Relationship between Mortality and the Timing of Admission to Intensive Care Units

O Tasargol[1], E Bombaci[2], S Tulgar[3], S Colakoglu[2], Z Tasargol[4], HC Kose[2], I Uzun[2]

ABSTRACT

Objectives: The objective of this study was to assess the effect of the timing of intensive care unit (ICU) admissions ("off hours" or "business hours") on patients' subsequent risk of death.

Methods: This study was conducted at the Dr. Lutfi Kirdar Kartal Training and Research Hospital in Turkey. We retrospectively analyzed the mortality rates of 1605 patients treated between January 2007 and December 2010 according to their ICU admission times and outcomes (discharged from or died in the ICU). All patients admitted to one of the hospital's ICUs during this four-year period were evaluated, with no exclusion criteria applied. The primary outcome measures included the time of admission and the discharge and mortality rates. In this study, "business hours" referred to 8:00-16:59 on weekdays, whereas "off hours" referred to 17:00-07:59 on weekdays and weekends (from 00:00 Saturday to 23:59 Sunday).

Results: Mortality rates were significantly lower among the patients admitted on Mondays and Wednesdays compared to the other patients (p=0.037 and p=0.045, respectively). Among the patients admitted to the ICU on Saturdays, the mortality rate was higher than the discharge rate (p=0.004). The risk of death was higher for the patients admitted on weekends compared to the patients admitted on weekdays (p=0.005). In this study, a significant relationship between time of admission and mortality was observed.

Conclusions: Our study suggests that patients admitted to the ICU over the weekend and during "off hours" have a higher mortality risk compared to patients admitted on weekdays during "business hours".

Keywords: Intensive care unit, mortality rate, time of admission

From: [1]Department of Anesthesiology and Reanimation, Dr. Burhan Nalbantoglu State Hospital, Nicosia/Cyprus, [2]Department of Anesthesiology and Reanimation, Dr. Lutfi Kirdar Kartal Training and Research Hospital, Semsi Denizer Cad. E-5 Karayolu Cevizli Mevkii 34890 Kartal / Istanbul, Turkey, [3]Department of Anesthesiology and Reanimation, Maltepe University Hospital / Istanbul, Turkey, and [4]Department of Gynecology and Opstetric, Dr. Burhan Nalbantoglu State Hospital, Nicosia / Cyprus.

Correspondence: Dr O Tasargol, Department of Anesthesiology and Reanimation, Dr Burhan Nalbantoglu State Hospital, Nicosia, Cyprus, Fax: +90 392 227 15 65,
e-mail: omertasargol@yahoo.com

INTRODUCTİON

Intensive care units (ICUs) treat patients with serious functional disorders of one or more organs or organ systems, utilize specific spaces and intervention procedures, are equipped with advanced technology and closely follow patients' vital signs and treatment responses for 24 hours.

Factors affecting ICU admission and discharge include disease consequences, available treatment facilities, the effects of treatment on potential disease consequences, the benefits and drawbacks of therapy, the views of the patient's family and the ICU's strategy (1–3). ICUs remain operational 24 hours a day. Similar to other units, ICUs have extremely limited numbers of team staff members during weekends and "off hours". During these times, various types of equipment may not be readily accessible; consequently, certain diagnostic and therapeutic interventions may be prolonged during "off hours" or may be postponed until regular working hours. Other studies assessing the relationship between the time of ICU admission and mortality have observed a relationship between ICU admission on weekends or during "off hours" and increased mortality rates (4–6). Because no prior studies have addressed this topic in Turkey, we sought to determine whether this relationship exists in a Turkish ICU.

In this retrospective study, the length of ICU stay, mechanical ventilation (MV) duration, and the effects of ICU admission timing on patients' subsequent risk of death were investigated.

METHODS

A total of 1605 patients admitted to two ICUs (one ICU with 15 beds and one ICU with 10 beds) at Dr. Lutfi Kirdar Kartal Training and Research Hospital in Turkey between January 2007 and

December 2010 were retrospectively evaluated. Over this four-year period, all patients admitted to these ICUs were analyzed, with no exclusion criteria applied. This study was approved by the hospital's regional research ethics committee.

Data collection

The data pertaining to the ICU patients were retrospectively assessed from the hospital records and database files. Concomitant diseases, indications and ICU stay results were examined. The data collected included demographic information, the Acute Physiology and Chronic Health Evaluation II (APACHE II), Glasgow Coma Scale (GCS) and Sequential Organ Failure Assessment (SOFA) scores, the day, year and season of ICU admission, the general distributions of times of admissions to and discharges from the ICU, length of ICU stay, mechanical ventilation (MV) duration, ICU admission timing (during "business hours" or "off hours" and weekdays or weekends) relative to ICU outcomes (discharged from or died in the ICU) and the relationship between mortality and ICU hospitalization days.

"Business hours" were defined as the time between 8:00 and 17:00 on weekdays. "Off hours" were defined as weekends and the hours between 17:01 and 7:59 on weekdays.

Statistical analysis

Regarding the assessment of the data obtained in the study, NCSS (Number Cruncher Statistical System) 2007 (NCSS, LLC, East Kaysville, Utah, USA) and PASS (Power Analysis and Sample Size) 2008 statistical software (NCSS, LLC, East Kaysville, Utah, USA) were used. For the analyses of quantitative data and descriptive statistics (means and standard deviations), Student's t-test was used for intergroup comparisons of normally distributed parameters, whereas the Mann-Whitney U test was used for intergroup comparisons of non-normally distributed parameters. The Pearson chi-square test was used for intergroup comparisons of categorical parameters. Differences with $p<0.05$ were regarded as statistically significant.

RESULTS

A total of 1605 patients were included in this study; 883 patients (55%) were male and 722 patients (45%) were female. The patients' ages ranged from 1 month to 104 years, with an average of 45.87±25.81 years. The patients' APACHE II, GCS, and average SOFA scores, mean MV duration and mortality distribution by year are summarized in Table 1. In total, 959 patients (59.8%) were discharged from the ICU, whereas 646 patients (40.2%) died.

Analysis of the ICU admission days demonstrated significant differences in the mortality rates for different ICU admission days. Among patients admitted on Mondays and Wednesdays, the discharge rate was significantly higher than the mortality rate (Table 2, p=0.037 and p=0.045, respectively). Among patients admitted on Saturdays, the mortality rate was 1.745 times higher (odds ratio: 1.559, 95% CI: 1.161-2.203) than the discharge rate (Table 2, p=0.004). A significant difference between the discharge and mortality rates was observed for ICU outcomes during “off hours” (Table 2, p=0.001); moreover, the risk of death was 6.033 times higher for “off hours” ICU admissions than for ICU admissions during “business hours” (odds ratio: 6.033, 95% CI: 4.815-7.560) (Table 2).

We observed a significant difference between the overall mortality rates for patients admitted to the ICU on weekdays and patients admitted to the ICU on weekends (Table 2, p=0.005). In particular, the mortality rate for patients admitted on weekends was 1.418 times higher than the mortality rate for patients admitted on weekdays (odds ratio: 1.418, 95% CI: 1.109-1.813) (Table 2).

We observed no significant seasonal differences with respect to ICU outcomes (i.e., whether patients were discharged from or died in the ICU) ($p > 0.05$) (Table 3).

The general characteristics of the patients who died in the ICU are summarized in Table 4. We observed that hospital stays were significantly longer for “business hours” admissions than for “off hours” admissions ($p < 0.05$). A statistical difference was also observed between “business hours” and “off hours” admissions with respect to patient diagnoses. Notably, trauma patients were significantly more frequent among “off hours” ICU admissions ($p < 0.05$), whereas the diagnostic frequencies of malignancy ($p < 0.05$), cardiovascular system diseases ($p < 0.01$) and other conditions ($p<0.01$) were significantly higher among “business hours” ICU admissions (Fig. 1).

DISCUSSION

Although the literature includes studies that are similar to our investigation, relatively few studies have addressed the factors affecting ICU mortality in Turkey in relation to other countries. Specifically, Arslanköylü *et al*. observed no significant differences in mortality rates among patients admitted to the ICU at different times [based on comparisons between weekends and weekdays and between nighttime and daytime hours] (3). However, in our study the discharge rate was significantly higher than the mortality rate for patients admitted to the ICU on Mondays and Wednesdays but not for patients admitted on other days. Additionally, the death rate was 1.745 times higher for patients admitted to the ICU on Saturdays than the discharge rate.

In certain studies, weekend admissions to the ICU have been associated with increased mortality rates. These elevated mortality rates have been linked to a reduced physician:patient ratio, fewer staff certified in intensive care, physician fatigue, complex diagnoses, and difficulty accessing diagnostic and treatment modalities, among other factors (4–6). Our study findings were consistent with the results of these studies. In our study, we classified patients into two groups based on the ICU admission time ("business hours" and "off hours"). Among patients admitted during "business hours", the discharge and death rates were similar; however, among patients admitted during "off hours", the mortality rate was higher than the discharge rate.

The mortality rates were significantly higher among patients admitted to the ICU on Saturdays than the rates for patients admitted on other days, whereas the mortality rates were lower among patients admitted to the ICU on Mondays than those of other patients. We believe that these results may be attributed to two related factors. First, the patients admitted during "business hours" were primarily diagnosed with stable diseases that required minimal intervention such as malignancies and cardiovascular system diseases. By contrast, during "off hours", unstable cases such as trauma patients who require many interventional teams and a multidisciplinary approach were admitted to the ICU. Second, on weekdays, the ICU is sufficiently staffed, and the necessary diagnostic and treatment equipment may be easily accessed. However, on weekends, inadequate numbers of qualified staff are available, and diagnostic and treatment equipment may be difficult to access (7).

The cases examined in our study were distributed as follows: 266 cases (16.6%) of trauma, 176 cases (11%) of respiratory insufficiency, 265 cases (16.5%) of malignancy, 58 cases (3.6%) of cardiovascular disease, 291 cases (18.1%) of cranial disease, 184 cases (11.5%) of intoxication, 141 cases (8.8%) involving postoperative patients, and 224 other cases (14.0%). We evaluated the relationships between the types of cases and the ICU admission days and observed that trauma cases were more frequently admitted to the ICU during weekends than during weekdays.

With respect to patient mortality, the first few hours following an ICU admission are more critical than subsequent periods (8, 9). Differences in the quality of care provided during “business hours” and “off hours” may be reflected in patients’ final outcomes (4, 10). In our study, the relative mortality was primarily higher among the patients admitted during “off hours”, whereas the patients admitted during “business hours” were generally more likely to be discharged.

Romo *et al* evaluated the relationship between gender differences and ICU mortality and noted that for individuals older than 50, mortality was higher among women than men (11). However, these investigators observed no correlation between gender differences and increased mortality in younger age groups. In our study, men and women exhibited no differences in mortality in either the “off hours” or the “business hours” groups.

In contrast to other studies in the literature, our study examined whether mortality rates were associated with the seasonal admission of patients to the ICU. The highest admission and discharge rates were observed during winter, whereas the lowest admission and discharge rates were observed during fall; however, the season of ICU admission did not correlate with mortality (12).

In our study, disease severity was assessed using APACHE II, SOFA and GCS scores. The patients’ mean APACHE II, SOFA, and GCS scores were 18.26±6.87, 6.05±3.73, and 10.26±4.67, respectively. With respect to other studies that have used these scoring systems to evaluate ICU patients, Amin *et al*. studied patients treated in a 22-bed surgical oncology ICU and observed that the mean APACHE II score of the admitted patients was 12.11 (13). In a study by Uysal *et al*., the patients' mean APACHE II score was 19.5±9.6 (14). These two aforementioned values are similar to the APACHE II scores in our study. We observed no significant differences between weekend and weekday admissions with respect to the APACHE II, SOFA and GCS scores of the patients who died. This finding suggests that illness severity alone was not significantly different between the weekend and weekday admissions. Additionally, our statistical analysis revealed that the season of patient admission was unrelated to mortality.

CONCLUSİON

As a result, our study suggests that patients admitted to the ICU over the weekend and during "off hours" have a higher risk of dying than those admitted on weekdays and during "business hours". Whether this is because trauma patient admissions to the ICU were managed more optimally during routine working hours than during "off hours" will require further investigation. However, incomplete adjustments for certain confounders may still play an important role in interpreting these results. Further studies are needed to fully explain this disparity.

AUTHORS' NOTE

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O Tasargol conceived paper, oversaw data collection, conducted data analysis, wrote manuscript and approved final version. E Bombaci participated in study design, data analysis and interpretation, critically revised manuscript and approved final version. S Tulgar participated in study design, data analysis, and interpretation of data and revision of manuscript and approved final version. S Colakoglu participated in study design, interpretation of data and revision of manuscript and approved final version. Z Tasargol participated in study design and interpretation of data; critically revised manuscript and approved final version. HC Kose participated in study design and interpretation of data, critically revised manuscript and approved final version. I Uzun provided oversight to study, participated in data interpretation and revision of manuscript, and approved final version. The authors declare that they have no conflicts of interest.

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

		Min-Max	Mean ± 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

Table 2: Mortality associated with day of admission

	Mortality		
Days of admission	**Discharged (n = 59)**	**Died (n = 646)**	***p***
	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*****
Sunday	88 (%9.2)	67 (%10.4)	***0.427***
Weekdays	788(%82.2)	494(%76.5)	
Weekend	171(%17.8)	152(%23.5)	***0.005*****
Hours	781(%81.4)	272(%42.1)	
Off hours	178(%18.6)	374(%57.9)	***0.001*****

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

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

Seasons	**Mortality** Discharged (n = 959) n (%)	Died (n = 646) n (%)	***p***
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: Assessment of general characteristics of death cases according to admission times

Death cases (n=646)		Admission Hours (n=442) Mean ± SD (median)	Off hours (n=204) Mean ± SD (median)	*P*
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 time		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***
Gender	**Male**	116 (56.9%)	261 (59.1%)	***0.600***
	Female	88 (43.1%)	181 (41.0%)	
Diagnosis	**Trauma**	19 (9.3%)	71 (16.1%)	***0.021****
	Respiratory	25 (12.3%)	55 (12.4%)	***0.946***
	Malignancy	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***
	Intoxication	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's chi-square test*

* *p<0.05*   ***p<0.01*

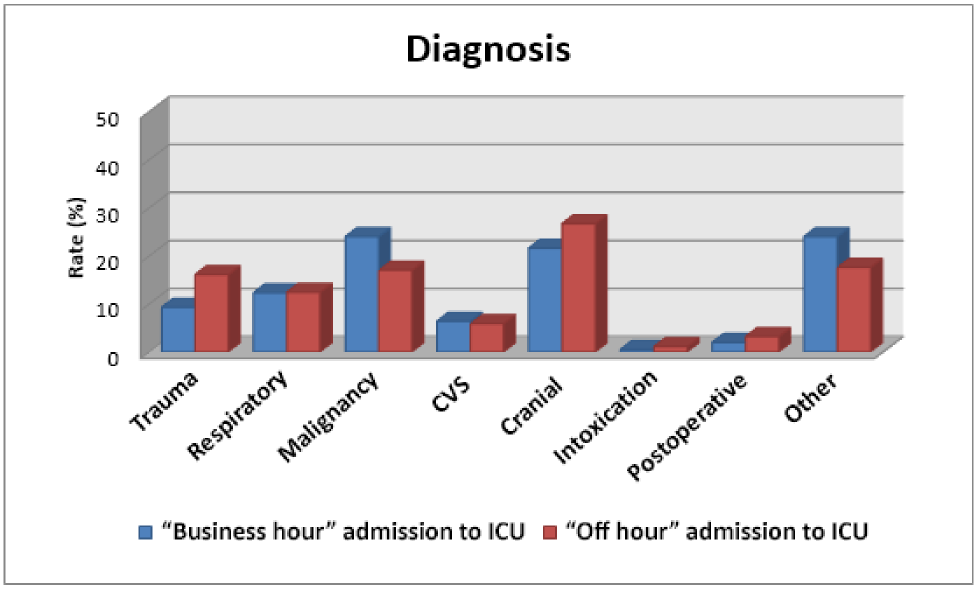

Figure: Frequency of ICU admission and mortality in the patient groups according to the diagnosis of ICU admission.