Brief Communication

Assessing the Performance of a Medical Intensive Care Unit: A 5-year single-center Experience

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Abstract

Patient care in the Intensive Care Unit (ICU) is complex and expensive, serving to provide optimal outcome as well as the adequate use of resources. Our objective was to determine variables associated with admission practices, processes of care, and clinical outcomes for critically ill patients. Admission records of a 10-bed ICU were gathered during a 5-year period. Variables such as average length of stay, bed turnover, bed occupancy rate, and turnover interval were evaluated. Of the 1719 patients evaluated, 54% were men. Mortality was highest between 10 pm and 2 am. There was no significant difference in ICU mortality during different days of the week. We showed that nonoffice hour admissions were not associated with poorer clinical outcomes, and significant differences in ICU mortality and ICU length of stay were not seen. Moreover, hospital mortality rates were not significantly higher for patients admitted to our ICU on weekends, at nights, or any day of the week.

Keywords: Intensive Care Unit, mortality, performance

Introduction

The Intensive Care Unit (ICU) is a place where physicians and nurses provide continuous monitoring and life support care. Despite improving patients' outcomes, there is still a relatively high mortality rate in ICU ward. Patient care in the ICU is complex and has high costs. The care of patients should ultimately serve as to provide optimal outcome as well as the adequate use of resources.

In addition, length of stay standardized for severity and type of illness and unplanned readmission rates are important outcomes; the classic outcome variable is mortality rate. The costs per surviving patient could also be an extremely important outcome variable.

The appropriate timelines of care and availability of complex tests and therapy are even more important in the first hours after admission to an ICU, when patients are more likely to be unstable and require extreme resuscitative measures. Although admission of patients who are unstable to ICUs occurs 24 h a day, not all ICUs maintain the same level of staffing during off-hours, that is, during nighttime, weekends, and holidays. A number of studies have demonstrated that ICUs with mandatory intensivist consultation or closed ICU are associated with reduced mortality when compared with units with low-intensity physician staffing.[1]

Patients admitted in ICUs during off-hours may face worse outcomes. Several cohorts have shown an increased risk of death for patients admitted during off-hours,[2,3] while others showed a surprising protective effect.[4,5]

Among various approaches, Pabon Lasso's (PL) model has proved itself to be one of the most useful models in assessing performance in patient health services. This model makes an overall assessment of hospital performance with the use of three indices; bed turnover (BTO), bed occupancy rate (BOR), and average length of stay (ALS).[6]

Our objective was to compare different variables concerning ICU performance and mortality to optimize ICU performance and patient care.

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Case Report

From March 2008 to March 2012, all admission records of 10-bed medical ICU of a teaching general hospital with 358 beds[7] were retrieved from hospital information system (HIS). The outputs of HIS included the chart and card numbers, age, gender, date of admission and discharge, and outcome. To evaluate the ICU performance during this 5-year period, we calculated the ALS, BTO, BOR, and turnover interval (TI) through the following definitions and formula. ALS refers to the average number of days that a patient stays in a hospital. It is calculated by dividing the inpatient days to the number of admissions. BTO is a measure of productivity hospital beds and represents the number of patients treated per bed in a defined period of time (usually a year). We calculated this index by dividing total admissions into the number of beds. BOR indicates the percentage of beds occupied by patients in a defined period of time, usually a year. BOR = 100 × (ALS × admissions/number of beds × 365). TI is a measure that is related to the BTO. It measures the average time that beds are unoccupied between successive patients. TI = (365/BTO) − ALS.

PL technique provides a graphical method that makes use of the three indicators (BTO, BOR, and ALS) concurrently in assessing the relative performance of hospital wards.[6] According to Figure 1, the horizontal and vertical demarcations represent the mean values of the BTO ratio and 70% BOR based on the standard of Iranian Ministry of Health.[8]

All data were analyzed by the Statistical Package for the Social Sciences software version 11.5 (SPSS Inc., Chicago, IL, USA). Continuous data are presented as mean ± standard deviation (SD). Proportions are presented as number (%). Comparisons between groups were analyzed using unpaired two-tailed *t*-test, Mann–Whitney test, Chi-square test, or Fisher's exact test as appropriate. Statistical significance was defined as $P < 0.05$.

A total of 1719 patients were studied from March 2008 to March 2012. The mean ± SD (median) of age and length of ICU stay were 44.28 ± 21 (40) and 9.16 ± 12.9 (4.65), respectively. More men were admitted in our medical ICU than women (54% vs. 46%). The overall mortality rate was 29.1% during the period of study [Table 1]. As shown in Figure 2, the peak of admission was between 10 pm and 4 am and the least was between 6 am to 8 am and 9 am to 11 am that could be explained by the shifting time of nursing staffs. Mortality was highest between 10 pm and 2 am. There was no significant difference in ICU mortality during different days of the week. Figure 3 shows admissions on different days of the week, with the highest admission rate on Wednesdays.

PL's graph of ICU performance showed an ascending trend from 2008 to 2010, and then it became flat to descending during 2011–2012 [Figure 4]. While during 2008–2010, the slope of the median of ICU stay increased slowly it has had sharp increment in 2012 and subsequently our medical ICU accepted fewer patients with higher occupancy rate than 2008–2011 [Table 2].

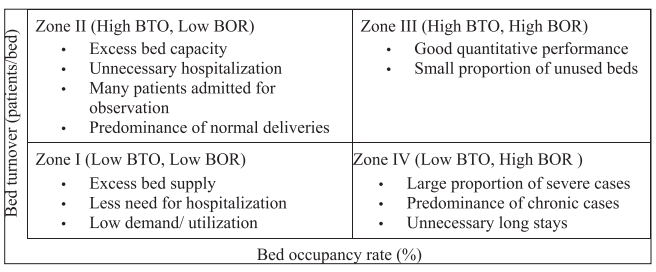

Figure 1: The Pabon Lasso's model and the interpretation of each zone (BTO; Bed turnover, BOR; Occupancy rate).

Discussion

Our study showed that nonoffice hour ICU admissions were not associated with poorer outcomes. There were no significant

Table 1: Mean length of stay, age, and time of admission of patients based on outcome in a medical Intensive Care Unit of a teaching hospital, Shiraz, Iran, 2008-2012

	Expired	Survived	*P*
Length of stay (days)	9.19±13	9.07±11	0.870
Age (year)	50.3±21	41.7±20	<0.001
Admission			
Holiday	98 (28.4)	247 (71.6)	0.791
Workday	403 (29.3)	971 (70.7)	
Sex			
Men	269 (28.9)	663 (71.1)	0.790
Women	239 (29.5)	555 (70.5)	
Time of admission (h)			
7.00-13.00	53 (26.5)	147 (73.5)	0.663
13.00-21.00	171 (29.8)	402 (70.2)	
21.00-7.00	277 (29.3)	669 (70.7)	

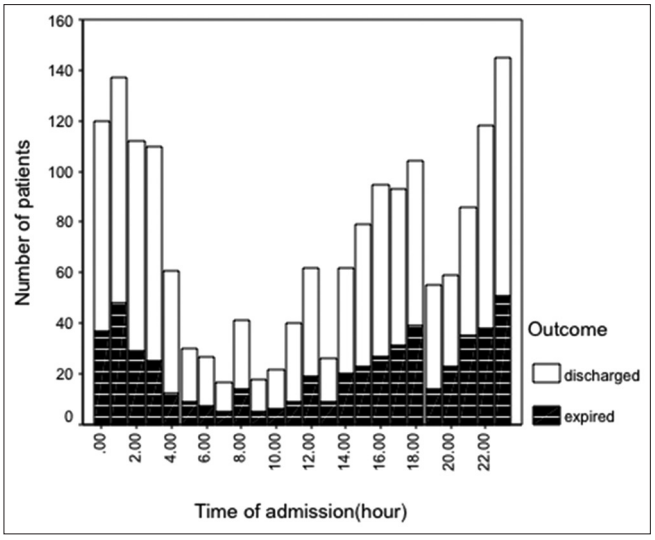

Figure 2: The frequency and distribution of admissions and mortality based on time of admission in a medical Intensive Care Unit of a teaching hospital, Shiraz, Iran, 2008–2012.

differences in ICU mortality and length of stay between patients admitted during office hours and nonoffice hours. Moreover, statistical analyses showed that hospital mortality rates were not significantly higher on weekends, at night, or any day of the week. This implies that our ICU had a good quantitative performance 24 h a day, 7 days a week.

Our study showed that 20.1% of ICU admissions occurred during weekends and 55% during nights (21:00–7:00). As a result, a remarkably high proportion (75.1%) of patients was admitted during nonoffice hours. Other studies have reported similar findings where 65.6%–69% of ICU admissions occurred during weekends or at night.[9] Appropriate management during the first few hours after admission in the ICU is crucial for the clinical outcomes of critically ill patients; it is very important to maintain a good quantitative performance during nonoffice hours.

The 2003 Society of Critical Care Medicine guidelines for adult ICUs have recommended a 24-h in-house coverage by intensivists who are dedicated to the care of ICU patients and do not have conflicting responsibilities.[10]

Although the differences were not significant, the rate of hospital death was lower for patients admitted to the ICU at night (14.1%), compared to those admitted during the day (15%) ($P = 0.417$). Mortality was also higher during nonoffice hours during the day (13:00–21:00) compared with office hours (7:00–13:00). On the other hand, the rate of hospital death was not higher for patients admitted to the ICU on weekends (5.7%), compared with those admitted on weekdays (23.4%) ($P = 0.735$). These results could be related to the staffing pattern in our ICU where resident physicians and critical care nurses staffed the ICU in-house at constant levels every day of the week and 24 h a day, while dedicated intensivists led the morning rounds on every day of the week but did not stay in-house overnight. We had fewer ICU admissions (20.1%) and no conferences or classes on weekends. With the same staffing levels, the lighter workload might have resulted in better patient care and therefore, lower hospital mortality for patients admitted on weekends.

Table 2 shows BTO, length of stay, and occupancy in our ICU throughout the 5 years of our study. According to PL's model, except for 2012, our ICU was in zone III, with a high BTO rate and a high occupancy [Figure 4]. Although the aging of population and increases in underlying comorbidities in community could prolong ICU stay, we think the main explanation for decrement in BTO in 2012 was due to changes in intensivist's team controlling ICU admissions and management. During 2008–2010, four pulmonologists were in charge for patients' admission and their management,

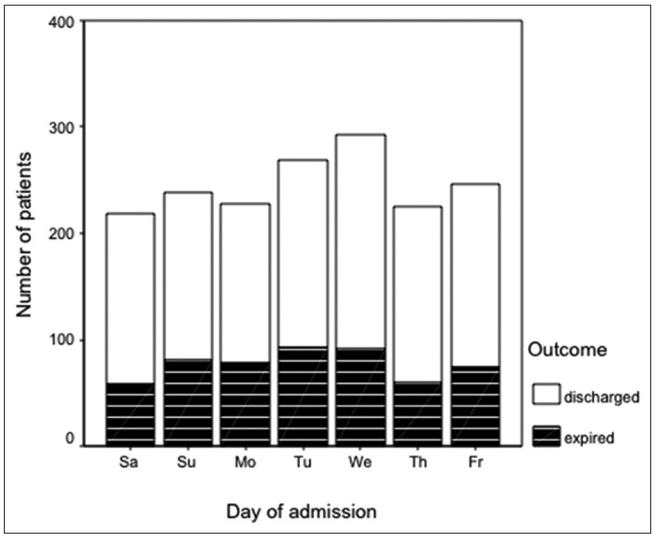

Figure 3: The frequency and distribution of admissions and mortality based on day of the week of admission to a medical ICU of a teaching hospital, Shiraz, Iran, 2008–2012.

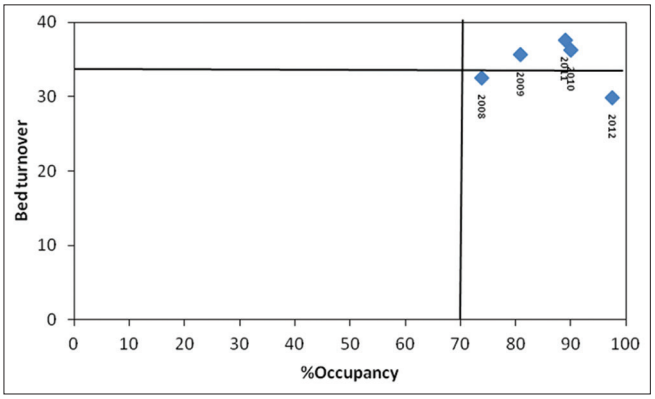

Figure 4: The status of the medical Intensive Care Unit of Shahid Faghihi Hospital, Shiraz, Iran, based on Pabon Lasso's Model 2008–2012.

Table 2: Data on the performance indicator of a medical Intensive Care Unit in a teaching hospital, Shiraz, Iran, 2008-2012

Year	Total number	Men (%)	Mean±SD (median)		Bed turnover	Occupancy (%)	Turnover interval (days)	Mortality (%)
			Length of stay (days)	Age (years)				
2008	331	54.4	8.58±12.6 (3.84)	42.47±21 (38)	32.50	73.92	2.93	23.3
2009	357	54.1	8.36±9.6 (4.60)	44.31±21 (40)	35.60	80.89	1.96	25.8
2010	362	56.1	9.01±13.5 (4.86)	44.65±21 (42)	36.30	90.00	1.01	36.7
2011	377	51.2	8.55±9.9 (4.72)	45.52±21 (42)	37.60	89.01	1.07	31.6
2012	292	55.8	11.76±17.9 (5.47)	44.22±20 (38)	29.90	97.50	0.31	27.4
Total	1719	54.2	9.16±12.9 (4.65)	44.28±21 (40)	34.38	86.28	1.46	29.1

SD: Standard deviation

while during 2011–2012, two of them retired and two newly graduated pulmonologists were involved. Nevertheless, we had an acceptable quantitative performance in our ICU with a small proportion of unused beds.

While HIS was started in late 2007 in our hospital, the clinical information system (CIS) section has not been accepted by our physicians. Hence, data regarding the underlying comorbidities and APACHE scores were not available and we could not exactly compare the severity of diseases among our patients during the study period. Another limitation was that our study was single centered and based on a university hospital.

In conclusion, our results showed that nonoffice hour ICU admissions were not associated with poorer outcomes in a medical ICU equipped with patient management guidelines and staffed by intensivists who were on-call for 24 h and led the morning rounds on every day of the week, but did not stay in-house overnight. Moreover, the time of day and day of the week admissions to our ICU were not associated with significant differences in hospital mortality.

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Conflicts of interest

There are no conflicts of interest.

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