Risk Factors for Predicting Mortality in a Surgical Intensive Care Unit in the Year 2000†

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Abstract

Objective : To determine the mortality and risk factors of mortality in a surgical intensive care unit (SICU), King Chulalongkorn Memorial Hospital.

Design : Review of retrospective data.

Setting : a SICU of a tertiary-care academic medical center.

Patients : Out of a total of 546 patients admitted to SICU during a one year period (January 1, 2000 - December 31, 2000), 458 (83.9%) had complete medical data which were analyzed.

Measurements and Main Results : One hundred and ninety-three variables of 6 categories of patients' characteristics, chronic disease, acute illness, physiologic variables, therapy and miscellaneous were studied. Univariate and multivariate analyses were used. The SICU and hospital mortality was 8.1 and 14.6 per cent, respectively. Multivariate logistic regression analysis identified seven variables as independent risk factors for mortality ($p < 0.05$): chronic renal failure (adjusted odds ratio [AOR], 7.5; 95% CI, 3.0 to 19.0; $p = 0.000$), coma (AOR, 11.7; 95% CI, 2.4 to 57.4; $p = 0.002$), *Staphylococcus aureus* infection (AOR, 15.4; 95% CI, 1.6 to 147.6; $p = 0.018$), diagnosis of systemic inflammatory response (AOR, 2.9; 95% CI, 1.2 to 7.1; $p = 0.017$), mechanical ventilation (AOR, 11.2; 95% CI, 2.0 to 61.4; $p = 0.005$), having received adrenaline (AOR, 7.1; 95% CI, 2.3 to 22.2; $p = 0.001$) and diuretic (AOR, 3.3; 95% CI, 1.4 to 8.1; $p = 0.008$). Besides weight (AOR, 0.9; 95% CI, 0.9 to 1.0; $p = 0.002$) and having received H_2-blocker (AOR, 0.2; 95% CI, 0.1 to 0.5; $p = 0.001$) were two independent protective factors for mortality.

Conclusion : Knowing the risk factors of SICU mortality will help physicians to improve patient care, educate patients and their families, optimize ICU resource planning and may decrease health care costs.

Key word : Risk Factor, Mortality, Surgical, Intensive Care Unit

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Critical illness implies failure of one or more vital organ systems and needs intensive therapy. Four main determinants of outcome from critical illness are physiological reserve, severity of acute illness, diagnosis and therapy. Mortality is the most important outcome and an interesting issue that has been studied worldwide during the past two decades. From previous studies, the surgical intensive care unit (SICU) mortality and hospital mortality of this group of patients were 1.7-23.0 per cent[1-6] and 4.2-32.5 per cent[1-4,7-12]. Since the prediction of mortality is complicated and no previous mortality has been reported from the SICU of King Chulalongkorn Memorial Hospital, the purposes of this study were to determine the SICU mortality, the hospital mortality of this group and to identify the risk factors of mortality.

METHOD

Records of all patients admitted to the SICU on the 2nd floor of Sirinthorn building from January 1, 2000 to December 31, 2000 were analyzed. Data were collected from the patient's chart, SICU flow chart, anesthetic record and OPD card. Six categorical variables from 193 variables were

1. demographic data : age, sex, weight etc.
2. chronic health status : diabetic mellitus, hypertension, heart disease, respiratory disease and chronic renal failure etc.
3. acute diagnosis that brought the patient to the hospital : carcinoma, trauma etc. Including morbidity and complications which happened in the ward : infection etc.
4. physiology and investigation : vital signs, physical examination, Glasgow coma scale, hemoglobin, white blood cell count, platelet, blood urea nitrogen, creatinine, electrolyte, calcium, liver function test, lipid profile, coagulogram, arterial blood gas etc.
5. therapy

5.1. procedure : type of surgery, ventilatory support, dialysis etc.

5.2. drug : sympathomimetic (dopamine, dobutamine, adrenaline) vasodilator, calcium blocker, beta blocker, H_2-blocker, omeprazole, antiarrhythmic, amiodarone, ACE inhibitor, sodium bicarbonate, calcium, digitalis, diuretic, vasodilator, steroid, insulin, sedative, analgesia, muscle relaxant, antibiotic etc.

6. micellaneous : preadmission cardiopulmonary resuscitation (CPR), indication of ICU admission, urgency of admission, length of ICU stay, reoperation during ICU stay and cause of death etc.

Data were analyzed using the SPSS (Statistical Package for the Social Sciences) for Window version 10.00. Mortality was reported as per cent. Univariate statistical analysis was conducted to determine the relation between each of the potential risk factors and mortality. Chi square (χ^2) *t*-test, p-value, adjusted odds ratio (AOR) and 95 per cent Confidence Interval (95% CI) were calculated. Each of the variables that were significant in the univariate analysis at the $p < 0.05$ level were entered into a multivariate logistic regression model where $p < 0.05$ was again statistically significant.

Besides, 15 variables in Mortality Probability Models (MPM) II (Table 1) were calculated for probability of hospital mortality of each patient (Lemeshow S et al[13]) and expected hospital mortality rate for the whole group to find out the Standardized Mortality Ratio (SMR) (Table 2).

RESULTS

A total of 546 patients were admitted to the SICU during the one -year study period. Four hundred and fifty-eight (83.9%) had complete medical data which were investigated.

Two hundred and ninety-two (55.94%) were male and 230 (44.06%) were female. The mean age was 60.26 (range 15-97) yrs, mean weight was 54.77 (range 28-100) kg. Three hundred and ninety cases (74.71%) were admitted electively to the ICU and

Table 1. Categorical variables in the Mortality Probability Models (MPM II)[13].

Variables
Physiology
- Coma or deep stupor
- Heart rate ≥ 150 beats/min
- Systolic blood pressure ≤ 90 mm Hg
Chronic diagnoses
- Chronic renal insufficiency
- Cirrhosis
- Metastatic neoplasm
Acute diagnoses
- Acute renal failure
- Cardiac dysrhythmia
- Cerebrovascular incident
- Gastrointestinal bleeding
- Intracranial mass effect
Other
- Cardiopulmonary resuscitation prior to admission
- Mechanical ventilation
- Medical or unscheduled surgery admission

Table 2. Standardized Mortality Ratio (SMR)[13].

SMR = actual hospital mortality rate/expected hospital mortality rate
(expected hospital mortality rate for the whole group of ICU patients = summation of probability of hospital mortality of each patient)

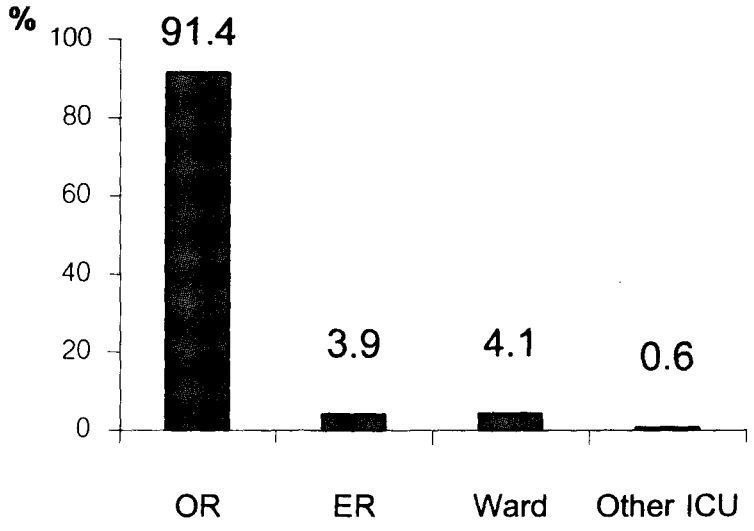

Fig. 1. Source of SICU admission.

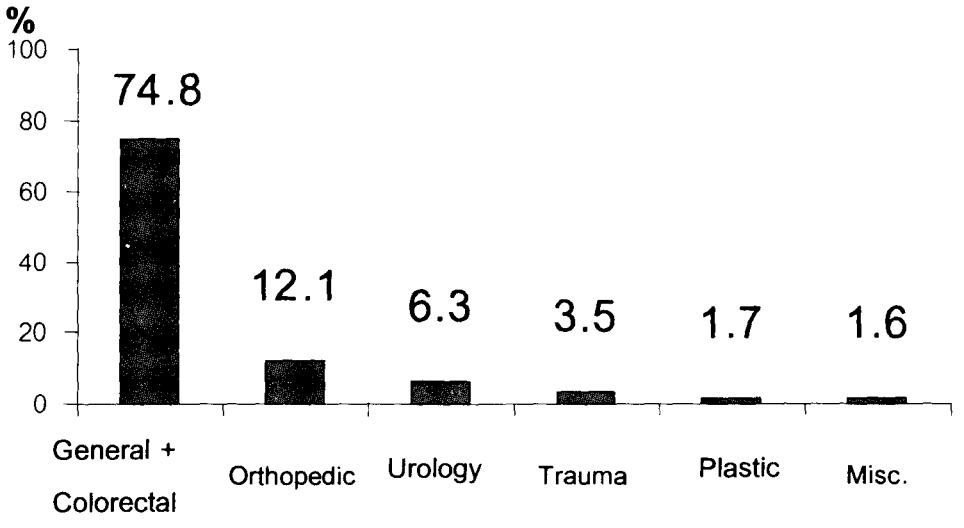

Fig. 2. Service.

132 cases (25.29%) were emergency admitted. Fig. 1, 2 and 3 show the source of ICU admission, service of the patients and indication of admission, respectively.

The SICU mortality was 8.1 per cent. Fig. 4 and 5 are mortality *vs* service and mortality *vs* indication of admission. In addition, surgical ward mortality after ICU discharge was 6.5 per cent, hospital mortality for this group of patients was 14.6 per cent and SMR was 1.4.

Table 3. shows the significant risk factors for predicting mortality in the SICU in the multi-

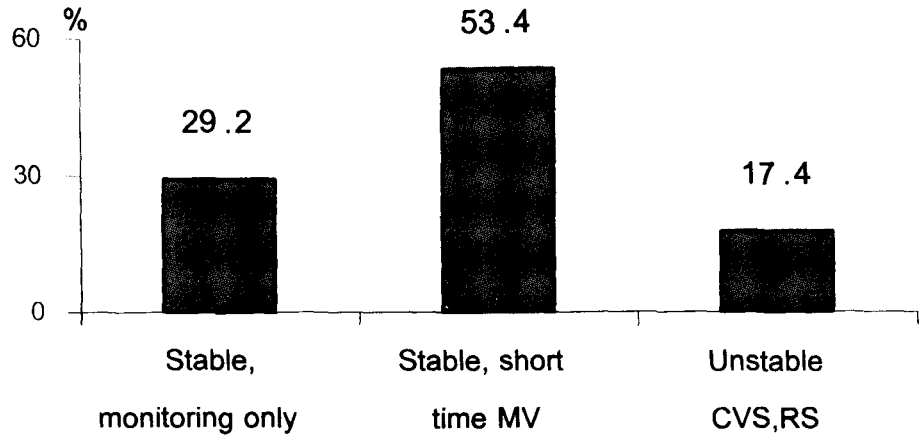

Fig. 3. Indication for SICU admission.

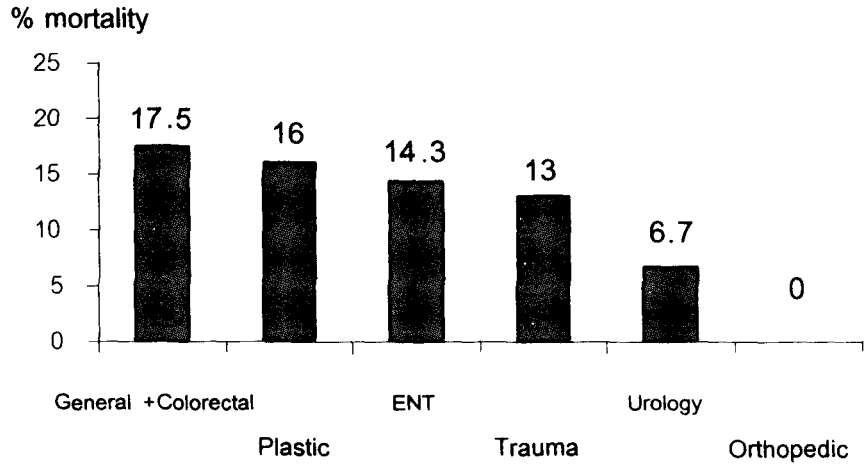

Fig. 4. % Mortality *vs* service.

variate analysis which were chronic renal failure, coma, staphylococcus aureus infection, diagnosis of systemic inflammatory response, mechanical ventilation, having received adrenaline and diuretic. In contrast, weight and having received H_2-blocker were two independent protective factors for mortality.

In the present study, insignificant factors for predicting mortality in the SICU in the multivariate analysis were age, sex, ASA physical status, indication for admission, emergency admission, respiratory, cardiac, gastrointestinal disease, length of ICU stay, pseudomonas aeruginosa, bronchodilator, antibiotic, omeprazole, sodium bicarbonate, calcium channel blocker therapy and endotracheal intubation etc.

DISCUSSION

Previous studies reported many scoring systems to predict severity of illness, mortality of the SICU patients and to compare ICU performance. These were Acute Physiology and Chronic Health Evaluation (APACHE) II score[14], APACHE III score[15], Mortality Probability Models (MPM) II score[13], Simplified Acute Physiology Score (SAPS) II[16], Therapeutic Intervention scoring system (TISS) [17] etc. Most of those were prospective studies and calculated at the time of ICU admission and within 24 hours thereafter.

Since the present study was retrospective and matched only the MPM II score which predicted the mortality of ICU patients and could consequently

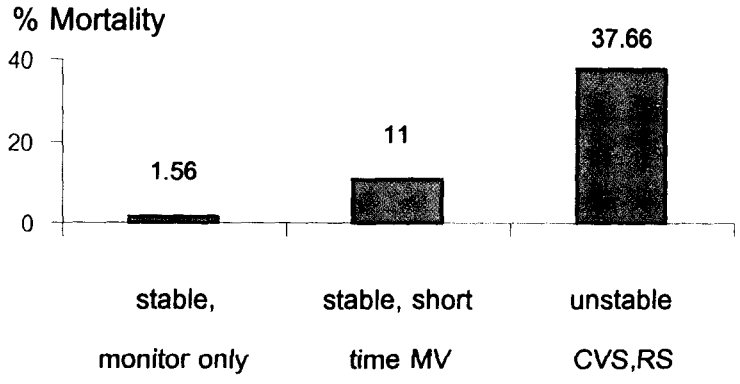

Fig. 5. % Mortality *vs* indication of ICU admission.

Table 3. Risk factors for mortality by logistic repression and backwards stepwise regression.

Risk factor	Coefficient	Standard error	P-value	AOR 995% CI)
Chronic renal failure	2.018	0.472	0.000*	7.5 (3.0-19.0)
COMA	2.462	0.810	0.002*	11.7 (2.4-57.4)
Staphylococcus aureus infection	2.735	1.153	0.018*	15.4 (1.6-147.6)
Diagnosis of systemic inflammatory response	1.080	0.451	0.017*	2.9 (1.2-7.1)
Mechanical ventilation	2.417	0.868	0.005*	11.2 (2.0-61.4)
Adrenaline therapy	1.966	0.579	0.001*	7.1 (2.3-22.2)
Diuretic therapy	1.200	0.454	0.008*	3.3 (1.4-8.1)
Weight	-.060	0.020	0.002*	0.9 (0.9-1.0)
H_2-blocker therapy	-1.576	0.484	0.001*	0.2 (0.1-0.5)

AOR = Adjusted odds ratio, CI = Confidential interval, * $p < 0.005$

be calculated for SMR, the ratio of the observed mortality rate to the predicted mortality rate which quantitates the quality of health-care[18]. If the SMR for a studying ICU is < 1, then overall outcomes for that unit are better than those of the reference set which has the similar ICU population or case mix, suggesting a superior level of care. Alternatively, an SMR of > 1 suggests inferior quality of care since the overall observed mortality rate is higher than the predicted mortality rate[19]. From the present study, the authors could not adjust for ICU population, so the values of ICU mortality (8.1%) and SMR (1.4) could not been used to compare the ICU performance to others, since Glance LG et al[19] strongly reported that prediction models are themselves sensitive to case mix and, therefore, should only be used if there are no significant differences in case mix between ICUs.

Significant risk factors for predicting mortality from previous reports were : magnitude of organ dysfunction[9], APACHE III score[9], SAPS[1], TISS [6], SAPS[6], multiorgan failure[10], pre-operative or post-operative anemia and blood transfusion[20], emergency ICU admission[1], length of ICU stay[21], infection[10,22] especially Staphylococcus epidermis, Staphylococcus aureus, Candida albicans[23] etc, prolonged mechanical ventilation for more than 5 days [24], mechanical ventilation in female patients[25], extubation failure[26], inotropic therapy[27] etc. Also, early discharge of terminally ill patients from the ICU can also decrease ICU mortality as well[1].

Insignificant factors for predicting mortality from previous studies was unplanned extubation[28] etc.

Factors that were controversial for predicting mortality from previous reports were age[3,8,29],

ventilator-associated pneumonia[30,31], APACHE II score[4,5,11,32,33] etc.

In the present study, significantly high to low risk factors were staphylococcus aureus infection (AOR, 15.4), coma (AOR, 11.7), mechanical ventilation (AOR, 11.2), chronic renal failure (AOR, 7.5), having received adrenaline (AOR, 7.1), diuretic (AOR, 3.3), diagnosis of systemic inflammatory response (AOR, 2.9). Chronic renal failure was the only underlying disease that had a significant risk factor.

In opposition, the mean weight was 54.77 kg (range 28-100) and more low body weight patients died than high body weight patients (AOR, 0.9). So, body weight was the independent protective factor as well as having received H_2-blocker (AOR, 0.2).

From the present study, some possible suggestions to decrease the ICU mortality were: to replace adequate volume, maintain optimum pressure and urine output to prevent renal deterioration especially in chronic renal failure, actively prevent infection, mechanically ventilate only if indicated and extubate early, use H_2-blocker rather than omeprazole to prevent gastrointestinal bleeding, early perioperative nutritional support to prevent morbidity and mortality etc.

In conclusion, in the present study, the SICU mortality was 8.1 per cent. Knowing the risk factors of SICU mortality will help physicians to improve patient care, educate patients and their families, and to optimize ICU resource planning which may decrease health care costs.

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ปัจจัยเสี่ยงสำหรับการทำนายการเสียชีวิตในห้องบริบาลผู้ป่วยหนักศัลยกรรม พ.ศ. 2543†

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วัตถุประสงค์ : ศึกษาอัตราการเสียชีวิตและปัจจัยเสี่ยงสำหรับการทำนายการเสียชีวิตของผู้ป่วยหนักศัลยกรรมทั่วไป

วิธีการศึกษา : เป็นการศึกษาย้อนหลังจากเวชระเบียนผู้ป่วย

วัสดุและวิธีการ : ในช่วงเวลาตั้งแต่ 1 มกราคม 2543 ถึง 31 ธันวาคม 2543 มีผู้ป่วย 546 รายที่เข้ารับการรักษาในห้องบริบาลผู้ป่วยหนักศัลยกรรมทั่วไป โรงพยาบาลจุฬาลงกรณ์ เวชระเบียนผู้ป่วยที่มีข้อมูลเพียงพอและนำมาศึกษาได้มีทั้งหมด 458 ราย (83.9%) ทำการศึกษาปัจจัยเสี่ยงทั้งหมด 193 ปัจจัย โดยแบ่งเป็น 6 กลุ่มได้แก่ ลักษณะของผู้ป่วย สรีระวิทยา โรคประจำตัว โรคทางศัลยกรรม การรักษาและผลแทรกซ้อน นำค่าที่ได้มาคำนวณด้วยสถิติ univariate และ multivariate logistic regression analysis

ผลการศึกษา : ในปี พ.ศ. 2543 อัตราการเสียชีวิตในห้องบริบาลผู้ป่วยหนักศัลยกรรมและหลังกลับหออภิบาลศัลยกรรมเป็น 8.1 และ 6.5% ตามลำดับ อัตราการเสียชีวิตในโรงพยาบาล 14.6 % จาก multivariate analysis พบว่าปัจจัยเสี่ยงที่มีนัยสำคัญทางสถิติ ($p < 0.05$) ต่อการเสียชีวิตได้แก่ ภาวะไตวาย (adjusted odds ratio [AOR], 7.5; 95% CI, 3.0–19.0; $p = 0.000$), โคม่า (AOR, 11.7; 95% CI, 2.4–57.4; $p = 0.002$), การติดเชื้อ *Staphylococcus aureus* (AOR, 15.4; 95% CI, 1.6–147.6; $p = 0.018$), การเกิด systemic inflammatory response (AOR, 2.9; 95% CI, 1.2–7.1; $p = 0.017$), การใช้เครื่องช่วยหายใจ (AOR, 11.2; 95% CI, 2.0–61.4; $p = 0.005$) การรักษาด้วย adrenaline (AOR, 7.1; 95% CI, 2.3–22.2; $p = 0.001$) และ ยาขับปัสสาวะ (AOR, 3.3; 95% CI, 1.4–8.1; $p = 0.008$). นอกจากนั้น พบว่าปัจจัยป้องกันที่มีนัยสำคัญทางสถิติต่อการเสียชีวิตได้แก่ น้ำหนัก (AOR, 0.9; 95% CI, 0.9–1.0; $p = 0.002$) และการรักษาด้วย H_2-blocker (AOR, 0.2; 95% CI, 0.1–0.5; $p = 0.001$)

สรุป : การศึกษาปัจจัยเสี่ยงสำหรับการทำนายการเสียชีวิต ช่วยให้แพทย์สามารถพัฒนาการรักษาพยาบาล การให้ความรู้แก่ผู้ป่วยและญาติ การบริหารทรัพยากรต่าง ๆ และอาจช่วยลดค่าใช้จ่ายของโรงพยาบาลได้

คำสำคัญ : ปัจจัยเสี่ยง, การเสียชีวิต, ศัลยกรรม, ห้องบริบาลผู้ป่วยหนัก

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