Characteristics, Outcomes and Costs of Prolonged Stay ICU Patients

Yoğun Bakımda Uzun Yatan Hastaların Özellikleri, Sonuçları ve Maliyetleri

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Abstract

Aim: Prolonged stay in the intensive care unit (ICU) is associated with high mortality, morbidity and costs. Understanding the characteristics of prolonged stay ICU patients would be helpful, particularly if some factors could be modified or used in making clinical decisions. The objective of this study was to evaluate the characteristics, outcomes and cost of ICU patients with a prolonged stay (≥21 days).

Materials and Methods: This retrospective study was performed in our nine-bed adult medical ICU in Gazi University Hospital. Patient data from our local database were analysed. Data were collected between April 1, 2007 and April 1, 2009. Patients with an ICU stay ≥21 days formed the study group.

Results: A total of 72 patients met the inclusion criteria, with a mean age of 65.9±16.29 years (median: 70.5 years; min: 21 years; max: 91 years), mean ICU stay of 36.96±20.58 days (median: 30 days; min: 21days; max: 102 days) and ICU mortality of 69.5%. They accounted for 9.23% of total admissions. Intubation, reintubation, catheter insertion, catheter complications, mechanical ventilation, vasopressor support, additional investigations and procedures, changing antibiotics frequently and using expensive antibiotics had a significant association with prolonged ICU stay and costs.

Conclusion: Patients with prolonged ICU stay form a small proportion of ICU patients, yet they consume a significant proportion of ICU resources. Studies identifying factors associated with prolonged length of stay can be used in targeting this group to improve resource utilisation and the efficiency of ICU care. (Yoğun Bakım Derg 2011; 3: 53-8)

Key words: Prolonged ICU stay, characteristics, outcome, cost

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Özet

Amaç: Yoğun bakım ünitesinde (YBÜ) uzun yatış, artmış mortalite, morbidite ve maliyet ile birlikte gider. YBÜ'de uzun yatan hastaların özelliklerinin anlaşılması; neden olan bazı faktörlerin düzeltilebilmesi ve hastalar hakkında karar verilmesi aşamasında kullanılırsa yararlı olabilir. Bu çalışmanın amacı YBÜ'de uzun süreli yatan hastaların (≥21 gün) özelliklerinin, sonuçlarının ve maliyetlerinin belirlenmesidir.

Gereç ve Yöntemler: Bu retrospektif çalışma Gazi Üniversitesi Hastanesi 9 yataklı İç Hastalıkları YBÜ'de yapılmıştır. Lokal veri sistemimiz üzerinden alınan hasta verileri analiz edilmiştir. 1 Nisan 2007-1 Nisan 2009 tarihleri arasında veriler toplanmıştır. YBÜ'de 21 gün ve üstünde yatan hastalar çalışma grubunu oluşturmuştur.

Bulgular: Toplam 72 hasta çalışma kriterlerini karşılamıştır, yaş ortalaması 65.9±16.29 yıl (median: 70.5 yıl; min: 21 yıl-max: 91 yıl), YBÜ'de ortalama kalış süreleri 36.96±20.58 gün (median: 30 gün; min: 21 gün-max: 102 gün) ve YBÜ mortalitesi ise %69.5'dir. Bu hasta grubu toplam yatan hastaların %9.23'ünü oluşturmaktadır. Entübasyon, reentübasyon, kateter yerleştirilmesi, kateter komplikasyonu gelişmesi, mekanik ventilasyon uygulanması, hemodinamik destek tedavisi verilmesi, ek işlem veya tetkik yapılması, sık antibiyotik değişikliği yapılması, pahalı antibiyotiklerin kullanılması uzamış yoğun bakım yatışı ve artmış maliyet ile birlikte gitmektedir.

Sonuç: YBÜ'de uzun yatan hastalar yoğun bakım yatışlarının küçük bir kısmını oluşturmakla birlikte, yoğun bakım kaynaklarının büyük kısmını tüketmektedir. YBÜ'de uzun yatan hastaların özelliklerini belirleyen çalışmalar bu grup için YBÜ'nün etkinliğinin artırılması ve kaynak kullanımının iyileştirilmesini sağlayabilir.
(Yoğun Bakım Derg 2011; 3: 53-8)

Anahtar sözcükler: Uzamış YBÜ yatışı, özellikler, sonuç, maliyet

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Introduction

Intensive care units (ICU) manage patients who have acute, life-threatening single or multiple organ system failure due to disease or injury. The care of critically ill patients relies upon the use of skilled personnel and sophisticated equipment with the expenditure of large amounts of time and money (1). Based on all these characteristics, intensive care consumes a significant portion of health-care costs. Despite the relatively small proportion of hospital beds, ICUs account for 8% to 30% of hospital expenditures. Compared to those in other hospital areas, direct ICU costs per day are six times higher than those for non-ICU care (2, 3).

The demand for ICUs will likely grow because of new technologies and increasing population age, resulting in more interventions in high-risk patients. Furthermore, the ICU has evolved to support some patients for an exceptionally long period of time. Concerning this issue of prolonged intensive care management, official data indicate that, in the USA, this patient group exceeds 100.000 patients annually and consumes considerable ICU resources. Studies that have examined long-stay ICU patients have shown that while they account for <10% of the total ICU patient population, >30% of ICU resources are expended on this group (4). Moreover, mortality is higher among prolonged-stay patients than short-stay patients. Given the associated mortality and economic impact of these patients, a more detailed understanding of this patient population may facilitate care management decisions for these patients (5, 6).

The primary objective of this study was to examine the characteristics, outcomes and costs of a group of patients requiring prolonged ICU

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stay (≥21 days). Describing the epidemiology, characteristics, outcomes and costs of prolonged stay ICU patients may help with advancing various approaches, treatment protocols and alternative interventions to reduce the length of ICU stay and the use of intensive care resources. This study is also one of the first studies to examine the costs of prolonged ICU stay in Turkey.

Materials and Methods

Gazi University Hospital is a 1.000-bed tertiary care teaching hospital in Ankara, Turkey. Its nine-bed adult medical ICU is staffed with two full-time intensivists and has about 400 admissions annually. This institution also has separate neurosurgery, cardiac surgery, general surgery, pulmonology, anesthesiology and coronary critical care units.

Over a two-year period (April 1, 2007 to April 1, 2009), all admissions to the medical ICU were identified and all patients requiring at least 21 (consecutive) days of ICU care during their hospital admission were included in the study. Indeed, there is no generally accepted definition of "long-term intensive care". Because of the markedly skewed distribution of the length of stay in the ICU, no obvious cut-off exists and time periods of ≥7 days up to ≥30 days have been used to define prolonged ICU stay (7). For the present study "long-term intensive care" was defined as an ICU stay of at least 21 days. Baseline demographic data including age, gender, the main reasons for ICU admission, the source of admission, comorbidities, the presence/absence of neurologic, renal or hepatic dysfunction, infections on admission, laboratory investigations (days on admission to discharge/death) and severity of illness score (Acute Physiology and Chronic Health Evaluation [APACHE] II score) were recorded at the time of initial ICU admission (8). Comorbidities included the following: diabetes, chronic obstructive or restrictive lung disease, congestive heart failure, disabling neurological conditions, end-stage renal disease, chronic liver disease, any malignancy and immunosuppression. For each patient, we also recorded the details of the ICU course (total number of ICU days, requiring invasive or non-invasive ventilatory support, renal replacement therapy, haemodynamic support with inotropes or vasopressors at any dose, whether tracheostomy was done, extra investigations and extra procedures) and outcomes.

Patient-related costs were calculated based on the internal costing system of the hospital, which in turn is based on the Turkish medical tariff rate used for hospital and outpatient medical services. We know that tariffs may have some relation to real cost, but they cannot cover the term "cost". In any case, we used to same method to calculate the "cost" of each patient in the study, as this was used for a comparison between patient-related expenses. All data are given in US dollars at a rate of 1.50 TL per 1.00 US dollars.

Statistical Analysis

The chi-square test was used in order to evaluate categorical variables; when one of the expected values in the 2x2 cross-tables measured below 5, significance was calculated by Fisher's exact chi-square test and in other cases by Yates' correction for continuity. In tables larger than 2x2, the Pearson test was used. In the analysis of differences between categories of the status of constant variables (survivors or non-survivors), Student's t-test was used when the group distribution was coherent with the normal distribution; however, in cases of non-coherence, the Mann-Whitney U-test was used. In the analysis, values at $p<0.05$ were found to be statistically significant.

Results

Over a two-year period, 780 patients were admitted to our ICU. They ranged in age from 17 to 107 years, with a mean age of 61.89±18.26 years. 56.2% of patients were male and 48.2% of the patients died during their stay in the ICU. The mean length of ICU stay for all inpatients was 8.61±12.12 days (median: 5 days; min: 1 day; max: 102 days). During this two-year period, the number of patients staying in the ICU for 21 days or more was 72 (9.23%). 59.7% of the patients staying 21 days or more were male and the average age of the group was 65.9±16.29 years (median: 70.5 years; min: 21 years; max: 91 years). The mean APACHE II score of the patients was 22.13±6.89 (median: 21; min: 9; max: 39). The mean length of stay of this group was 36.96±20.58 days (median: 30 days; min: 21 days; max: 102 days). Patient distributions according to to the reasons for stay in the ICU and co-morbidities are displayed in Tables 1 and 2. The majority of patients were transferred from our internal medicine clinics (31.9%) or our emergency medicine service (48.6%) to stay in the ICU.

Mechanical ventilation was performed on 70 patients (97.2%), invasive mechanical ventilation was used on 62 patients (86.1%), and both invasive and non-invasive mechanical ventilation were applied on 45 patients (62.5%). Thirty-six of the patients (58%) were extubated on the first trial. However, in some patients, this process was extended. Tracheostomy was done in 25 patients (34.7%); a central venous catheter was inserted for haemodynamic monitoring or renal replacement therapy in 65 patients (90.3%). During the placement of the central

Table 1. Causes of admission to ICU for patients staying ≥21days

Causes of admission to ICU	Patient number, %
Respiratory causes	29 (40.3%)
Sepsis	23 (31.9%)
Postresuscitation	8 (11.1%)
Renal causes	6 (8.3%)
Gastrointestinal causes	2 (2.8%)
Neurologic causes	2 (2.8%)
Metabolic causes	1 (1.4%)
Intoxication	1 (1.4%)
Total	72 (100%)

Table 2. Co-morbidities of ICU patients staying ≥21days

Comorbidities	Patient number, %
Cardiovascular diseases	18 (25%)
Neurologic diseases	12 (16.7%)
Renal diseases	11 (15.3%)
Hematologic diseases	9 (12.5%)
No-comorbidities	7 (9.7%)
Respiratory diseases	4 (5.6%)
Oncologic diseases	3 (4.2%)
Gastrointestinal diseases	3 (4.2%)
Endocrinologic diseases	2 (2.8%)
Romatologic diseases*	2 (2.8%)
Chronic infectious disease	1 (1.4%)
Total	72 (100%)
*One patient has lupus, the other one has romatoid arthritis	

catheter, pneumothorax developed in one of the patients, and due to thrombus, infection or dislocation of the catheter, more than one catheter had to be inserted in 23 patients (35.4%). During patient stay, renal function tests were found to be abnormal in 45 patients (62.5%) and liver function tests were interpreted as abnormal in 22 patients (30.6%). Haemodialysis was performed on 38 patients (52.8%) during the ICU process. In five patients, ARDS was found upon admission, whereas ARDS was observed during the follow-up process in three patients.

Upon admission, infection was found or suspected in 71 patients (98.6%). The most frequent focus of infection was pulmonary infection in 30 patients (41.7%) and pulmonary and urinary tract infection in 14 patients (19.4%). During ICU stay, it was observed that infections developed in 66 patients (91.7%). The focus of the infections was mostly ventilator-associated pneumonia at a rate of 34.7% and ventilator-associated pneumonia together with blood and urinary tract infection at a rate of 16.7%.

Prophylaxis of the gastroinstestinal system was applied to all ICU inpatients with PPI. Despite this, bleeding in the gastrointestinal system was observed in 13 prolonged ICU stay patients (18%). When patients were able to receive oral nutrition, they were closely monitored and supported in the ICU. Enteral or parenteral nutritional support was initiated on patients who failed to take oral nutrition or who were intubated. Enteral nutrition support was provided to 27 patients (37.5%) while 36 patients (50%) received both enteral and parenteral nutritional support.

Sepsis/septic shock was encountered in three patients (4.1%) upon admission, in 20 patients (27.8%) during both admission and ICU stay and in 34 patients (47.2%) during ICU stay. Sixty-one patients (84.7%) required support with vasopressors or inotropes during ICU stay.

The threshold haemoglobin value for erythrocyte replacement treatment is 7 g/dL. However, the haemoglobin level is kept around 9 g/dL in patients with cardiovascular comorbidites. During stay in the ICU, erythrocyte replacement was performed in 60 patients (83.3%).

During the course of ICU stay, additional procedures were performed on 38 patients (52.8%). The most frequent procedures were tracheostomy, gastrostomy and chest tube insertion. Eight patients were transferred to the surgery unit for various reasons (gastrointestinal bleeding, prosthesis infection, etc.) and postoperative follow-up of these patients was performed in our intensive care unit.

Sixty-four patients (88.9%) went through additional investigations. The most frequently performed additional investigations were abdominal ultrasonography (54.2%), computerised brain tomography (56.9%) and electroencephalography (41.7%).

Ultimately, 15 patients (20.8%) who stayed in the ICU for 21 days or more were discharged, seven patients (9.7%) were transferred to related units and 50 patients (69.5%) died. None of the patients who were transferred to the related units died during their hospital stay.

We found some differences according to laboratory values upon admission and discharge of patients staying in the ICU ≥21 days. Discharge values of haemoglobin, platelet counts, creatinine, albumin, calcium, AST and ALT levels were significantly lower than admission values.

During the intensive care process, carbapenems were used in 69.4% (50 patients) of this patient group, linezolide in 30.6% (22 patients), liposomal amphotericin in 12.5% (9 patients), voriconazole in 11.1% (8 patients), caspofungine in 20.8% (15 patients) and antiviral agents in 13.9% (10 patients).

The average cost of patients staying in the ICU ≥21 days was calculated as $21,488.65±13,874.20 (median: $17,045.06; min: $7,435.62; max: $74,068.30).

Patients who stayed in the ICU for 21 days or more were grouped into patients who survived (survivors; 22 patients, 30.5%) and who died (non-survivors; 50 patients, 69.5%), and these two groups were analysed in terms of clinical variables. Significant differences were found with regard to laboratory findings and procedures done in the intensive care unit. Age was not an important factor in mortality (61.18±17.54 vs. 67.98±15.45 years, p=0.117).

Haemoglobin values upon admission and discharge for the non-survivors were significantly lower compared to the values of the survivors (p=0.013, p=0.001). Even though the number of white blood cells upon admission were significantly higher in the survivors compared to the number in non-survivors, the number of white blood cells upon discharge were found to be significantly lower in the survivors (p=0.045, p=0.009). Platelet values on discharge were found to be significantly higher in patients who survived (p<0.0001). HsCRP values upon discharge were significantly lower (p<0.0001) in survivors. BUN and creatinine values upon discharge were significantly lower in survivors. While AST and ALT values on admission and discharge did not show any significant differences between survivors and non-survivors, AST and ALT values upon admission and discharge in survivors displayed significant differences. Liver tests of survivors were significantly improved. Calcium levels upon discharge were found to be significantly higher in the patients who survived (p<0.0001). Albumin levels upon admission and discharge were also significantly higher in survivors (p=0.036, p<0.0001, respectively). Total bilirubin on discharge was found to be significantly lower in survivors (p=0.007). The APACHE II scores showed a significant difference between survivors and non-survivors (p=0.014); 52% of 25 patients with APACHE II scores lower than 20 survived, while 19.1% of 47 patients having scored 20 or higher survived. The difference was found to be significant (p=0.009).

In conclusion, some laboratory values of survivors who stayed 21 days or more in the intensive care unit were better than those of the non-survivors, and even though these survivors initially had values as bad as the non-survivors, most of their values improved by the time of discharge. Moreover, those who survived were the ones who were less infected, intubated or re-intubated and subjected to fewer transfusions. Fewer catheters were inserted and less haemodynamic support was provided in these survived patients (Table 3). However, no difference in cost was detected between the survivors and non-survivors. While the cost for the survivors was $19,269.5±15 135.13 (median: $13,613.18; min: $7,435.60; max: $74,068.30), the cost for the non-survivors was calculated as $22,465.10±13 325.20 (median: $18,156.10; min: $8,837.30; max: $68,067.60) (p=0.064).

When the intensive care process was re-evaluated, it was observed that certain procedures and some complications increased the cost of stay. The effects of some of these procedures and complications on the cost of ICU stay are shown in Table 4.

Additionally, patients treated with linezolide, liposomal amphotericin, caspofungine or antiviral agents proved to increase the cost of stay significantly (p=0.002, p=0.013, p=0.017 and p=0.008, respectively).

Discussion

The objectives of this study were to determine the outcomes of a mixed population of medical patients requiring at least 21 days of ICU care and to identify factors associated with prolonged stay and the costs of these patients. Prolonged ICU stay can adversely affect health status by increasing the risk of infection, complications and possibly mortality. The identification of factors of prolonged stay may help pre-

dict the length of ICU stay, possible complications and mortality at the beginning of the ICU stay.

The main findings of our study can be summarised as follows:

1) Patients with prolonged ICU stay form a small proportion of ICU patients (9.23%), yet they consume a significant proportion of ICU resources (mean cost $21,488.65±13 874.2).

2) The outcomes of patients with prolonged ICU stay are comparable to those of all patients staying in the ICU (30.5% vs. 51.8% survival).

3) The characteristics of patients with prolonged ICU stay are quite different. This enabled us to identify factors associated with prolonged ICU stay.

4) Variables that were found to be significant for long-stay patients in the ICU may be identified as: re-intubation, the number of catheters inserted, catheter complications, infection in the ICU, support with vasopressors, blood and blood product replacement, other additional procedures and investigations, frequent changes in antibiotics during treatment and the use of expensive antibiotics such as carbapenems. Moreover, haemoglobin and albumin levels upon discharge were found to be significantly lower in long-stay patients.

5) Variables that were found to be significant in terms of the cost for long-stay patients in the ICU may be identified as: the length of stay, re-intubation, opening tracheostomy, catheter insertion, more than three central venous catheter placements, catheter complications, support with vasopressors, blood and blood product replacement, other additional procedures (surgery, etc.) and investigations (abdominal US, CT, etc.), number of changes in antibiotics and the use of expensive antibiotics such as carbapenems, linezolide, etc.

6) Parameters that created a significant difference between surviving and non-surviving patients who stayed for 21 days or more in the ICU may be identified as: APACHE II score, intubation status, invasive and non-invasive mechanical ventilation, number of intubations, central venous catheter insertion, development of infection in the ICU, support with vasopressors, blood and blood product replacement, number of changes in antibiotics, opening tracheostomy and gastrostomy. There were also significant differences between the survivors and non-survivors concerning their haemoglobin values, the number of white blood cells as well as hsCRP, BUN creatinine and albumin values upon admission and/or discharge.

As previous studies have found, the causes for most prolonged stays in the ICU are related to respiratory problems. This type of patient requires longer stays and, particularly in cases where patients receive invasive mechanical ventilation support, weaning from mechanical ventilators becomes difficult. Most of the time during their stay is spent on withdrawal trials from ventilatory support or coping with problems that develop as a result of mechanical ventilation support. In particular, infections cause longer stays and the use of more expensive antibiotics (9, 10). In this study, invasive mechanical ventilation was performed in 62 patients (86.1%). While half of the patients were extubated on the first trial, several extubation weaning trials were attempted on the rest of the patient group. The most frequently developed type of infection in the ICU was found to be ventilator-associated pneumonia (34.7%). In this patient group, extubation trials, infections, changes in antibiotics for non-responding patients, trache-

Table 3. Differences between survivors and nonsurvivors who stayed 21 days or more on basis of some procedures performed in ICU

Parameters	Survivors (n=22)	Nonsurvivors (n=50)	P value
≥5 antibiotics change rate	31.8%	72%	0.003
Tracheostomy rate	13.6%	44%	0.026
Intubation rate	68.2%	96%	0.003
Invasive mechanical ventilation rate	68.2%	94%	0.007
Non-invasive mechanical ventilation rate	95.5%	48%	<0.0001
≥3 intubation rate	0%	20%	0.026
Central catheter insertion rate	68.2%	100%	<0.0001
Infection development rate in ICU	72.7%	100%	<0.0001
Erythrocyte replacement rate	68.2%	90%	0.037
Gastrostomy rate	18.2%	2%	0.028
Vasopressor use rate	45.5%	100%	<0.0001
Hemodialysis rate	40.9%	66%	0.084

Table 4. Effects of certain procedures and complications on the cost of patients staying 21 days or more in the ICU

Parameters	Present (cost, $)	Absent (cost, $)	p value
Reintubation	26 013.6±14 859.1	18 609.15±12 545.2	0.002
Opening tracheostomy	27 243±17 916.6	18 427.83±10 102.5	0.023
Central venous catheter insertion	22 487.8±14 211.4	12 211.14±3 511.18	0.007
Central catheter complication	27 722.64±17 752.3	18 371.7±10 334.5	0.011
≥3 central catheter insertion	32 100.9±20 333.7	18 927.1±10 542.2	0.013
≥3 artery line insertion	27 977.2±17 551	17 112.7±8 448.2	0.003
Infection development	22 395±14 102.2	11 518.9±4 238.8	0.007
Vasopressor support	23 369.1±14 402	12 086.4±3 771.4	<0.0001
Erythrocyte replacement	23 309.13±14 441.8	12 386.3±3 914	<0.0001
Thrombocyte replacement	26 737.1±15 981.7	19 327.5±12 443.5	0.009
Fresh frozen plasma replacement	23749.65±13695.45	18 136.14±13 684.6	0.01
Additional procedures	26 415±16 623.7	15 982.7±6 717.7	0.001
Applying surgery	37 046.9±21 225.46	19 543.9±11 502.1	0.004
Additional investigations	22 453.25±14 387.5	13 771.9±3 587.4	0.025
≥5 antibiotic changes	26 095.6±9 236.8	14 657.7±5 162.9	<0.0001
Using carbepenems	24232.43±14887.64	15 252.8±8 659.35	<0.0001

ostomy, etc. led to increases both in costs (Table 4) and the length of stay. This particular study and similar studies reveal once again the need for intermediate care units, and long-term respiratory support and care units for patients who particularly require prolonged mechanical ventilation but are haemodynamically stabilised. Existing units in developed countries, predominantly in the USA, promote both efficient use of beds in the ICU and desired outcomes in patients through reasonable costs (11, 12).

Some studies have identified certain predictors of prolonged ICU stay (13, 14). In one of these studies, medical conditions at 24 hours, specifically the presence of coma, infection or mechanical ventilation, were the most important predictors (13). According to one study, non-elective admissions, readmissions, respiratory or trauma-related causes of admission, first 24-hour evidence of infection, oliguria, coagulopathy and the need for mechanical ventilation or vasopressor therapy were found to be significantly associated with prolonged ICU stay (14). In our study, the primary reason for ICU admission in patients who stayed in the ICU for 21 days or more was respiratory disease (40.3%). On the initial of stay, it was observed that 98.6% of the patients had possible or certain infection. Within the first 24 hours, 41.6% of the patients required vasopressor support. Liver function tests were abnormal in 62.5% of the patients during their stay. Within the first 24 hours, 41.6% of the patients received invasive mechanical ventilation support.

Most illness severity or organ dysfunction scoring systems are designed for patients with shorter ICU stays, and the predictive value of admission scoring systems based on acute physiological derangements decreases significantly beyond 7 days. However, according to some studies, the relationship between the severity of illness and ICU length of stay is interesting. Patients with a low severity of illness (APACHE II score <15) have short ICU stays, probably because they require intensive care for a short period only, then they are discharged from ICU. In contrast, patients with a very high severity of illness (APACHE II score ≥30) have a shorter ICU stay because they die early in the ICU course. It is those patients in the middle who use more resources. Because their prognosis is uncertain, every effort is made to support failing organs in the hope that reversible pathology can be corrected. This implies the provision of invasive monitoring, mechanical ventilation, sedation and neuromuscular blockade, haemodialysis and other interventions (15, 16). The APACHE II score of our long-stay patients was 22.13±6.89 (median 21); in other words, the score was moderate.

The other important, amenable factor is the organisational structure of the ICU. The presence of a full-time ICU physician reduces the likelihood of excess ICU length of stay. Full-time ICU physicians reduce costs and improve outcomes in a variety of critical care settings (17). On the other hand, Zimmerman et al. (18). have demonstrated that teaching hospitals care for more complex patients and achieve better risk-adjusted survival rates but at a higher production cost, which is driven in part by prolonged length of stay. There is a full-time ICU physician in our ICU, but our ICU is located in a teaching hospital.

ICUs are departments where undesired incidents occur quite often. Close to 20% of the patients experienced an adverse event while in the ICU and one in five adverse events was considered preventable. Adverse events are independently associated with an average increase in hospital length of stay and cost (19). This study was not designed to identify adverse events.

According to some studies, the effect of age is a statistically significant factor, although its effect is considerably smaller than that of the other factors (20). In our study, age was not found to be a factor with an important effect on the length of stays and costs. Furthermore, other than immunosuppression, no other comorbidities were consistently found to have a large impact on survival and cost. A potential explanation for this finding is that baseline co-morbidities are important predictors of short-term survival, but patients surviving to a prolonged stay have demonstrated sufficient physiological reserve, despite their advanced age or any other co-morbidities. New physiological derangements, as reflected in ongoing or new requirements for life support therapies, become the important factors associated with survival and indirectly with costs (21). In our long-stay patient group, there existed no distinctive immunosuppression group. Patients with cardiovascular problems predominantly formed this group.

The costs of intensive care are extraordinary and consume a disproportionate amount of available resources for health care. In addition, considerable resources in the ICU are allocated to patients with a poor prognosis, many of whom ultimately die. Given this degree of resource expenditure, which often results in a questionable or undetermined quality of life, there is increasing pressure to examine and justify the utilisation of critical care resources. Previous retrospective studies have suggested that patients with a prolonged stay in an ICU are at high risk for poor outcomes and high costs, and these studies question the value of treating such patients. In addition, patients with a prolonged stay in the ICU are the most expensive cohort of critically ill patients. If the long-term quality of life for such patients is poor and the costs are extraordinary, the justification for considering alternative approaches for caring for such patients exists. If, however, the long-term outcomes and costs of patients with a prolonged stay in the ICU are reasonable, then there is a good justification for continuing to care for such patients. Efforts have been made to limit expenditures for those patients who are in the terminal stages of their illnesses or who are deemed as having little chance of surviving ICU care. Studies have attempted to identify reliable "predictors of early death" in critically ill patients as well as patients with a high risk of high cost. There is currently no reliable system that predicts outcome in the intensive care unit, and we cannot consistently determine which patients are unlikely to benefit from prolonged management in the ICU. In short, although there are currently increasing pressures to limit expenditures, the data are not always available to allow physicians and patients to make informed therapeutic or triage decisions regarding prolonged intensive care unit stays (22-24).

The present study has a number of limitations. The sample size of the population of interest was small and limits the generalisability of our findings. Additionally, our study represents the practice at only one institution. To the extent that practice patterns are different, our results may not be generalisable to other institutions. Our cost data may also lack generalisability to other health care systems. As a tertiary center, our ICU receives referrals of complicated medical cases with high levels of severity of illness. This might suggest the possibility of selection bias due to case-mix accounting for some of our findings. There are varying definitions of what constitutes prolonged ICU stay and therefore the cut-off value of 21 days is arbitrary. Because of the ambiguity in defining long-term ICU stay, it is difficult to compare the results of different studies. Despite all its limitations, we are convinced that this particular study will lead to other studies related to cost issues in the ICU.

Conclusion

Long-term ICU patients are an important subgroup of critically ill patients on whom a considerable proportion of hospital resources is

spent. In this population, prolonged ICU stay results in an acceptable survival rate despite significant economic investment. Further research into patient preferences, as well as cost effectiveness and cost utility studies, is necessary to develop guidelines for the use of scarce ICU resources by this subgroup.

Conflict of Interest

No conflict of interest was declared by the authors.

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