remains consistent between daytime and evening or nighttime admissions, as well as between weekends and weekdays.

We hypothesized that mortality rates might exhibit an increase in admissions to the ICUs on off-hours, characterized by lower staff numbers and potentially suboptimal care practices. To evaluate the impact of diminished ICU personnel and associated variables on death rate, we performed a retrospective cohort research utilizing prospectively obtained data from an ICU situated in the metropolitan İstanbul region, Turkey, over a 4-year period. Our objective was to compare the rate of deaths between admissions during daytime shifts and during off- hours. Additionally, we aimed to investigate potential disparities in the duration of ICU stay and the utilization of mechanical ventilation (MV) between admissions during business-hours and those admissions during off-hours.

MATERIALS & METHODS

A retrospective analysis was conducted on a cohort of 1605 admissions to ICU within Dr. Lutfi Kirdar Kartal Training and Research Hospital. The study period spanned from January 2007 to December 3, 2010, encompassing a four-year duration. All admissions to the ICUs during this timeframe were included in the analysis, with no specific exclusion criteria applied. The study protocol received approval from the ethics committee. Data relevant to the patient population in the ICUs were retrospectively retrieved and assessed by accessing hospital records and database files. This study involved an examination of comorbid conditions, indications for admission, and outcomes of patients in the ICU. The collected data encompassed demographic characteristics, clinical assessment scores such as the Acute Physiology and Chronic Health Evaluation II (APACHE II), Glasgow Coma Scale (GCS), and Sequential Organ Failure Assessment (SOFA), as well as details regarding the timing and seasonality of ICU admissions, the overall patterns of admission and discharge times, length of ICU stay, duration of mechanical ventilation (MV), the timing of ICU admissions (categorized as "business hours" or "off hours" and weekdays or weekends) in relation to ICU outcomes (discharge or

mortality within the ICU), and the correlation between mortality and the number of days spent in the ICU. "Off hours" referred to weekends and the hours between 17:01 and 7:59 on weekdays, while "business hours" were defined as the time interval between 8:00 and 17:00 on weekdays.

STATISTICAL ANALYSIS

Regarding the statistical analysis of the collected data, we employed NCSS (Number Cruncher Statistical System) 2007 and PASS (Power Analysis and Sample Size) 2008 statistical software, both developed by NCSS, LLC, East Kaysville, Utah, USA. The quantitative data were analyzed utilizing the student's t-test for comparing parameters with a normal distribution and calculating descriptive statistics (means and standard deviations). The Mann-Whitney U test was employed to analyze parameters that did not follow a normal distribution. Categorical parameters were compared using the Pearson chi-square test. Statistical significance was defined as differences with a p-value less than 0.05.

RESULT

This study encompassed a cohort of 1605 patients, consisting of 883 males (55%) and 722 females (45%). The age range of these patients spanned from 1 month to 104 years, with a mean age of 45.87±25.81 years. Summary statistics for patient scores on the APACHE II, GCS, SOFA, average duration of MV, and distribution of death by year are indicated in Table 1. Among the patient cohort, 959 patients (59.8%) were discharged from the ICU, while 646 patients (40.2%) experienced mortality during their ICU stay.

Table 1. Length of ICU stay, length of MV time, length of hospital stays, the average scores for ICU and distribution of mortality by year

		Min-Max	**Ort±SD**
Length of ICU stay (day) (n=1605)		1-201	10,51±17,26 (4)
Length of hospital stay (day) (n=1130)		1-239	9,57±14,45 (5)
Length of MV time (day) (n=1605)		1-193	6,96±12,35 (3)
APACHE II (n=1605)		2-37	18,26±6,87 (18)
SOFA (n=1605)		0-49	6,05±3,73 (6)
GCS (n=1605)		3-15	10,26±4,67 (11)
		n	%
Mortality (n=1605)	Discharged	959	59,8
	Died	646	40,2
Year (n=1605)	2007	153	9,5
	2008	606	37,8
	2009	560	34,9
	2010	286	17,8

When examining the days of ICU admission, significant differences in mortality rates were observed among different weekdays. In particular, patients admitted on Mondays and Wednesdays exhibited a significantly higher rate of discharge compared to mortality (p=0.037 and p=0.045, respectively). Conversely, for admissions on Saturdays, the mortality rate was 1.745 times greater (OR: 1.559, 95% CI: 1.161-2.203) than the discharge rate (p=0.004) (Table 2). There was a significant difference in the comparison of outcomes within the ICU between periods classified as "off hours" (p=0.001). Additionally, the risk of mortality was 6.033 times greater for ICU admissions occurring during "off hours" in comparison to those on "business hours" (OR: 6.033, 95% CI: 4.815-7.560). Moreover, a statistically significant variance was noted in the overall rates of death between admissions to the ICU on weekdays and weekends (p=0.005). Specifically, patients admitted during weekends exhibited a mortality rate 1.418 times higher than their weekday-admitted counterparts (OR: 1.418, 95% CI: 1.109-1.813) (Table 2).

Table 2. Mortality associated with day of admission

Admission Day	Mortality		*P*
	Discharged (n=959)	Died (n=646)	
	n (%)	n (%)	
Monday	158 (%16,5)	82 (%12,7)	*0,037**
Tuesday	153 (%16,0)	97 (%15,0)	*0,611*
Wednesday	180 (%18,8)	98 (%15,2)	*0,045**
Thursday	145 (%15,1)	100 (%15,5)	*0,884*
Friday	152 (%15,8)	117 (%18,1)	*0,234*
Saturday	83 (%8,7)	85 (%13,2)	*0,004***
Weekdays	788 (%82,2)	494 (%76,5)	*0,005***
Weekend	171 (%17,8)	152 (%23,5)	
Business hours	781 (%81,4)	272 (%42,1)	*0.001***
Off hours	178 (%18,6)	374 (%57,9)	

Pearson's chi-square test was used. *p < 0.05 **p < 0.01

No significant seasonal variations were identified in the context of ICU outcomes, specifically in terms of whether patients were discharged from the ICU or experienced mortality (p > 0.05) (Table 3).

Table 3. The seasonal distribution of the admission to the ICU and mortality assessment

Seasons	Mortality		*P*
	Discharged (n=959)	Died (n=646)	
	n (%)	n (%)	
Spring	243 (%25,3)	178 (%27,6)	*0,322*
Summer	204 (%21,3)	130 (%20,1)	*0,578*
Autumn	176 (%18,4)	136 (%21,1)	*0,603*
Winter	336 (%35,0)	202 (%31,3)	*0,117*

Pearson's chi-square test was used

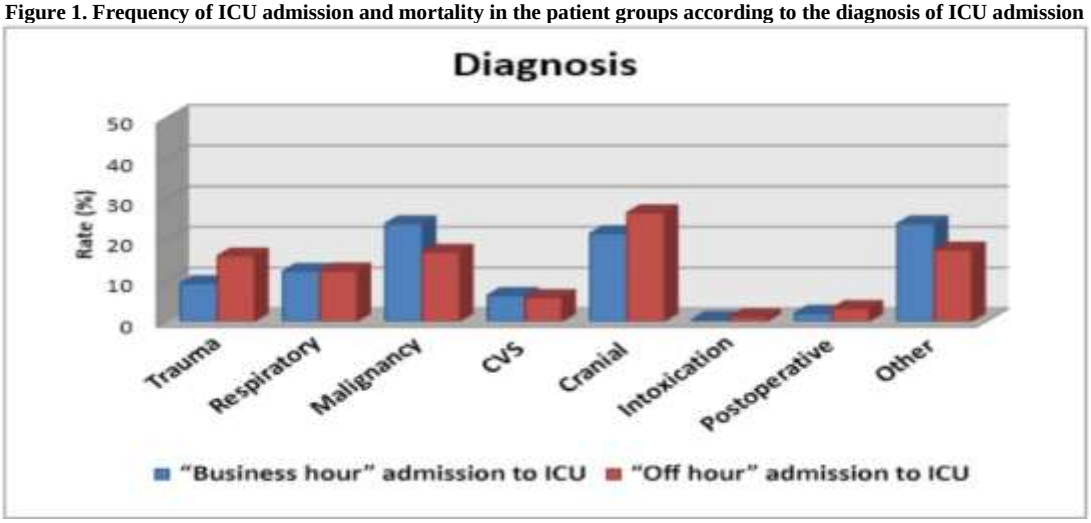
Table 4 provides an overview of the common attributes of patients who succumbed within the ICU. It was observed that hospital stays were notably prolonged for admissions occurring during "business hours" as compared to those during "off hours" (p < 0.05). Furthermore, there was a statistically significant difference between "business hours" and "off hours" admissions with regard to patient diagnoses. Significantly, admissions during "off hours" were characterized by a higher prevalence of trauma cases (p < 0.05). Conversely, diagnostic classifications including malignancies (p < 0.05), cardiovascular conditions (p < 0.01), and a range of other medical diseases (p < 0.01) demonstrated increased frequencies among patients admitted to the ICU during "business hours" (Fig. 1).

Table 4. Assessment of general characteristics of death cases according to admission times

Death cases (n=646)				*p*
		Businesshours (n=442)	Off hours (n=204)	
		Mean±SD (median)	Mean±SD (median)	
Age		52,42±23,99	55,53±23,21	[1]*0,118*
Length of ICU stay		11,23±15,47 (5,0)	10,90±17,34 (6,0)	[2]*0,917*
Length of hospital stay		11,07±14,06 (6,0)	7,38±13,13 (4,0)	[2]*0,015**
Length of MV stay		7,85±12,77 (4,0)	6,76±9,18 (4,0)	[2]*0,701*
APACHE 2		23,63±5,12 (24,0)	24,06±4,86 (25,0)	[2]*0,274*
SOFA		8,96±2,92 (9,0)	9,16±3,55 (9,0)	[2]*0,975*
GCS		7,82±4,76 (6,0)	8,01±4,50 (7,0)	[2]*0,478*
		n (%)	n (%)	[3]*p*
Sex	Male	116 (%56,9)	261 (%59,1)	*0,600*
	Female	88 (%43,1)	181 (%41,0)	
Tanı	Trauma	19 (%9,3)	71 (%16,1)	*0,021**
	Respiratory	25 (%12,3)	55 (%12,4)	*0,946*
	Malignency	49 (%24,0)	75 (%17,0)	*0,034**
	CVS	13 (%6,4)	26 (%5,9)	*0,005***
	Cranial	44 (%21,6)	118 (%26,7)	*0,162*
	İntoxication	1 (%0,5)	5 (%1,1)	*0,430*
	Postoperative	4 (%2,0)	14 (%3,2)	*0,386*
	Others	49 (%24,0)	78 (%17,6)	*0,001***

[1]Student t test [2]Mann-Whitney U test [3]Pearson Ki-Kare test
***p<0,05 **p<0,01**

Figure 1. Frequency of ICU admission and mortality in the patient groups according to the diagnosis of ICU admission



DISCUSSION

In this cohort study, we investigated the effects of ICU admission and discharge times on mortality using our hospital ICU database. Our study determined that ICU admissions during the weekend and 'off hours,' when compared to admissions on weekdays and 'business hours,' were associated with higher mortality rates. While patients admitted during 'business hours' exhibited similar discharge and death rates, those admitted during 'off hours' experienced a higher mortality rate compared to their discharge rate. These observations were not explained by disease severity, our results demonstrated that disease severity was not significantly different between the weekend and weekday admissions.

While the existing body of literature encompasses similar studies to our inquiry, it's worth noting that research into the determinants of ICU mortality in Turkey remains relatively limited, particularly in comparison to data from other nations. For example, Arslanköylü et al. reported no significant differences in mortality rates across various temporal admission intervals, including weekends versus weekdays and nighttime versus daytime hours [3].In contrast, our study unveiled noteworthy distinctions: specifically, patients admitted on Mondays and Wednesdays exhibited a significantly higher rate of discharge in comparison to their mortality rate, a pattern not observed for patients admitted on other days. Furthermore, our analysis discerned that the mortality rate for admissions to the ICU on Saturdays was 1.745 times greater than the rate of discharge. Some prior inquiries have linked weekend ICU admissions to elevated mortality rates, attributing these outcomes to factors such as a diminished physician-to-patient ratio, reduced availability of certified ICU personnel, fatigue, diagnoses, and challenges in accessing diagnostic and therapeutic resources, among other variables [4-6]. Importantly, our study findings align with the conclusions drawn from these earlier investigations. We categorized patients into two distinct cohorts according to their admission periods to the ICU, distinguishing between "business hours" and "off-hours." Among those admitted during "business hours," we noted a similar frequency of discharges and mortality. Conversely, for admissions during "off-hours," we observed an increased mortality rate compared to the rate of discharge.

The mortality rates were notably elevated for patients admitted to the ICU on Saturdays in comparison to patients admitted on other days, while, conversely, the mortality rates were comparatively lower for patients admitted on Mondays in contrast to patients admitted on different weekdays. These findings may be explicable through two interrelated factors. Firstly, patients admitted during "business hours"

predominantly presented with diagnoses characterized by clinical stability, necessitating minimal medical interventions. These diagnoses often included conditions such as malignancies and cardiovascular diseases. Conversely, during "off hours," the admissions primarily involved patients with unstable clinical conditions, particularly trauma patients, necessitating the involvement of multiple interventional teams and a multidisciplinary approach. Secondly, on weekdays, the ICU maintains an optimal staffing level, ensuring streamlined access to essential diagnostic and therapeutic equipment. In contrast, during weekends, a deficiency in the availability of adequately trained healthcare personnel becomes apparent, leading to challenges in access to essential diagnostic and treatment resources [7].

The primary reasons for ICU admission were categorized into predefined diagnostic categories. The prevalence of these seven distinct diagnostic classifications within our study cohort, stratified by admission timing, is detailed in Table 4. We conducted an examination to assess the correlations between the specific diagnoses and the temporal patterns of ICU admissions. Our results highlighted those cases related to trauma demonstrated a heightened frequency of ICU admissions during weekends in contrast to weekdays.

In the context of patient mortality, the initial hours following admission to the ICU are recognized as a critical period phase [8,9]. Disparities in the quality of care administered during " business hours" versus "off-hours" may affect the outcomes of patients [4,10]. In our investigation, we predominantly observed a heightened relative mortality rate among patients admitted during "off-hours," while those admitted during "business hours" generally exhibited a higher likelihood of discharge. Romo et al. assessed the association between gender and ICU mortality, noting that for individuals aged over 50, mortality rates were greater among women than men [11]. However, these researchers did not observe any correlation between gender disparities and elevated mortality among younger age cohorts. In our study, we found no differences in mortality between men and women within either the "off-hours" or "business hours" groups.

In contrast to prevailing research in the literature, the results of our cohort investigation scrutinized the potential connection between mortality rates and the seasonal patterns of patient admissions to the ICU. Notably, our observations revealed that the winter season experienced the highest frequency of ICU admissions and discharges, while conversely, the fall season demonstrated the lowest rates of both ICU admissions and discharges. However, it is noteworthy that the season of ICU admission did not display a statistically significant correlation with mortality outcomes [12]. In our research, we investigated disease severity using three established scoring systems and our patient cohort exhibited mean APACHE II, SOFA, and GCS scores of 18.26±6.87, 6.05±3.73, and 10.26±4.67, respectively. To provide context, when comparing these scores with those reported in previous studies evaluating ICU patients, Amin et al. conducted research in a 22-bed surgical oncology ICU and documented a mean APACHE II score of 12.11 among the admitted patients [13]. In another investigation by Uysal et al., the mean APACHE II score for patients was 19.5±9.6 [14]. Notably, these two reference values align closely with the scores observed in our research. We detected no statistically significant differences between weekend and weekday admissions when considering these three disease severity scores of patients who died. This observation suggests that the severity of illness, as quantified by these scoring systems, did not exhibit significant difference between weekend and weekday admissions. Moreover, our statistical analysis revealed that the timing of patient admission during distinct seasons exhibited no statistically significant correlation with mortality outcomes.

CONCLUSION

In conclusion, our study found that admissions to the ICU during the weekend and off hours, as compared to those admissions on weekdays and during 'business hours,' are associated with increased mortality. Whether this phenomenon is attributable to the more effective management of trauma patient admissions to the ICU during standard working hours as opposed to off-hours necessitates additional investigation. Nonetheless, it should be noted that incomplete adjustments for specific confounding variables may still exert a significant influence on the interpretation of these findings. Whether mortality could be higher for admissions during off hours compared with admissions during day shifts requires additional studies.

Declaration by Authors

Ethical Approval: Approved
Acknowledgement: None
Source of Funding: None
Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Nyman DJ, Sprung CL. International perspectives on ethics in critical care. Crit Care Clin 1997; 13: 409–15.
2. Andrew B, Egol R, Fromm E. Consensus statement on the triage of critically ill patients. Society of Critical Care Medicine Ethics Committee. JAMA 1994; 271: 1200–3.
3. Arslankoylu AE, Bayrakci B, Oymak Y. Admission time and mortality rates. Indian J Pediatr 2008; 75: 691–2.
4. Ensminger SA, Morales IJ, Peters SG, Keegan MT, Finkielman JD, Lymp JF, et al. The hospital mortality of patients admitted to the ICU on weekends. Chest 2004; 126: 1292–8.
5. Sheu CC, Tsai JR, Hung JY, Yang CJ, Hung HC, Chong IW, et al. Admission time and outcomes of patients in a medical intensive care unit. Kaohsiung J Med Sci 2007; 23: 395–404.
6. Uusaro A, Kari A, Ruokonen E. The effects of ICU admission and discharge times on mortality in Finland. Intensive Care Med 2003; 29: 2144–8.
7. Needleman J, Buerhaus P, Pankratz VS, Leibson CL, Stevens SR, Harris M. Nurse staffing and inpatient hospital mortality. N Engl J Med 2011; 364: 1037–45.
8. Pearse RM, Rhodes A, Grounds RM. Clinical review: how to optimize management of high-risk surgical patients. Crit Care 2004; 8: 503–7.
9. Rivers E, Nguyen B, Havstad S, Ressler J, Muzzin A, Knoblich B et al. Early goal directed therapy in the treatment of severe Sepsis and Septic shock. N Engl J Med 2001;345: 1368–77.
10. Bell CM, Redelmeier DA. Mortality among patients admitted to hospitals on weekends as compared with weekdays. N Engl J Med 2001; 345: 663–8.
11. Romo H, Amaral AC, Vincent JL. Effect of patient sex on intensive care unit survival. Arch Intern Med 2004; 164: 61–5.
12. Brims FJ, Asiimwe A, Andrews NP, Prytherch D, Higgins BR, Kilburn S, et al. Weekend admission and mortality from acute exacerbations of chronic obstructive pulmonary disease in winter. Clin Med 2011; 11: 334–9.
13. Amin N, Divatia J, Agarwal V, Kulkarni A. Readmissions in a surgical intensive care unit: patient characteristics and outcome. Indian J Crit Care Med 2003; 7: 14–7.
14. Uysal N, Gündoğdu N, Borekci S, Dikensoy O, Bayram N, Uyar M, et al. Yoğun bakım hastalarının prognozu. Turkish J Med Surg Intensive Care Med 2010; 1: 1–5.

How to cite this article: Omer Tasargol, Elif Bombaci, Serkan Tulgar, Serhan Colakoglu, Zeynep Tasargol, Halil Cihan Kose et.al. The Effects of Intensive Care Unit Admission Time on Mortality. *International Journal of Research and Review*. 2023; 10(10):161-167. DOI: *https://doi.org/10.52403/ijrr.20231021*

******