Factors Influencing Length of Stay in Adult Intensive Care Units at a University Hospital in Thailand

Petsunee Thungjaroenkul[1*], Wipada Kunaviktikul[2], Thitinut Akkadechanunt[2] and Philip Jacobs[3]

[1]*Ph.D. candidate, Faculty of Nursing, Chiang Mai University, Chiang Mai 50200, Thailand*

[2]*Faculty of Nursing, Chiang Mai University, Chiang Mai, 50200, Thailand*

[3]*University of Alberta, Alberta, T5J3N4, Canada*

**Corresponding author. E-mail: petsunee@mail.nurse.cmu.ac.th*

ABSTRACT

The problem of prolonged-stay in an Intensive Care Unit (ICU) may be due to patients' conditions and inefficient care management. To solve this problem requires empirical information on factors affecting ICU Length of Stay (LOS). The purposes of this study are to assess LOS in four ICUs at a university hospital in Thailand and factors influencing length of ICU stay. In this descriptive correlational study, data were obtained from a total of 242 patient records, assignment sheets and daily nurses' reports. The following data were recorded: patient age, diagnosis, ICU type, severity of illness, serum albumin level, lymphocyte count, day and time of patient admission, duration of mechanical ventilation, LOS, discharge status, the average ratio of registered nurse (RN)-to-patient and the average ratio of RN-to-other nursing staff. Findings showed a mean ICU LOS of 5.2 days. The predictors for ICU LOS were severity of illness, serum albumin level, lymphocyte count, ICU type, day and time of patient admission and the average ratio of RN-to-patient (R2adj = 0.29, p < 0.001). The study provides information for health personnel to facilitate care management decisions for prolonged-stay patients.

Key words: Length of stay, Intensive care, Severity of illness, Nurse staffing

INTRODUCTION

ICUs are highly-specialized hospital areas where critically-ill patients are monitored and treated by skilled personnel and complex equipment, resulting in higher expenditures per patient day than other areas in the hospital (Bonvissuto, 1994). Due to ICUs being the most costly place to care for patients, a typical critically-ill patient should require only a short length of stay (LOS) in a unit during the most acute phase of illness (Daly et al., 1991). However, a study showed that 3% of the total number of ICU patients had durations of intensive care greater than 21 days and accounted for approximately 25% to 38% of patient days (Daly et al., 1991). An additional study in a university hospital in Thailand revealed that LOS in surgical ICUs ranged from 1 to 78 days with mean of 2 days (Bunburaphong et al., 2001). Although the majority of ICU patients in that study were concentrated on ICU LOS of two days, a subpopulation had prolonged-stay of more than one month. Prolonged-ICU stay adversely affects patients' health status by increasing the risk of infection, complications and possibly mortality (Gilio et al., 2000). It also results in high resource utilization and often blocks other patients who also could have been in greater need of the critical care resources (Bunburaphong et al., 2001).

Prolonged-ICU stays represent a challenge to the current system because of concern for hospital budget limitation. Several authors have shown that age (Smith, 1989; Emori et al., 1991; Ruiz-Bailen et al., 2002), severity of illness (Wood et al, 2000; Arabi et al, 2002), and malnutrition(Bower, 1990; Christman and McCain, 1993; Braunschweig et al., 2000), all of these influence ICU stays. Management factors will also influence the ICU stays, and information on factors affecting ICU LOS may facilitate care management decisions for prolonged-stay patients. Sufficient number of registered nurses (RNs) may prevent patients from adverse events that would cause patients to stay longer than necessary (Pronovost et al., 1999; Amaravadi et al., 2000). Furthermore, limited access to laboratory or diagnostic tools on the weekend-days and non-office hours may also lead to prolonged-ICU stay (Barnett et al., 2002; Uusaro et al., 2003).

While contemporary literature confirms that hospital management and patient characteristics affected lengths of ICU stay, none was conducted in the context of hospitals in Thailand. Instead, most of these studies had been conducted in hospitals which differed from those in Thailand in terms of the competency of nursing staff, technology and diagnostic equipment. Consequently, studies in Thailand society may yield different results. Therefore, the objectives of this study are (a) to assess length of ICU stay and (b) the predictors of length of ICU stay.

MATERIALS AND METHODS

Study Design and Setting

This is a descriptive correlational study that was approved by the Ethical Committee of the Faculty of Nursing, Chiang Mai University, Thailand and that of the Maharaj Nakorn Chiang Mai Hospital. Our study was carried out in 3 medical ICUs and 1 surgical ICU in a 1,400-bed university hospital in Thailand, the Maharaj Nakorn Chiang Mai Hospital. Within these ICUs, intensive care was provided by an ICU team, consisting of critical care trained physicians, residents, medical students, RNs, practical nurses (PNs), helpers (HPs) and respiratory therapists.

Sample and Measure

Data were obtained from three sources: patient records, assignment sheets and daily nurses' reports. The patient records were selected by purposive sampling with the following criteria: 1) records of patients who were aged 15 years old or older; 2) those of patients who were admitted to one of three medical or a surgical ICU; and 3) those of patients who stayed longer than 24 hours in the ICU. The sample size of the patient records was estimated based on a case to variable ratio of approximately 30 times the number of independent variables for multiple regressions (Tabanchnick and Fidell, 1996). Thus, the total number of the patient records sought for the current study was 242, divided into 122 and 120 charts of medical and surgical patients, respectively. Assignment sheets of ICU personnel and daily nurses' reports were obtained from each ICU that the eligible patients were admitted to over a seven-month period from November 1, 2005 to May 30, 2006.

The research instrument was data collecting forms. Data collected included patient age, ICU type, admission diagnosis, location prior to ICU admission, level of serum albumin, lymphocyte count, duration of mechanical ventilation, discharge destination, day and time of discharge and discharge status. A severity of illness score for each patient was measured by using Simplified Acute Physiology Score II, developed by Le Gall et al., (1993). Nutrition status is defined as the levels of serum albumin and lymphocyte counts in the human body. It was performed within 48 hours after admission. Nurse staffing levels were determined by the average ratio of RN-to-patient on an 8-hour nursing shift and the average ratio of RNs-to-other nursing staff (practical nurses and helpers) on an 8-hour nursing shift. Length of ICU stay was calculated by subtracting day of discharge from day of admission.

Data Collection

Prior to starting the data collection process, an instructional booklet was developed to assist the research team. The booklet contained a brief guide on how to score each variable. Two RNs with prior ICU experience were hired to be research assistants (RAs) and formally trained by the investigators. The information regarding the objectives of this study, inclusion criteria of the patient records and the information of collecting data forms were provided and discussed. During the training sessions, questions and concerns from the RAs were clarified. Inter-rater agreement was monitored before data were collected independently. The couple of RAs and the first author reviewed the same 25 patient records. The inter-rater reliability between the first author and the two RAs was 1.0.

During the data collection process, the first author and RAs assessed patient eligibility. Assessment of individual patient information was performed during the first 24 hours after admission and on the date of discharge. To assess nurse staffing in each 8-hour shift, we reviewed assignment sheets of ICU personnel to capture the total number of RNs, PNs and HPs in each 8-hour shift. We also reviewed daily nurses' reports to obtain the total number of patients in each 8-hour shift.

Data Analysis

Mean, standard deviation, median and percentile were used to assess length of ICU stay in this study. Stepwise multiple regression analysis was used to determine the predictors of length of ICU stay. The p-value was set at 0.05 and the squared multiple correlation (R^2), defined as the magnitude of the relationship between a dependent variable and several independent variables, was reported.

Analyses were performed by using SPSS for Windows, version 13. The regression model was first developed using the known values of length of ICU stay as a dependent variable (DV), and independent variables (IVs) that included patient age, severity of illness at admission, the groups of serum albumin level, the groups of lymphocyte count, day and time of patient admission, ICU type, the average ratio of RN-to-patient and the average ratio of RN-to-other nursing staff. When data were tested for the regression assumptions by using a residual analysis, the analysis illustrated the problem of non-normality and non-homoscedasticity of the variable of length of ICU stay. To avoid this problem, a logarithmic transformation of the original values of length of ICU stay was tried and the transformed distributions checked once again for the regression assumptions. Residual analysis following regression with the logarithmically-transformed lengths of ICU stay indicated that a residual scatter plots were considerably improved over the previous distribution. Furthermore, the normal probability plot of residuals following regression with the transformed lengths of ICU stay showed that the scatter of points was located along the straight line. This signified that the logarithmic transformation could help to stabilize the variance and achieve assumptions of regression. Therefore, the DV in this study became the logarithmically-transformed length of ICU stay whereas transformation was not undertaken in the case of all IVs.

RESULTS

Demographic data of the sample are shown in Table 1. The age distribution of patients was found to concentrate in the older-than-60-years category. Diseases of the nervous system as well as the digestive system were most prevalent among surgical ICU patients while the respiratory system disorder and renal failure were most prevalent in medical units. The majority of the surgical ICU patients (62.5%) were male whereas half of medical ICU patients (50.8 %) were female. The percents of patients who had abnormal level of serum albumin and abnormal lymphocyte count, respectively, were approximately 27.5% and 85% of surgical patients and were slightly higher in medical patients (36.9% and 86.1%, respectively). The mean scores of severity of illness for surgical patients on admission was 28.7 (SD = 16.1) and was higher in medical patients (M = 50.0, SD = 20.7). Medical patients were more likely to have longer duration of mechanical ventilation than surgical ones (M = 3.3 vs 2.0 days). Death rates in surgical and medical ICUs were 8.3% and 19.7%, respectively.

Length of ICU stay ranged from 1 to 21 days, with a mean of 5.2 (SD = 2.2) days and median of 5 days (Table 2). Data also showed that there were 34 (14%) patients staying in an ICU for more than one week. Of 34 patients, approximately 90% were cared for in the medical ICU and nearly 10% in the surgical ICU. Stratification of length of ICU stay of surviving patients by diagnostic groups indicated that mean lengths of ICU stay ranged from 3.8 to 6.6 days and median ranged from 3 to 6 days (Table 3). The 75th percentile lengths of ICU stay of each patient group were less than 6 days, except a group of patients with respiratory system diseases which had the 75^{th} percentile ICU LOS of 8 days and those with renal failure which had the 75th percentile ICU LOS of 7 days. This signified that surviving patients with these diseases were more likely to have longer stay in an ICU.

To assess the predictors of length of ICU stay, the results for the regression model, shown in Tables 4 and 5, illustrated that the predictors of length of ICU stay were severity of illness, the groups of serum albumin level, the groups of lymphocyte count, ICU type, day of patient admission, time of patient admission and the average ratio of RN-to-patient with $R^2 = 0.31$, $R^2adj = 0.29$, F (7, 209) = 13.35, $p < 0.001$. This model accounted for 31% of variance in logarithmically-transformed length of ICU stay.

The predicted equation of length of ICU stay also showed the magnitude of change in the predicted value of length of ICU stay for a specific rate of change in independent variables (IVs). For every unit change in each predictor, the magnitude of change in the predicted value of length of ICU stay can be estimated by 2.72 to the power of its regression coefficient. Thus, the regression coefficient for the severity of illness was 0.01; this indicated that, holding constant the values on the other predictors, lengths of ICU stay increased 1% for every unit decreasing in the severity of illness point. The regression coefficient for the average ratio of RN-to-patient was 0.005, meaning that for every one percent decrease in the average ratio of RN-to-patient, length of ICU stay increased 0.5% if the values on the other IVs were held constant.

In case of dummy variables which consisted of types of ICU, the groups of serum albumin level, the groups of lymphocyte count, time and day of patient admission, their regression coefficients were interpreted as follows. The regression coefficient of the variable of types of ICU was 0.06. This meant that length of ICU stay for medical patients was 1.06 times longer than that of surgical patients. For the variables of groups of albumin level and groups of lymphocyte count, the regression coefficients were 0.18 and 0.24, respectively. This signified that length of ICU stay for the patients who had an abnormal level of albumin was 1.20 times longer than those with a normal albumin level. Patients with an abnormal level of lymphocyte were likely to have 1.27 times longer length of ICU stay compared to those with a normal level.

The regression coefficients of the variable of time and day of patient admission were 0.14 and 0.13, respectively. This meant that patients who were admitted to an ICU on non-office hour were likely to have 1.2 times longer length of ICU stay relative to those with office-hour admission while those who were admitted on a weekend-day increased length of ICU stay to 1.2 times longer than patients who were admitted on a weekday.

DISCUSSION

In this paper, we conducted an analysis of ICU length of stay in a Thai hospital, focusing on those variables that can be influenced by patient management decision. Our analysis indicated the importance of certain non-modifiable variables such as patient age, severity of illness and malnutrition. It also identified certain modifiable predictors of prolonged-ICU stay. Understanding some of these predictors can help plan strategies to improve resource utilization. This study confirmed that the presence of abnormal serum albumin level and lymphocyte count at admission was significantly associated with increased length of ICU stay ($p < 0.01$). A potential explanation for this finding may be due to malnutrition leading to a catabolic state (Bower, 1990; Christman and McCain, 1993). Thus, if physicians, nurses and other staff can identify the nutrition status of patients and provide appropriate nutrition intervention early on, ICU length of stay might decrease and this might also lead to quicker recovery and discharge

Our findings highlighted the importance of sufficient availability of services during weekend-days and non-office hours in ICUs. The results demonstrated that length of ICU stay had been increased if patients were admitted to an ICU on weekends and during 4.00 pm one day to 8.00 am the following day. One explanation for the effect of day and time of patient admission on length of ICU stay in this study may be related to personnel and procedural issues. Although ICUs are organized with continuous coverage by physicians and a very high nurse-to-patient ratio, the reduction in the number of medical staff and the availability of laboratory and diagnostic tests is a real situation found in ICUs on weekends and after office hours. In addition, people who work in ICUs during these times often have less seniority and experience. The reduction of service capacity over the weekend-days and non-office hours might result in prolonged length of ICU stay through delays in obtaining the necessary initial work-up for newly-admitted cases.

A negative association between the average ratio of RN-to-patient and length of ICU stay was found in this study. Reasons for better outcomes with sufficient number of RNs may be related to the immediate availability of a RN to evaluate and care for patients. Evidence suggested that educational background and clinical experiences of RNs could enhance the nurses' ability to judge actual situations, detect changes in patient status as well as alter planned interventions in response to the patient's condition (Behner et al., 1990; Bloom et al., 1997). Furthermore, professional nurses could improve patient recovery by using proactive management, weaning from ventilation, coping with unpredictable events and prompt interventions in the event of sudden deterioration (Thorens et al., 1995; Archibald et al., 1997; Kovner et al., 2002). Despite the advances in technological expertise in ICUs, there was still no substitute for properly-trained professionals providing direct patient care (Beckman et al., 1996; Buckley et al., 1997). According to the above authors, this evidence suggests that ICUs can benefit greatly from exploiting the full potential of RNs.

Our findings also indicated that skill mixes, featuring higher RN-to-other nursing staff ratios, were not related to length of ICU stay when severity of illness, nutrition status and the average ratio of RN-to- patient were constant. From these results, one can infer that increasing other nursing staff will not affect length of ICU stay whenever an adequate number of RNs is maintained. The above observation may be due to the fact that although other nursing staff, including PNs or HPs, are employed within critical care environments to assist RNs in performing non-nursing duties, the majority of direct patient-care activities still remain within the remit of the RNs. Therefore, greater use of other nursing staff does not reduce the amount of time which different RNs spend on performing ICU-related activities. The investigators suggest that within ICUs, RNs are more productive than unlicensed assistive staff because the former can perform the entire range of nursing tasks without supervision. However, the assistive staff are needed because hospital policy frequently requires an extra nurse to assist with ICU nursing procedures. Examples of these procedures included tube care, tube suction, tuning of patients, nasogastric feeding, bed bathing and housekeeping in the bed area. Further continuity in patient care and safety will be compromised if there are sufficient numbers of non-RNs to cover for the movement of RNs away from the bedside.

There are some limitations in the current study. The results of the study cannot be generalized directly since data used in this study represented only one university hospital in Thailand. This stems from a limitation of resources for investigation. The challenges to validity and reliability were related to potential errors in the data collection by the two research assistants. The investigators attempted to control this error through inter-rater reliability training at the start of the study and by providing guideline for collecting data. Given that detailed procedure on coding and scoring the research instruments were outlined, we kept these errors to a minimum.

CONCLUSION

Results of the study reflected that significantly increasing length of ICU stay was associated with abnormal serum albumin level and lymphocyte count as well as weekend-day admission. Prolonged-stay in the ICU was also reduced with greater RN staffing as RNs have adequalte knowledge and skill levels to provide more effective nursing care. Many of these results provided evidence for hospital management decisions on the quality of healthcare in ICUs. In addition, prospective collection and analysis of demographic and clinical data on ICU patients helped identify predictors of prolonged-length of ICU stay and evolve pragmatic strategies for decreasing durations of intensive care.

Table 1. Demographic characteristics of the study sample (N = 242).

Characteristics	Surgical ICU (*n* = 120) Number (%)	Medical ICU (*n* = 122) Number (%)
Patient age		
15 through 25 years	18 (15.0%)	10 (08.2%)
26 through 40 years	16 (13.3%)	13 (10.7%)
41 through 60 years	34 (28.3%)	28 (23.0%)
more than 60 years	52 (43.4%)	71 (58.1%)
Patient diagnoses categorized by ICD 10		
Diseases of the respiratory system	10 (08.3%)	59 (48.4%)
Renal failure	0 (00.0%)	24 (19.7%)
Diseases of the circulatory system	21 (17.5%)	10 (08.2%)
Infectious and parasitic diseases	37 (30.8%)	8 (06.6%)
Diseases of the nervous system	26 (21.7%)	6 (04.9%)
Diseases of the digestive system	20 (16.7%)	6 (04.9%)
Injury	2 (01.7%)	0 (00.0%)
Other diseases	4 (03.3%)	9 (07.3%)
Levels of serum albumin at admission		
< 3.2 grams per liter (abnormal level)	33 (27.5%)	45 (36.9%)
≤ 3.2 grams per liter (normal level)	66 (55.0%)	73 (59.8%)
No result	21 (17.5%)	4 (03.3%)
Lymphocyte count at admission		
< 2,000 cells/mm^3 (abnormal level)	102 (85.0%)	105 (86.1%)
≤ 2,000 cells/mm^3 (normal level)	18 (15.0%)	17 (13.9%)
Severity of illness scores at first 24 hour admission	96 (80.0%)	44 (36.1%)
Less than 40 (Predicted risk of death < 25%)	13 (10.8%)	27 (22.1%)
41 to 51(Predicted risk of death = 25% to50%)	6 (05.0%)	26 (21.3%)
52 to 63(Predicted risk of death = 50% to75%)	5 (04.2%)	25 (20.5%)
More than 63 (Predicted risk of death > 75%)		
Duration of mechanical ventilator		
No ventilation assistance	22(18.3%)	14(11.5%)
1.0 to 4.0 days	80(66.7%)	64(52.5%)
4.1 to 7.0 days	18(15.0%)	34(27.9%)
> 7 days	0(00.0%)	10(08.2%)
Discharge status		
Non-survival	10 (08.3%)	24 (19.7%)
Survival	110 (91.7%)	98 (80.3%)

Table 2. Lengths of ICU stay by types of patients (Unit: in day).

Types of Patients	*N*	Mean (± *SD*)	Median	75th percentile of LOS	95th percentile of LOS
Medical patients	122	6.6 (± 2.9)	6.0	8.0	11.0
Surgical patients	120	4.1 (± 1.0)	4.0	5.0	6.0
All patients in the study	242	5.2 (± 2.2)	5.0	6.0	10.0

Table 3. Lengths of ICU stay for surviving patients by diagnostic groups (N = 208).

Diagnostic groups	Number of survivors	Min (days)	Max (days)	Mean (±SD) (days)	Median (days)	75th percentile of LOS (days)	95th percentile of LOS (days)
Diseases of respiratory system	60	1	21	6.6 (± 2.9)	6.0	8.0	14.0
Diseases of digestive system	27	2	7	4.1 (± 1.0)	4.0	5.0	6.0
Renal failure	18	3	16	6.2 (± 2.2)	6.0	7.0	12.0
Diseases of circulatory system	29	2	11	4.9 (± 2.2)	4.0	6.0	10.0
Diseases of nervous system	43	1	9	4.8 (± 2.0)	4.0	6.0	8.0
Infectious & parasitic diseases	10	2	7	3.8 (± 1.5)	3.0	4.0	6.0
Injury	13	2	7	4.8 (± 1.9)	4.0	5.0	6.0
Other diseases	8	2	7	3.8 (± 0.9)	4.0	5.0	6.0

Table 4. A summary of the stepwise multiple regression model of logarithmically-transformed length of ICU stay (N = 216).

Step predictors	*R*	R^2	$R^2 adj$	R^2 *Change*	*F Change*	*P*	df_1, df_2
1. ICU types	0.35	0.12	0.12		29.61	0.00	1, 215
2. Severity of illness (unit: in point)	0.44	0.19	0.18	0.07	24.97	0.00	2, 214
3. The average ratio of RN to Patient (unit: in percent)	0.48	0.23	0.22	0.04	21.06	0.00	3, 213
4. Groups of serum albumin levels	0.51	0.26	0.24	0.03	18.19	0.00	4, 212
5. Groups of lymphocyte counts	0.53	0.28	0.26	0.02	16.45	0.00	5, 211
6. Time of patient admission	0.54	0.30	0.28	0.02	14.69	0.00	6, 210
7. Day of patient admission	0.56	0.31	0.29	0.01	13.35	0.00	7, 209

Table 5. A summary of regression coefficients for the stepwise multiple regression model of logarithmically-transformed length of ICU stay (*N* = 216).

Variables	*B*	*Std. Error*	*Beta*	*t*	*p-value*	Collinearity Statistic	
						Tolerance	*VIF*
(Constant)	1.95	0.13		14.76	0.00		
ICU types	0.60	0.07	0.57	8.19	0.00	0.69	1.44
Severity of illness (unit: in point)	-0.01	0.00	-0.28	-4.15	0.00	0.73	1.36
The average ratio of RN to Patient (unit: in percent)	-0.005	0.001	-0.30	-4.13	0.00	0.82	1.23
Groups of serum albumin levels	0.18	0.07	0.16	2.59	0.01	0.89	1.13
Groups of lymphocyte counts	0.24	0.09	0.16	2.74	0.01	0.99	1.01
Time of patient admission	0.14	0.07	0.12	2.13	0.03	0.99	1.02
Day of patient admission	0.13	0.07	0.12	2.01	0.04	0.95	1.06

ACKNOWLEDGEMENTS

The authors thank the administrators and the heads of departments in Maharaj Nakorn Chiang Mai Hospital for their cooperation and assistance along the data collection process. We also thank the Ministry of Education of Thailand, UMAP program and the Graduate School of Chiang Mai University for providing financial support. Special thanks are due to Assistant Professor Dr. Greta G. Cummings, School of Nursing, University of Alberta, Canada, for providing comments and editing the paper for us.

REFERENCES

Amaravadi, R. K., J. B. Dimick, P. J. Pronovost, and P. A. Lipsett. 2000. ICU nurse-to-patient ratio is associated with complications and resource use after esophagectomy. Intensive Care Med. 26: 1857-1862.

Arabi, Y., S. Venkatesh, S. Haddad, A. A. Shimemeri, and A. S. Malik. 2002. A prospective study of prolonged stay in the intensive care unit: predictors and impact on resource utilization. Int. J. Qual. Health Care 14: 403-410.

Archibald, L. K., M. L. Manning, L. M. Bell, S. Banerjee, and W. R. Jarvis. 1997. Patient density, nurse to patient ratio and nosocomial infection risk in a pediatric cardiac intensive care unit. Pediatr. Infect. Dis. J. 16: 1045-1048.

Barnett, M. J., P. J. Kaboli, C. A. Sirio, and G. E. Rosenthal. 2002. Day of the week of intensive care admission and patient outcomes: a multi-site regional evaluation. Med. Care 40: 530-539.

Beckman, U., I. Baldwin, G. K. Hart, and W. B. Runciman. 1996. The Australian incident monitoring study in intensive care (AIMS-ICU): an analysis of the first year of reporting. Anaesth. Intensive Care 24: 320-329.

Behner, K. G., L. F. Fogg, L. C. Fournier, J. Frankenbach, and S. B. Robertson. 1990. Nursing resource management: analyzing the relationship between costs and quality in staffing decisions. Health Care Manage. Rev. 15: 63-71.

Bloom, J. R., J. A. Alexander, and B. A. Nuchols. 1997. Nurse staffing patterns and hospital efficiency in the United States. Soc. Sci. Med. 44: 145-155.

Bonvissuto, C. A. 1994. Avoiding unnecessary critical care costs. Healthc. Financ. Manage. 48: 47-8, 50, 52-56.

Bower, R. H. 1990. Nutritional and metabolic support of critically ill patients. J. Parenter. Enteral Nutr. 14: 257S-259S.

Braunschweig, C., S. Gomez, and P. M. Sheean. 2000. Impact of declines in nutritional status on outcomes in adult patients hospitalized for more than 7 days. J. Am. Diet. Assoc. 100: 1316-22, quiz 1323-1324.

Buckley, T. A., T. G. Short, Y. M. Rowbottom, and T. E. Oh. 1997. Critical incident reporting in the intensive care unit. Anaesthesia. 52: 403-409.

Bunburaphong, P., W. Riyagoon, W. Ramdit, T. Werawatganon, and K. Techapichetvanich. 2001. Length of surgical intensive care unit stay and risk factors. J. Med. Assoc. Thai. 84, 1103-1108.

Christman, J. W., and R. W. McCain. 1993. A sensible approach to the nutritional support of mechanically ventilated critically ill patients. Intensive Care Med. 19: 129-136.

Daly, B. J., E. B. Rudy, K. S. Thompson, and M. B. Happ. 1991. Development of a special care unit for chronically critically ill patients. Heart Lung 20: 45-51.

Emori, T. G., S. N. Banerjee, D. H. Culver, R. P. Gaynes, T. C. Horan, J. R. Edwards, W. R. Jarvis, J. S. Tolson, T. S. Henderson, and W. J. Martone. 1991. Nosocomial infections in elderly patients in the United States, 1986-1990: national nosocomial infections survellian system. Am. J. Med. 91: 289S-293S.

Gilio, A., A. Stape, C. R. Pereira, M. Cardoso, C. Silva, and E. Troster. 2000. Risk factors for nosocomial infections in a critically ill pediatric population: a 25-month prospective cohort study. Infect Control Hos Epidemiol. 21: 340-342.

Kovner, C., C. Jones, C. Zhan, P. J. Gergen, and J. Basu. 2002. Nurse staffing and post surgical adverse events: an analysis of administrative data from a sample of U.S. hospitals, 1990-1996. Health Serv. Res. 37: 611-629.

Le Gall, J. R., S. Lemeshow, and F. Saulnier. 1993. A new simplified acute physiology score (SAPS II) based on a European/ North Amercian multicenter study. J.A.M.A. 270: 2957-2963

Pronovost, P. J., M. W. Jenckes, T. Dorman, E. Garrett, M. J. Breslow, B. A. Rosenfeld, P. A. Lipsett, and E. Bass. 1999. Organizational characteristics of intensive care units related to outcomes of abdominal aortic surgery. J. Am. Med. Assoc. 281: 1310-1317.

Ruiz-Bailen, M., E. Aguayo de Hoyos, J. A. Ramos-Cuadra, M. A. Diaz-Castellanos, Z. Issa-Khozouz, A. Reina-Toral, A. Lopez-Martinez, J. Calatrava-Lopez, F. Laynez-bretones, J. C. Castillo-Parra, and M. V. De La Torre-Prados. 2002. Influence of age on clinical course, management and mortality of acute myocardial infarction in the Spanish population. Int. J. Cardiol. 85: 285-296.

Smith, P. W. 1989. Nosocomial infections in the elderly. Infect. Dis. Clin. North Am. 3: 763-777.

Tabachnick, B. G., and L. S. Fidell. 1996. Using multivariate statistics (3rd ed.). Harper and Row, New York.

Thorens, J. B., R. M. Kaelin, P. Jolliet, and J. C. Chevrolet. 1995. Influence of the quality of nursing on the duration of weaning from mechanical ventilation in patients with chronic obstructive pulmonary disease. Crit. Care Med. 23: 1807-1815.

Uusaro, A., A. Kari, and E. Ruokonen. 2003. The effects of ICU admission and discharge times on mortality in Finland. Intensive Care Med. 29: 2144-2148.

Wood, W. A., N. F. MacKirdy, M. B. Livingston, J. Norrie, and C. J. Howie. 2000. Evaluation of predicted and actual length of stay in 22 Scottish intensive care units using the APACHE III system. Anaesthesia 55: 1058-1065.