# Length of Surgical Intensive Care Unit Stay and Risk Factors†

PAVENA BUNBURAPHONG, M.D.*,
WALEEPORN RIYAGOON, B.N.**,
WARALUCK RAMDIT, M.D.*
THEWARUG WERAWATGANON, M.D.*,
KAROON TECHAPICHETVANICH, M.D.*,

**Abstract**

**Objective :** To assess length of stay of patients in the surgical intensive care unit (ICU) and to determine risk factors for a long ICU stay.

**Design :** Review of retrospective data.

**Setting :** University hospital surgical ICU.

**Patients :** Out of a total of 681 admissions to the surgical ICU during a one year period (July 1, 1996 - June 30, 1997), 613 had complete medical data which were analysed.

**Measurements and Main Results :** The frequency distribution was skewed to the right. The median and mode were the same (2 days). 35.89 per cent of the ICU admissions had a long stay (>2 days). Independent risk factors for a long ICU stay in the multivariate logistic regression analysis are increasing age, unstable condition, long weaning time, diuretic therapy and re-operation.

**Conclusion :** Knowing the length of ICU stay, risk factors for a long ICU stay and how to shorten the ICU stay have potential application in optimizing ICU resource planning and decreasing the health care cost.

**Key word :** Length of Stay, Intensive Care Unit, Surgical, ICU, Risk Factor

**BUNBURAPHONG P, WERAWATGANON T, RIYAGOON W, TECHAPICHETVANICH K, RAMDIT W**
**J Med Assoc Thai 2001; 84: 1103-1108**

* Department of Anesthesiology, Faculty of Medicine, Chulalongkorn University, Bangkok 10330,
** Surgical Intensive Care Unit, King Chulalongkorn Memorial Hospital, Bangkok 10330, Thailand.
† Presented at the 49th Meeting of the Royal Collage of Anesthesiologists of Thailand, Bangkok, Thailand. 13th February 1999.

King Chulalongkorn Memorial Hospital has 357 surgical beds, 20 surgical intensive care unit (ICU) beds (6 general surgical ICU beds, 6 cardiothoracic ICU beds, 8 neurosurgical ICU beds) out of a total of 1,479 beds. Nevertheless, many patients have their elective surgery postponed because ICU beds are not available at this scheduled time and a lot of resource is wasted from this cancellation.

Patients at high risk who have long ICU stays consume a large amount of fixed ICU resource (1) and often "block" beds(2,3). In addition, risk factors for a long ICU stay are not the same in different populations(4-6).

The purposes of this study were to assess length of surgical ICU stay and to identify risk factors for a long ICU stay. Finally with these results we hope to be able to put forward suggestions for patient scheduling and ICU resource planning.

## METHOD

Records of all patients admitted to the surgical ICU on the 2nd floor of Sirinthorn building from July 1, 1996 to June 30, 1997 were analyzed. At that time, this unit had only 6 beds and admitted all the surgical patients requiring intensive care, except those patients who had had neurologic procedures. The length of stay of each patient was determined from admission and discharge dates. The variables that were studied as potential risk factors were

1. patient age (≤ 60 *vs* > 60 yr).
2. sex (female *vs* male).
3. weight (≤ 70 *vs* > 70 kg).
4. admission condition (stable *vs* unstable condition: blood pressure < 90/60 torr, heart rate > 140/min, on pacemaker, cardiac drugs, ventilatory support etc).
5. sympathomimetic therapy: dopamine, dobutamine, adrenaline or isoproterenol etc.
6. vasodilator therapy : sodium nitroprusside, nitroglycerin.
7. diuretic therapy : furosemide, etc.
8. dialysis : peritoneal or hemodialysis.
9. weaning time from mechanical ventilator (≤ 1 day *vs* > 1 days).
10. post-operative opioid analgesia.
11. method of post-operative pain management (conventional method : intermittent intramuscular or intravenous route *vs* special technic : continuous intravenous infusion *via* syringe or infusion pump, patient controlled analgesia, intermittent epidural analgesia or patient controlled epidural analgesia).
12. re-operation during ICU stay: reexploration, debridement, etc.
13. result of treatment (survival *vs* death).

Data were analyzed using the SPSS (Statistical Package for the Social Sciences) for Window version 7.5.1. Length of stay was reported as frequency distribution curve, mean (standard deviation), median, mode and range. Short and long ICU stays were defined as stays of 2 days or less and more than 2 days respectively. This was thought to be the most appropiate stratification point because virtually all patients with uncomplicated ICU stays were discharged from the ICU within 2 days. Univariate statistical analysis was conducted to determine the relation between each of the potential risk factors and length of ICU stay. Odds ratio (OR), Chi square ($X^2$) and p value were calculated for each potential risk factor based on the proportion of patients with a long stay. 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.

## RESULTS

A total of 681 admissions were recorded in the surgical ICU during the one-year study period. 613 admissions were completely recorded which were investigated. 334 (54.4%) were male and 279 (45.6%) were female. The mean age was 49.89 (range 0.02-96) yrs, mean weight was 52.28 (range 2.5-130) kg. Table 1 shows the use of ICU beds by patients in various services.

**Table 1. Services of the patients.**

| | Admission | % |
|---|---|---|
| 1. Cardiothoracic surgery | 386 | 63.0 |
| 2. General surgery | 188 | 30.6 |
| 3. Others : | 39 | 6.4 |
| - Orthopedic surgery | 20 | 3.3 |
| - Urologic surgery | 9 | 1.5 |
| - Trauma | 7 | 1.1 |
| - Plastic surgery | 2 | 0.3 |
| - ENT surgery | 1 | 0.2 |

The length of ICU stay varied from 0.06-78 days. The frequency distribution of length of stays is shown in Fig. 1. The data were highly skewed to the right. The median and mode were 2 days. The mean was 3.05 (± 4.3) days. When compared among major services, there was no statistically significant difference of median and mode as shown in Table 2.

**Table 2. Length of ICU stay (days).**

| | Mean | SD | Median | Mode | Range |
|---|---|---|---|---|---|
| Total (n = 613) | 3.05 | 4.3 | 2 | 2 | 0.06 - 78 |
| Cardiothoracic surgery (n = 386) | 2.89 | 4.7 | 2 | 2 | 0.4 - 78 |
| General surgery (n = 188) | 3.49 | 3.8 | 2 | 2 | 0.06 - 29 |
| Others (n = 39) | 2.45 | 2.4 | 2 | 2 | 0.25 - 13.0 |

**Table 3. Univariate analysis of potential risk factor for a long ICU stay.**

| | Case | % | No of admission with a stay >2d | % | $X^2$ | p-value | OR | 95% CI (OR) |
|---|---|---|---|---|---|---|---|---|
| Age (yr) | | | | | | | | |
| ≤ 60 | 379 | 61.8 | 122 | 32.2 | | | | |
| > 60 | 234 | 38.2 | 98 | 41.8 | 5.9 | 0.015* | 1.51 | 1.08 - 2.12 |
| Sex | | | | | | | | |
| Female | 279 | 45.5 | 93 | 33.3 | | | | |
| Male | 334 | 54.5 | 127 | 38.0 | 1.4 | 0.22 | 1.22 | 0.8 - 1.7 |
| Weight (kg) | | | | | | | | |
| ≤ 70 | 553 | 90.2 | 195 | 35.2 | | | | |
| > 70 | 60 | 9.8 | 25 | 41.6 | 0.96 | 0.32 | 1.31 | 0.7 - 2.2 |
| Admission condition | | | | | | | | |
| Stable | 402 | 65.5 | 83 | 20.6 | | | | |
| Unstable | 211 | 34.4 | 137 | 64.9 | 117.9 | 0.00* | 7.11 | 4.9 - 10.3 |
| Sympathomimetic therapy | | | | | | | | |
| No | 190 | 31 | 42 | 22.1 | | | | |
| Yes | 423 | 69 | 178 | 42.0 | 22.7 | 0.00* | 2.56 | 1.7 - 3.8 |
| Vasodilator therapy | | | | | | | | |
| No | 395 | 64.4 | 142 | 35.9 | | | | |
| Yes | 218 | 35.6 | 78 | 35.7 | 0.001 | 0.96 | 0.99 | 0.7 - 1.4 |
| Diuretic therapy | | | | | | | | |
| No | 247 | 40.3 | 38 | 15.3 | | | | |
| Yes | 366 | 59.7 | 182 | 49.7 | 75.6 | 0.00* | 5.44 | 3.6 - 8.1 |
| Dialysis | | | | | | | | |
| No | 601 | 98 | 212 | 35.2 | | | | |
| Yes | 12 | 2 | 8 | 66.6 | 5.0 | 0.02* | 3.67 | 1.1 - 12.3 |
| Weaning time (day) | | | | | | | | |
| ≤ 1 | 459 | 87.3 | 130 | 28.3 | | | | |
| > 1 | 67 | 12.7 | 66 | 98.5 | 123 | 0.00* | 83.7 | 20.2 - 346.3 |
| Opioid therapy | | | | | | | | |
| No | 45 | 7.3 | 11 | 24.4 | | | | |
| Yes | 568 | 92.7 | 209 | 36.7 | 2.7 | 0.09 | 1.79 | 0.8 - 3.6 |
| Method of pain management | | | | | | | | |
| Special | 238 | 38.8 | 92 | 38.6 | | | | |
| Conventional | 375 | 61.2 | 128 | 34.1 | 1.3 | 0.25 | 1.21 | 0.8 - 1.7 |
| Reoperation | | | | | | | | |
| No | 549 | 89.6 | 176 | 32.0 | | | | |
| Yes | 64 | 10.4 | 44 | 68.7 | 33.5 | 0.00* | 4.66 | 2.6 - 8.1 |
| Result | | | | | | | | |
| Survive | 571 | 93.1 | 190 | 33.2 | | | | |
| Death | 42 | 6.9 | 30 | 71.4 | 24.7 | 0.00* | 5.01 | 2.5 - 10.0 |

* $P < 0.05$

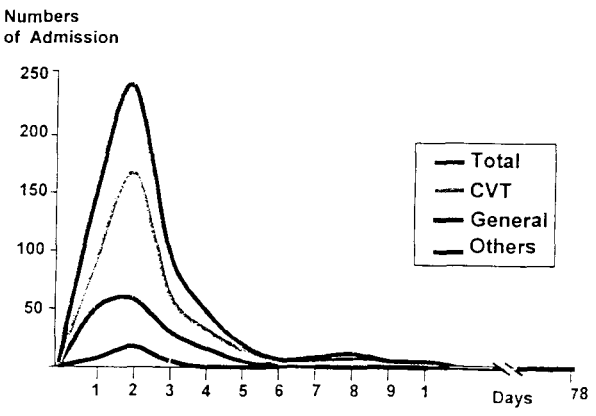


**Fig. 1. Length of ICU stay.**

**Table 4. Logistic regression model for length of ICU stay.**

| | Coeffi-cient | Standard Error | ODDS Ratio | $X^2$ | p-value |
|---|---|---|---|---|---|
| Age >60 yr | 0.66 | 0.22 | 1.9 | 8.5 | 0.003* |
| Admission condition | 1.47 | 0.24 | 4.3 | 37.8 | 0.000* |
| Sympathomimetic therapy | -0.03 | 0.26 | 0.9 | 0.01 | 0.89 |
| Diuretic therapy | 1.34 | 0.25 | 3.8 | 28.9 | 0.000* |
| Dialysis | -0.27 | 0.8 | 0.7 | 0.09 | 0.75 |
| Weaning time | 3.56 | 0.75 | 35.3 | 22.4 | 0.000* |
| Reoperation | 1.29 | 0.36 | 3.6 | 12.6 | 0.000* |
| Death | -0.27 | 0.50 | 0.7 | 0.3 | 0.58 |
| Intercept | -8.32 | 0.93 | | | |

* $P < 0.05$

A total of 35.89 per cent (220 admission) were classified as long-stay patients. The results of the univariate statistical analysis of potential risk factors for long ICU stay are shown in Table 3. Age > 60 yrs, admission condition, sympathomimetic therapy, diuretic therapy, dialysis, weaning time, re-operation and death were found to be statistically significant risk factors for a long ICU stay in the univariate analysis and were entered into the multivariate analysis (Table 4). Five variables were found to be statistically significant independent predictors of a long ICU stay in the multivariate analysis (age, admission condition, diuretic therapy, weaning time and re-operation).

## DISCUSSION

Weissmann C[7], in a retrospective review of 4,499 patients, analyzed the use of the mean, median and mode for evaluating the length of ICU stay. He found that most of the studies[8-25] used the mean, but the average of the means length of stay was higher than the average of the medians ($3.9 \pm 1.8$ *vs* $2.7 \pm 1.1$ days, $p < 0.001$) and modes ($2.1 \pm 1.2$ days, $p < 0.001$), reflecting the rightward skew of the length of stay frequency distributions. In contrast, the median and mode are more accurate in reflecting central tendency so he recommended using the median and mode instead of the mean.

This study also demonstrated both the skew of the frequency distribution and the longer mean than the median and the mode as in Weissmann's report. The median and the mode lengths of ICU stay were 2 days which corresponded accurately with the clinical practice.

From this study, age, admission condition, diuretic therapy, weaning time and re-operation were found to be statistically significant, independent predictors of a long ICU stay (> 2 days) which is similar to previous studies. TU JV et al[1] reported five variables of increasing age, female sex, left ventricular function, type of surgery and urgency of surgery to be independent risk factors for a long ICU stay. Tuman et al[4] developed a 11-variable model (emergency surgery, age, renal dysfunction, previous myocardial infarction, female sex, re-operation, pulmonary hypertension, cerebrovascular disease, type of surgery, congestive heart failure and left ventricular dysfunction) for predicting illness following cardiac surgery and found that increasing risk scores in their model were associated with higher mean lengths of ICU stay. Our study indicates that there are several measures which could shorten ICU stay. It is very important to be extremity careful in the care of the old-age group in order to prevent major organ dysfunction. The unstable patients should be aggressively treated from the start to ensure good homeostasis, hydration and to maintain adequate urination. The necessity for ventilatory support should be evaluated early and the patient should be properly weaned off as soon as indicated to prevent unnecessarily prolonged use of the ventilator.

This study enabled us to predict the ICU course and cost so that the doctor would be in a

better position to advise the patients and relatives accordingly. Patients at lower risk or patients with the shortest expected length of ICU stay should be scheduled for operation earlier in the week and high-risk patients whose condition is stable should be scheduled for operation later in the week so as to maximize the utilization of ICU beds over the weekend when the operation caseload is low. Finally, the best ventilator and equipment should be made available for patients at higher risk to maximize their chances of recovery and shorten the length of ICU stay.

In conclusion, median length of surgical ICU stay at King Chulalongkorn Memorial Hospital from July 1, 1996 to June 30, 1997 was 2 days. 35.89 per cent of the ICU admissions had a long ICU stay (> 2 days) Independent risk factors for a long ICU stay were age, admission condition, diuretic therapy, weaning time and re-operation. Finally, suggestions for patient scheduling and ICU resource planning were presented.

(Received for publication on May 26, 2000)

## REFERENCES


1. TU JV, Mazer CD, Levinton C, Armstrong PW, Naylor CD. A predictive index for length of stay in the intensive care unit following cardiac surgery. Can Med Assoc J 1994; 151: 177-85.
2. Jitapunkul S. Outcome and predicting factors of mortality among newly admitted female medical inpatients. J Med Assoc Thai 1998; 81: 491-6.
3. Thampreechavai S, Somerville K, Jitapunkul S, Bunnag S, Ebrahim S. Elderly bed blockers in a Thai teaching hospital : is it a problem? J Med Assoc Thai 1992; 75: 418-22.
4. Tuman KJ, McCarthy RJ, March RJ, Najafi H, Ivankovich AD. Morbidity and duration of ICU stay after cardiac surgery. A model for preoperative risk assessment. Chest 1992; 102: 36-44.
5. Katz NM, Ahmed SW, Clark BK, Wallace RB. Predictors of length of hospitalization after cardiac surgery. Ann Thorac Surg 1988; 45: 656-60.
6. Lazar HL, Wilcox K, McCormick JR, Roberts AJ. Determinants of discharge following coronary artery bypass graft surgery. Chest 1987; 92: 800-3.
7. Weissmann C. Analyzing intensive care unit length of stay data : Problems and possible solutions. Crit Care Med 1997; 25: 1594-600.
8. Scheeres DE, Scholten DJ. DRGs and outliers in surgical critical care. Am Surg 1989; 55: 511-5.
9. MacKenzie EJ, Morris JA, Edelstein SL. Effect of pre-existing disease on length of hospital stay in trauma patients. J Trauma 1989; 29: 757-65.
10. Kollef MH. Do age and gender influence outcome from mechanical ventilation? Heart Lung 1993; 22: 442-9.
11. Pesau B, Falger S, Berger E, et al. Influence of age on outcome of mechanically ventilated patients in an intensive care unit. Crit Care Med 1992; 20: 489-92.
12. Byrne K, Tatum JL, Henry DA, et al. Increased morbidity with increased pulmonary albumin flux in sepsis-related adult respiratory distress syndrome. Crit Care Med 1992; 20: 28-34.
13. Rutledge R, Fakhry SM, Rutherford EJ, et al. Acute Physiology and Chronic Health Evaluation (APACHE II) score and outcome in the surgical intensive care unit : An analysis of multiple intervention and outcome variables in 1,238 patients. Crit Care Med 1991; 19: 1048-53.
14. Goins WA, Reynolds HN, Nyanjom D, Dunham CM. Outcome following prolonged intensive care unit stay in multiple trauma patients. Crit Care Med 1991; 19: 339-45.
15. MacPherson DS, Parenti C, Nee J, et al. An internist joins the surgical service. J Gen Intern Med 1994; 9: 440-4.
16. Mazer CD, Byrick RJ, Sibbald WJ, et al. Postoperative utilization of critical care services by cardiac surgery : A multicenter study in the Canadian healthcare system. Crit Care Med 1993; 21: 851-9.
17. Becker RB, Zimmerman JE, Knaus WA, et al. The use of APACHE III to evaluate ICU length of stay, resource use, and mortality after coronary artery bypass surgery. J Cardiovasc Surg 1995; 36: 1-11.
18. Limthongkul S, Charoenlap P. Community and hospital acquired pneumonia in medical intensive care unit. J Med Assoc Thai 1993; 76: 129-36.
19. Charash WE, Fabian TC, Croce MA. Delayed surgical fixation of femur fractures is a risk factor for pulmonary failure independent of thoracic trauma. J Trauma 1994; 37: 667-72.
20. Thibault GE, Mulley AG, Barnett O, et al. Medi-

cal intensive care: indications, interventions and outcomes. N Engl J Med 1980; 302: 938-42.
21. Jayr C, Matthey MA, Goldstone J, et al. Pre-operative and intraoperative factors associated with prolonged mechanical ventilation. Chest 1993; 103: 1231-6.
22. Zobel G, Rodl S, Rigler B, et al. Prospective evaluation of clinical scoring systems in infants and children with cardiopulmonary insufficiency after cardiac surgery. J Cardiovasc Surg 1993; 34: 333-7.
23. Mason RA, Newton GB, Cassel W, Mancksha F, Giron F. Combined epidural and general anesthesia in aortic surgery. J Cardiovasc Surg 1990; 31: 442-7.
24. Caldwell MT, Murphy PG, Page R, Walsh TN, Hennessy TP. Timing of extubation after oesophagectomy. Br J Surg 1993; 80: 1537-9.
25. Millns H, Woodward M, Bolton-Smith C. Is it necessary to transform nutrient variables prior to statistical analysis? Am J Epidemiol 1995; 141: 251-62.

# ระยะเวลาการครองเตียงของผู้ป่วยในห้องบริบาลผู้ป่วยหนักศัลยกรรมและปัจจัยเสี่ยง†

*ปวีณา บุญบูรพงศ์, พ.บ.*, เทวารักษ์ วีระวัฒกานนท์, พ.บ.*,*
*วลีภรณ์ ริยะกูล, พย.บ.**, การุณย์ เตชะพิเชฐวนิช, พ.บ.*, วราลักษณ์ รามดิษฐ์, พ.บ.**

**วัตถุประสงค์** : ประเมินระยะเวลาการครองเตียงของผู้ป่วยในห้องบริบาลผู้ป่วยหนักศัลยกรรม และหาปัจจัยเสี่ยงที่มีความสัมพันธ์กับระยะเวลาการครองเตียงนาน

**วิธีการศึกษา** : ศึกษาย้อนหลังจากเวชระเบียนผู้ป่วย

**วัสดุและวิธีการ** : ในช่วงเวลาตั้งแต่ 1 กรกฎาคม 2539 ถึง 30 มิถุนายน 2540 มีผู้ป่วยเข้ามารับการรักษาในห้องบริบาลผู้ป่วยหนักศัลยกรรม โรงพยาบาลจุฬาลงกรณ์ทั้งหมด 681 ครั้ง เวชระเบียนผู้ป่วยที่มีข้อมูลเพียงพอและนำมาศึกษามีทั้งหมด 613 ครั้ง

**ผลการศึกษา** : กราฟแจกแจงความถี่ของระยะเวลาการครองเตียงเป็นกราฟเบ้ขวา โดยที่มัชฌิมเลขคณิต (median) และมัธยฐาน (mode) มีค่า 2 วันเท่ากัน นอกจากนั้น 35.89% ของการเข้ารับการรักษาในห้องบริบาลผู้ป่วยหนักมีระยะเวลาการครองเตียงนานกว่า 2 วัน ปัจจัยเสี่ยงที่มีความสัมพันธ์อย่างมีนัยสำคัญทางสถิติ ($p<0.05$) ใน multivariate logistic regression analysis กับระยะเวลาการครองเตียงที่นานกว่า 2 วัน ได้แก่ อายุที่มากขึ้น, อาการของผู้ป่วยขณะที่เข้าห้องบริบาลผู้ป่วยหนักที่ไม่คงที่, ระยะเวลาการเลิกใช้เครื่องช่วยหายใจนาน การใช้ยาขับปัสสาวะ และการผ่าตัดซ้ำ

**สรุป** : การทราบถึงระยะเวลาการครองเตียง และปัจจัยเสี่ยงที่มีความสัมพันธ์กับระยะเวลาการครองเตียงนานจะช่วยให้การบริหารเตียงในห้องบริบาลผู้ป่วยหนักมีประสิทธิภาพมากขึ้น เป็นการช่วยประหยัดค่าใช้จ่ายของผู้ป่วยและโรงพยาบาลลงได้

**คำสำคัญ** : ระยะเวลาการครองเตียง, ห้องบริบาลผู้ป่วยหนัก, ศัลยกรรม, ปัจจัยเสี่ยง

**ปวีณา บุญบูรพงศ์, เทวารักษ์ วีระวัฒกานนท์,**
**วลีภรณ์ ริยะกูล, การุณย์ เตชะพิเชฐวนิช, วราลักษณ์ รามดิษฐ์**
**จดหมายเหตุทางแพทย์ ฯ 2544; 84: 1103-1108**

* ภาควิชาวิสัญญีวิทยา, คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย, กรุงเทพ ฯ 10330
** ไอ.ซี.ยู ศัลยกรรม, โรงพยาบาลจุฬาลงกรณ์ กรุงเทพ ฯ 10330
† นำเสนอในการประชุมวิชาการ ราชวิทยาลัยวิสัญญีแพทย์แห่งประเทศไทย ครั้งที่ 49 กรุงเทพฯ 13 กุมภาพันธ์ 2542