

Audit of 2431 Admissions to the Surgical Intensive Care Unit, Singapore General Hospital

B L Lim,**FAMS, MBBS, M Med (Anaes)*, Y W Chan,***MBBS, M Med (Anaes)*

Abstract

A prospective analysis of 2431 patients admitted to the Surgical Intensive Care Unit (SICU) of Singapore General Hospital was conducted between January 1994 and June 1997. All patients were followed up until hospital discharge. This ongoing project serves as both audit and quality assurance in the SICU. The mean APACHE II score of patients was 12.67 ± 8.36 and the mean age was 59.17 (17.82 years). There were 157 re-admissions, giving a re-admission rate of 6.46%. Mortality rate for re-admitted patients was 48.4%. One hundred and four (4%) patients stayed in the SICU for more than 2 weeks. Thirty (29%) died before the SICU discharge. SICU mortality was 9.46%, hospital mortality was 10.86% and standardised mortality ratio was 1.95. Computerised tools that analyse ICU utilisation patterns and outcomes have the potential to better target resources and so lower hospital costs, reducing futile medical care by selecting patients for appropriate expensive ICU care.

Ann Acad Med Singapore 1998; 27:314-7

Key words: APACHE II, ICU outcome, Resource utilisation

Introduction

The Singapore General Hospital is a 1700-bedded tertiary hospital with subspecialty intensive care units (ICUs), i.e. Surgical ICU, Cardiothoracic ICU, Neurosurgical ICU, Medical ICU, Burns ICU, Medical ICU, Coronary Care Unit and Neonatal ICU. The SICU receives patients from various surgical disciplines (Table I).

In the United States (US), ICUs account for 5% to 10% of all inpatient beds yet use more than 30% of hospital budgets.¹ In the Singapore General Hospital, ICU beds are capped at 5% of total inpatient beds. Although the ICU cost does not approach the fiscal heights reached in US, it remains disproportionately high relative to other tertiary services.

There is an increasing demand to quantify more accurately the quality of care provided in ICUs in order to refine therapy, to improve patient care selection and to be more cost effective.¹⁻⁴

There are many methods of severity measurement, commonly used include Acute Physiological and Chronic Health Evaluation II (APACHE II),^{4,7} Simplified Acute Physiology Score (SAPS),⁸ Mortality Probability Mode (MPM),⁹ Therapeutic Intervention Scoring System

(TISS).¹⁰ Severity measurement has been used to analyse aspects of structure, process and outcome of intensive care medicine. Measures of severity of illness are calibrated against the frequency of a specific outcome in groups of patients. They cannot provide prediction for individual patients.

Materials and Methods

APACHE II score has been used extensively and validated throughout the world to quantify the severity of ICU patients.^{4,7} It consists of 12 easily measured acute physiological variables, age and chronic health scores.

The demographic data and APACHE II scores were calculated for all patients (2431) admitted to the Surgical Intensive Care Unit (SICU) between January 1994 and June 1997. The SICU doctors filled up a form and recorded the worst physiological values during the first 24 hours in SICU, except for neurological score (to avoid falsely high Glasgow Coma Score due to heavy sedation). The patients were assigned to specific diagnostic categories according to the one principal reason for their admission. Mortality data on hospital discharge were retrieved from the hospital computerised data system. Overflow patients from other ICUs were excluded from the study. All data collected were verified by the Direc-

* Director, Surgical Intensive Care Unit
Consultant

** Head and Senior Consultant
Department of Anaesthesia & Surgical Intensive Care
Singapore General Hospital

Address for Reprints: Dr B L Lim, Department of Anaesthesia & Surgical Intensive Care, Singapore General Hospital, 1 Hospital Drive, Singapore 169608.

TABLE I: SICU ADMISSION BASED ON DISCIPLINES

Discipline	Number	%
General Surgery	1412	58.08
Orthopaedic	393	16.17
Colorectal	193	7.94
ENT	132	5.43
Urology	103	4.24
O & G	94	3.87
Plastic	63	2.59
Dental	18	0.74
Others	17	0.70
Eye	6	0.25
Total	2431	100%

tor of SICU. A computer programme was developed by SICU to store and analyse the data.

Results

A total of 2431 patients were admitted to the SICU from January 1994 to June 1997 with bed occupancy of 90%. The mean APACHE II score of patients was 12.67 ± 8.36 (Fig. 1). Seventy per cent of patients had APACHE II scores between 5 and 19.

The age distribution is shown in Figure 2. The mean age was 59.17 ± 17.82 years with 64% more than 55 years old.

While the major source of admissions was from emergency operations (39.12%), elective postoperative unbooked cases made up 13.12% of admissions (Fig. 3).

Re-admission is defined as more than one SICU admission during the same hospital admission. There were 157 re-admissions to the SICU (Table II), giving a re-admission rate of 6.46%. Thirty re-admitted patients died in the SICU, 46 survived the SICU stay but died in the wards before hospital discharge, giving an overall mortality rate of 48.4% for re-admitted patients.

Length of stay and mortality rate are shown in Table III. The mortality was proportional to the length of SICU stay. The mortality rate of patients who stayed 1 to 2 days

and those who stayed for more than 2 weeks were 6% and 30%, respectively.

Two hundred and thirty patients died in the SICU (Table IV), giving a SICU mortality rate of 9.46%. Two hundred and sixty-four died in the wards before hospital discharge, giving a post SICU discharge hospital mortality of 10.86%. The computer programme developed by SICU was used to calculate the risk of mortality (R)⁴ using the formula:

$$\text{Ln} \frac{R}{1-R} = 3.517 + (\text{APACHE II} \times 0.146) + D + S$$

where

D : disease weight

S : additional weight (0.603) for emergency surgery

Ln: loge

Any patient with a risk of mortality greater than 50% was predicted to die, resulting in a calculated predicted mortality of 10.41%.

$$\text{Standardised Mortality Ratio (SMR)} = \frac{\text{Actual Mortality}}{\text{Predicted Mortality}} (\text{ICU} + \text{hospital mortality})$$

The SMR for our SICU was 1.95.

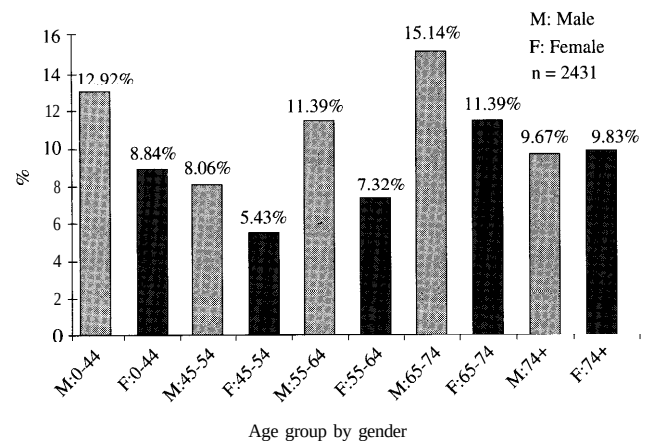


Fig. 2. Age and sex distribution.

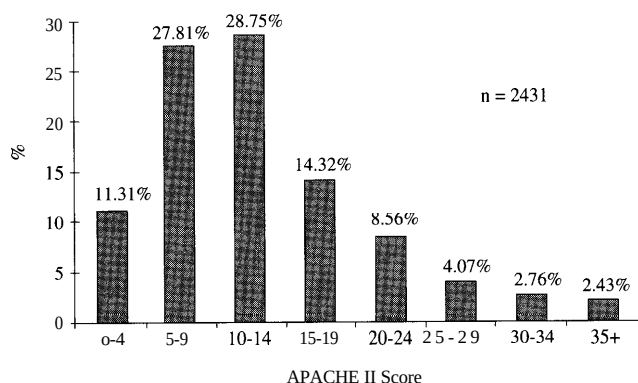


Fig. 1. APACHE II score.

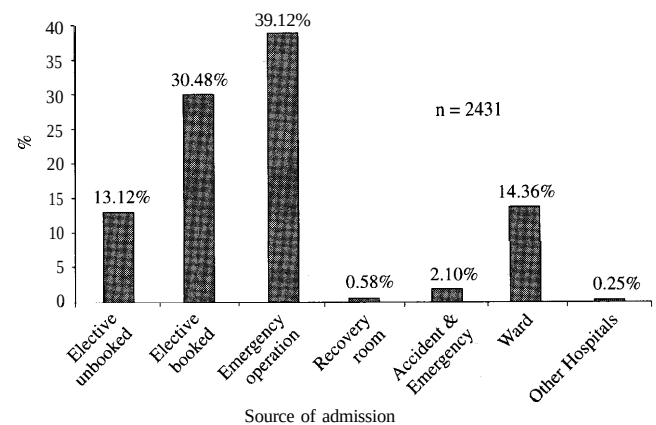


Fig. 3. Source of admission.

TABLE II: READMISSION AND MORTALITY

	n	(%)
Total patient admission	243	1 (100)
Readmission	157	(6.46)
Died in SICU	30	(19.1)
Died in the wards	46	(29.3)
Overall mortality	76	(48.4)

TABLE III: LENGTH OF STAY AND MORTALITY RATES

Days	1 to 2	3 to 7	8 to 14	>14
No. of admissions	998 (41%)	1143 (47%)	185 (8%)	104 (4%)
Mortality rate	65 (6%)	91 (8%)	43(23%)	30(29%)

TABLE IV: MORTALITY

	n	(%)
SICU mortality	230	(9.46%)
Hospital mortality	264	(10.86%)
Predicted mortality	253	(10.41%)
Standardised mortality ratio (SMR)	1.95	

Discussion

ICU should admit and manage patients with acute, reversible diseases. The APACHE II scoring system is a useful guide of ICU utilisation. Patients with low score of <5 should be admitted to the high dependency unit. If majority of the admitted patients have scores that were more than 30, then the ICU functions more like a mortuary where most deaths are placed.

Soon, Singapore will be facing the problem of an ageing population. It is estimated that by the year 2020, 20% of the population will be over 65 years old. In the past, most aged patients died peacefully in their own homes. With better standards of medical care, many are admitted to hospitals for chronic illnesses related to old age. Although advanced age has not been used as an admission criteria for our ICU, illness severity and outcome data help to audit our limited and expensive resources and assure that they are well utilised. The goals of ICU therapy should be directed towards good quality of life post-ICU discharge, rather than abusing it to prolong the dying process. Age-based rationing of health care may be unacceptable to most health care workers but is a fact of life."

Elective unbooked admissions are usually due to unexpected medical, anaesthetic or surgical complications.¹² All cases of unexpected events are audited with filled Anaesthetic Critical Incident Reports.¹³ Monthly reviews of such cases serve as peer review and as quality assurance in our department.

Re-admission to an ICU carries a risk of high mortality rate and increased length of stay. Re-admission may be due to premature ICU discharge, patient or surgical

complications.¹⁴ A review of these cases showed that many of them were elderly with multiorgan dysfunction or patients with advanced malignancies.

The mortality rate of re-admitted patients was 48.4%. The ICU Subcommittee of Singapore General Hospital was tasked to set admission and discharge guidelines to reduce futile ICU re-admission in 1996.

Using APACHE II, the SMR varies from 0.59 to 1.58 from the "best" to the "worst" ICU.¹⁵ SMR also varies with case mix. It is difficult to compare SMR of two units if the proportion of elective, surgical emergency and medical patients is not known. SMR is calculated based on principle diagnosis. It may be difficult to choose one if the patients are admitted with multiple diagnoses.

A SMR of 1.95 in SICU is very high. An ideal ICU should have a SMR of around 1, i.e. actual mortality (SICU + hospital) is equal to expected mortality (using the APACHE II severity of disease classification system). A review of patients who died with low APACHE II scores showed that these were patients with advanced malignancies or elderly with multiorgan dysfunctions. Most of them survived ICU stay but died in the wards before hospital discharge.

Length of ICU stay is commonly used as a measure of cost, even though intensity of care may lead to discrepancies for individuals. It can be used for evaluation and comparison of ICU effectiveness and efficiency.¹⁶ Mortality is increased with number of organ failure and duration of stay in ICU.¹⁷

Long-stay patients (arbitrarily defined as staying more than 14 days) were audited. One hundred and four (4.28%) patients stayed more than 14 days. Thirty out of 104 patients died in the SICU and a mortality rate of 28.8% was recorded for long-stay patients. Guidelines were drawn up in the SICU regarding withholding/withdrawing of therapy for long-stay patients. For many of these patients, death was imminent, continuing aggressive therapy only serves to prolong the dying process.

Conclusion

Quality assurance is a continuous duty of ICU directors. Segmented audits were done to tackle certain problems, e.g. re-admissions and long-stay patients. They will improve the performance of the unit, enhance ICU doctors' knowledge about the results of their daily work and participate in the ongoing discussions about cost containments. A significant opportunity for cost savings in health care lies in managing ICU utilisation. Computerised tools that collect data about patient's severity of illness, monitor ICU utilisation, and track patient's outcome have the potential to help hospital lower costs by changing practice pattern and treating patients in appropriate, less expensive settings.

REFERENCES

1. Chalfin D B. Analysis of cost-effectiveness in intensive care: an overview of methods and a review of applications to problems in critical care medicine. *Curr Opin Anaesthesiol* 1996; 9:129-33.
2. Spivack D. The high cost of acute health care: a review of escalating costs and limitations of such exposure in intensive care units. *Am Rev Respir Dis* 1987; 36:1007-11.
3. Muakkassa F F, Fakhyr S M, Rutledge R, Hsu H, Meyer A A. Cost-effective use of microcomputers for quality assurance and resource utilization in the surgical intensive care unit. *Crit Care Med* 1990; 18:1243-7.
4. Knaus W A, Draper E A, Wagner D P, Zimmerman J E. APACHE II: A severity of disease classification system. *Crit Care Med* 1985; 13:818-29.
5. Jacobs S, Chang R W S, Lee B. Audit of intensive care: a 30 month experience using the Apache II severity of disease classification system. *Intensive Care Med* 1988; 14:567-74.
6. Wong D T, Knaus W A. Predicting outcome in critical care: the current status of the APACHE prognostic scoring system. *Can J Anaesth* 1991; 38:374-83.
7. Berger M M, Marazzi A, Freeman J, Chioloro R. Evaluation of the consistency of Acute Physiology and Chronic Health Evaluation (APACHE II) scoring in a surgical intensive care unit. *Crit Care Med* 1992; 20:1681-7.
8. Le Gall J R, Lemeshow S, Saulnier F. A new simplified acute physiological score (SAPS II) based on a European/North American multicentre study. *J Am Med Assoc* 1993; 270:2957-63.
9. Lemeshow S, Teres D, Klar J, Avrunin J P, Gehlbach S H, Rapoport J. Mortality probability models (MPM II) based on an international cohort of intensive care unit patients. *J Am Med Assoc* 1993; 270:2478-86.
10. Cullen D J, Nemeskal A R, Zaslavsky A M. Intermediate TISS: a new therapeutic intervention scoring system for non-ICU patients. *Crit Care Med* 1994; 22:1385-91.
11. O'Malley N C. Age-based rationing of health care: A descriptive study of professional attitudes. *Health Care Management Rev* 1991; 16:83-93.
12. Swann D, Houston P, Goldberg J. Audit of intensive care unit admissions from the operating room. *Can J Anaesth* 1993; 40:137-41.
13. Runciman W B, Webb R K, Lee R, Holland R. The Australian Incident Monitoring Study. System failure: an analysis of 2000 incident reports. *Anaesth Intensive Care* 1993; 21:684-95.
14. Durbin C G, Kopel R F. A case-control study of patients readmitted to the intensive care unit. *Crit Care Med* 1993; 21:1547-53.
15. Gall J L, Loirat P. Can we evaluate the performance of an intensive care unit? *Curr Opin Crit Care* 1995; 1:219-20.
16. Knaus W A, Wagner D P, Zimmerman J E, Draper E A. Variations in mortality and length of stay in intensive care units. *Ann Intern Med* 1993; 118:753-61.
17. Knaus W A, Draper E A, Wagner D P, Zimmerman J E. Prognosis in acute organ-system failure. *Ann Surg* 1985; 202:685-92.