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Readmission to the Intensive Care Unit: An Indicator that Reflects the Potential Risks of Morbidity and Mortality of Surgical Patients in the Intensive Care Unit

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Abstract

Purpose. To investigate the characteristics and outcomes of surgical patients who were readmitted to the intensive care unit (ICU).

Methods. The data were collected for all readmissions to the surgical ICUs in a tertiary hospital in the year 2003.

Results. Of all the 945 ICU discharges, 110 patients (11.6%) were readmitted. They had a longer initial ICU stay (8.05 ± 7.17 vs 5.22 ± 4.95, $P < 0.001$) and were older and in a more severe condition than those not readmitted, but with a longer hospital stay and higher mortality rate (40% vs 3.6%, $P < 0.001$). A total of 26.4% of the readmission patients had an early readmission (<48 h), with a lower mortality rate than those with a late readmission (24.1% vs 45.7%, $P = 0.049$). A total of 46.4% of the patients were readmitted with the same diagnosis while the rest were readmitted with a new complication. Respiratory disease was the most common diagnosis for patients readmitted with a new complication (66.1%). The nonsurvivors had a significantly higher second Acute Physiology and Chronic Health Evaluation (APACHE II) score (22.1 ± 8.8 vs.14.6 ± 7.4, $P < 0.001$) and second Therapeutic Intervention Scoring System (TISS) score (30.1 ± 8.7 vs 24.7 ± 7.6, $P = 0.001$) and a longer stay in the first ICU admission (10.4 ± 9 days vs 6.4 ± 5 days, $P = 0.010$). A multivariate analysis showed that the first ICU length of stay and the APACHE II score at the time of readmission were the two risk factors for mortality.

Conclusion. The mortality of surgical patients with ICU readmission was high with respiratory complications being the most important issue.

Key words Surgical patients · Readmission · Intensive care unit

Introduction

Surgical intensive care units (ICU) treat patients with trauma, major elective surgery, and emergency surgery, as well as patients with complications from surgery. The ICU resources are limited and the cost is expensive. National costs are estimated to be about 8% of the total inpatient costs in Canada and 20% of all inpatient hospital costs in the United States.[1] These economic and institutional consequences have increased the need for outcome evaluation and guidance regarding efficient utilization. The factors affecting the mortality and morbidity in surgery have been widely studied.[2,3] In addition, the ICU readmission during the same hospitalization, which has been identified as an important indicator for the quality of care, also serves as a reliable performance indicator in intensive care. The premature discharge from the ICU (readmission <48 h) and substandard care in the general wards may also contribute to readmission.

In addition to the increased cost, ICU readmission also prolongs the length of hospital stay and increases the hospital mortality.[4,5] Substantial progress has also been made in identifying the clinical risk factors and strategies for reducing ICU readmission.[6–10] Intensive care unit readmission of surgical patients, however, has not been extensively studied.[11] Similar to previous studies regarding heterogeneous samples of medical ICU,[6–9] the current study aimed to determine the incidence, causal diseases, clinical characteristics, and outcome of readmission to the surgical ICU.

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Materials and Methods

Patient data were retrospectively collected for analysis from four surgical ICUs with 40 beds in a medical center in Taiwan from January 2003 to December 2003. The ICU admitted all surgical patients in need of intensive care, including those with trauma, general surgery, cardiothoracic surgery, neurosurgery, and other surgical subspecialties (orthopedic surgery, urology, plastic surgery, otorhinolaryngology, and transplantation). All of the surgical ICUs were hybrid ICUs, in which both the surgeons and the intensivists share the responsibility to care for the patients (combined care). Each intensivist cares for 8–10 patients. The surgeon and intensivist together decide upon the discharge of a patient from ICU. The surgeon on the floor will request readmission to the ICU if the patient requires intensive care and the intensivist will decide upon readmission according to the patient's condition. Any patients readmitted after a scheduled operation were excluded from this study.

Medical charts of all patients were reviewed. Patients older than 18 years of age and who were admitted to the ICU more than once during the same hospitalization were included.

The demographic data, Acute Physiology and Chronic Health Evaluation (APACHE II) scores, Glasgow Coma Scales (GCS), Therapeutic Intervention Scoring System (TISS), the length of ICU stay and hospital stay, early or late readmission (≤48 h or >48 h), and the diagnosis for admission to the ICU during the initial and readmission were investigated. The diagnoses were categorized into seven major categories: neurologic, cardiovascular, respiratory, gastrointestinal, renal, sepsis, or other. Readmission was classified as either a recurrence of the initial disease or a new complication.

Data were analyzed by using commercial statistical software (SPSS for Windows, version 12.0; SPSS, Chicago, IL, USA). All of the continuous data are expressed as the mean ± SD; categorical variables are reported as percentages. The statistical comparative analysis was performed using the chi-square test with Yates' correction for qualitative data. Fisher's exact test was used if any expected cell value in a 2×2 table was less than 5. Student's *t*-test or the Mann–Whitney *U*-test was used for quantitative data. A binary logistic regression with backward stepwise elimination method was used for the multivariate analysis of the risk factors for mortality in ICU readmission patients. Statistical significance was defined as $P < 0.05$.

Results

Of all the 945 ICU discharges there were 110 readmissions, with a readmission rate of 11.6%. The characteristics of the readmitted and non-readmitted patients are summarized in Table 1. The patients with readmission were significantly older (64.10 ± 16.98 vs 58.66 ± 17.42, $P = 0.02$) and in more severe condition in the initial admission with a higher APACHE II score (12.80 ± 6.69 vs 11.36 ± 7.31, $P = 0.046$) and TISS score (28.95 ± 8.93 vs 26.74 ± 8.88, $P = 0.015$). The patients with readmission also had a longer ICU stay (8.05 ± 7.17 vs 5.22 ± 4.95, $P < 0.001$) during the initial admission that those not readmitted. However, the outcomes of the readmitted patients were poorer, with a significantly longer hospital stay (59.49 ± 53.41 vs 18.40 ± 12.47, $P < 0.001$) and higher mortality rate (40% vs 3.6%, $P < 0.001$).

Fifty-one (46.4%) of the patients were readmitted with the same diagnosis of the previous admission

Table 1. Comparison of patients with or without readmission after SICU discharge

	Readmission ($n = 110$)	Non-readmission ($n = 835$)	*P*
Male sex	66.4%	61.3%	0.306
Age, years, mean ± SD	64.10 ± 16.98	58.66 ± 17.42	0.002
APACHE II score, mean ± SD			
Initial admission	12.80 ± 6.69	11.36 ± 7.31	0.046
Readmission	17.61 ± 8.79	—	—
TISS, mean ± SD			
Initial admission	28.95 ± 8.93	26.74 ± 8.88	0.015
Readmission	26.88 ± 8.29	—	—
GCS, mean ± SD			
Initial admission	12.38 ± 3.63	12.37 ± 3.94	0.980
Readmission	11.16 ± 4.36	—	—
Length of ICU stay (days), mean ± SD			
Initial admission	8.05 ± 7.17	5.22 ± 4.95	<0.001
Readmission	12.33 ± 11.99	—	—
Length of hospital stay (days), mean ± SD	59.49 ± 53.41	18.40 ± 12.47	<0.001
Overall mortality rate	40%	3.6%	<0.001

SICU, surgical intensive care unit; APACHE, Acute Physiology and Chronic Health Evaluation; GCS, Glasgow Coma Scales; TISS, Therapeutic Intervention Scoring System

while 59 (53.6%) patients were readmitted with a new complication. Twenty-nine (26.4%) of the patients were readmitted within 48 h of their ICU discharge (Table 2).

The diagnosis categories of the initial admission and readmission are shown in Fig. 1. The most common diagnosis category of initial ICU admission was neurological disease (35.5%), followed by cardiovascular disease (22.7%) and gastrointestinal disease (22.0%). However, respiratory disease (43.6%) was the most common disease for readmission, followed by neurological (20.9%) and cardiovascular disease (16.4%). In patients readmitted with new complications, respiratory disease was the major diagnosis at readmission (66.1%), followed by sepsis (15.3%) and neurological disease (6.8%)

Comparisons between the survivors and nonsurvivors were made and the results are summarized in Table 3. The nonsurvivors had significantly higher APACHE II and TISS scores on readmission. They also had a longer ICU stay but a much shorter hospital stay. The condition of the nonsurvivors during their readmissions tended to demonstrate a more significant deterioration (in comparison to their initial admission) than the survivors, as shown from the difference in APACHE II, TISS, and GCS scores.

Table 2. Characteristics of SICU readmission

	Readmission (n = 110)
Readmission diagnosis	
Same problem	46.4%
New complication	53.6%
Timing of readmission	
≤48 h	26.4%
>48 h	73.6%

A univariate analysis showed that the readmission APACHE II and TISS scores, the initial length of ICU stay, and the difference in APACHE II, TISS, and GCS scores were associated with mortality (Table 3). All six of these covariates with $P < 0.05$ were included in the multivariate logistic regression analysis with mortality as the dependent variable. Using the backward stepwise elimination method, only the length of the initial ICU stay (odds ratio 1.100, 95% confidence interval 1.026–1.179) and the APACHE II scores at the time of readmission (odds ratio 1.107, 95% confidence interval 1.041–1.177) were risk factors for mortality.

The patients who were readmitted early (≤48 h from ICU discharge) had a lower mortality rate. They also had a lower GCS and shorter ICU length of stay during their initial admission (Table 4).

Discussion

An ICU is a specially staffed and equipped hospital ward with advanced technologies, dedicated to the management of patients with life-threatening illness, injuries, and complications. However, such facilities are costly. Hence, the efficient utilization of this resource and the maintenance of the ideal quality of care are undoubtedly important. Intensive care unit readmission is an important indicator of the quality of care in hospital. As shown in this study, patients with ICU readmission not only would have a longer hospital stay, but their mortality rate would be much higher than those without readmission.

The readmission rate of this surgical ICU was 11.6%. The average ICU readmission rate in both North America and Europe is 7% (range, 4%–14%).[5] In comparison with readmission to surgical ICUs, the current results showed a slightly higher incidence than that

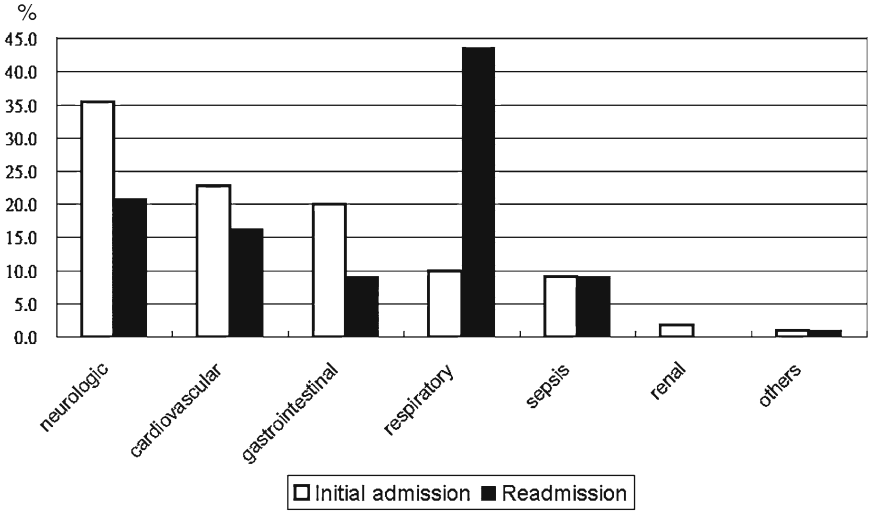

Fig. 1. Diagnosis categories of initial admission (*white bars*) and readmission (*black bars*)

Table 3. Comparison of survivors and nonsurvivors for SICU readmissions

Variables	Survivors (n = 66)	Non-survivors (n = 44)	P
Sex			
Male:female (n)	45:21	28:16	0.683
Age (years)	63.39 ± 18.40	65.16 ± 14.74	0.596
APACHE II			
Initial admission	12.21 ± 6.67	13.68 ± 6.70	0.261
Readmission	14.58 ± 7.43	22.16 ± 8.79	<0.001
TISS			
Initial admission	29.08 ± 9.36	28.77 ± 8.34	0.862
Readmission	24.73 ± 7.62	30.11 ± 8.29	0.001
GCS			
Initial admission	11.89 ± 3.88	13.11 ± 3.13	0.072
Readmission	11.77 ± 3.64	10.25 ± 5.17	0.095
Length of ICU stay			
Initial admission	6.45 ± 5.06	10.45 ± 9.04	0.010
Readmission	11.39 ± 9.55	13.73 ± 14.93	0.319
Length of hospital stay	67.52 ± 62.90	47.45 ± 31.70	0.030
Δ APACHE II	2.36 ± 7.07	8.48 ± 11.86	0.003
Δ TISS	–4.35 ± 11.18	1.34 ± 12.55	0.014
Δ GCS	–0.12 ± 3.84	–2.86 ± 5.72	0.007

Δ represents the score at readmission minus the score of initial admission

Table 4. Comparison between early and late readmission

	≤48 h	>48 h	P
Initial GCS	10.83 ± 4.44	12.94 ± 3.15	0.024
Initial ICU stay (days)	5.97 ± 5.60	8.80 ± 7.55	0.037
Δ APACHE II	2.07 ± 8.48	5.79 ± 9.98	0.077
Δ GCS	0.17 ± 5.45	–1.72 ± 4.55	0.072
Mortality	24.1%	45.7%	0.042

reported by Snow et al., namely a 9.4% ICU readmission rate.[11]

The early readmission to the ICU (readmission <48 h) may indicate the premature discharge of the patients from the ICU. In previous studies, early readmission to the ICU was found in 22%–30% of the readmitted patients.[6,12,13] The current study reports that 26.4% of ICU readmissions was recorded as early readmission. There was no obvious difference in comparison with the previous studies.

When the initial admission and readmission of a patient is for the same condition it raises the possibility of incomplete treatment of the condition during the initial admission. The current study reported that 46.4% of the readmissions were due to the same condition. This result was consistent with Chen et al. who reported from a mixed ICU[6] but higher than that of Snow et al.[11] from a surgical ICU. At the time of the initial ICU discharge, the patients who were discharged with residual organ dysfunctions were associated with an increased risk of being readmitted. Therefore, optimizing the organ functions in these patients before discharge from the ICU could result in a reduced readmission rate.

Most of the patients were readmitted with new complications. Among these patients, respiratory disease was the major reason for readmission, representing 66.1% of new complications of the readmitted patients. Nosocomial pneumonia that developed subsequent to prolonged mechanical ventilation, poor pulmonary toilet, and general weakness as consequence of disease were frequently reported reasons for ICU readmission. In the report of Sirgo et al.,[14] prolonged mechanical ventilation and a craniotomy were stated to be the risk factors for nosocomial pneumonia in trauma patients. The strong association between severe head trauma and ventilator-associated pneumonia was also reported by Cavalcanti et al.[15] Almost one third of the current patients were diagnosed to have neurological disease during the initial ICU admission; this may be the reason why the majority of these patients were readmitted with a new complication of respiratory disease.

The mortality rate of the ICU readmitted patients in the current study was 40%. According to a review of the literature, the mortality rate varied, ranging from 12% to 57%.[7] In cases of surgical patients, the mortality was higher than that reported by Snow et al., who reported 26% mortality.[11] The severity of the patients during readmission, including the APACHE II, TISS, and GCS scores, was higher in the nonsurvivors group. In addition, the ICU stays of the initial admission were significantly longer in the nonsurvivors group.

Although the efficacy of the APACHE II system for evaluating surgical ICU performance and risk stratification for the purpose of therapeutic trials were reported,[16] the current study attempted to compare the differences

in the APACHE II, TISS, and GCS scores, which represent the change in the degree of the disease's severity in patients between two ICU admissions during the same hospitalization. These differences could avoid the influence of the chronic underlying diseases and the distribution of the patients' ages while analyzing the scores of severity individually. The results revealed that the differences in the APACHE II, TISS, and GCS scores were higher in the nonsurvivors group than in the survivors group.

The correlation between the mortality of ICU readmitted patients was adjusted by a multivariate analysis. The results showed that the initial length of ICU stay and the APACHE II scores upon readmission were the two risk factors for mortality.

Strategies for reducing ICU readmission rates and decreasing the mortality in readmissions were introduced in previous studies. Yoon et al. reported that the readmission rate was lower when intensivists participated in the discharge decision-making.[10] Establishing a respiratory therapy assessment team may contribute to the reduced mortality of ICU readmission.[17] In addition, a step-down unit is indicated for reducing ICU readmission for high-risk patients who have respiratory problems after the first ICU discharge.

In conclusion, the mortality associated with surgical ICU readmission is high. Respiratory disease was the major reason for ICU readmission due to new complications. The initial ICU length of stay and the APACHE II score upon readmission are the two risk factors for the mortality of surgical ICU readmission patients. Strategies for reducing the number of patients readmitted to the surgical ICU and improving the outcome of these patients should therefore be studied further.

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