

Predicted Factors of Prolonged Postoperative ICU Admission More Than Four Days: Thai Tertiary University Hospital

Thitima Chinachoti, M.D., Kullamas Jongthansethakul, M.D., Panop Limratana, M.D., Patiparn Toomtong, M.D.

Department of Anesthesiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.

ABSTRACT

Objective: To identify the risk factors associated with prolonged intensive care unit admission (≥ 4 days) and mortality in postoperative surgical patients.

Methods: A retrospective, case-control study was conducted in 527 patients admitted to postoperative intensive care units during a 1-year period. Fifteen factors were included in univariate and only significant factors were included in multivariate analyses.

Results: Twenty one percent of all admissions had prolonged length-of-stay. From multivariate analysis, predicted risk factors were emergency surgery (OR 2.9, $p=0.001$, CI 1.6-5.2); remained intubation (OR 2.6, $p=0.007$, CI 1.3-5.4), unplanned ICU admission (OR 2.1, $p=0.03$, CI 1.1-4.2); SAPS II score >52 (OR 4.8, $p<0.001$, CI 2.5-9.2), SAPS II score >64 (OR 6.1, $p<0.001$, CI 2.7-13.8) and inotrope infusion in ICU (OR 4.5, $p<0.001$, CI 2.5-8) which were associated with prolonged ICU admission. Factors associated with ICU mortality (10.06%) were; ASA physical status >3 (OR 8.2, $p=0.003$, CI 2-32.9), ICU readmission (OR 3.9, $p=0.007$, CI 1.5-10.8), inotrope infusion in ICU (OR 3, $p=0.006$, CI 1.4-6.7), renal replacement therapy (OR 3.2, $p=0.007$, CI 1.3-8.2), SAPS II score 52-63 (OR 3.6, $p=0.018$, CI 1.2-6.8), SAPSII score >64 (OR 3.9, $p=0.006$, CI 1.4-9) and cirrhosis (OR 4.9, $p=0.04$, CI 1.1-21).

Conclusion: ASA physical status >3 and SAPS II score >52 were independent predictive factors of both prolonged intensive care unit admission and mortality.

Keywords: Prolonged ICU admission; mortality; SAPS II score

Siriraj Med J 2016;68:277-283

E-journal: <https://www.tci-thaijo.org/index.php/sirirajmedj>

INTRODUCTION

Siriraj Hospital was the first tertiary university hospital established in Thailand. The hospital has 2,000 in-patient capacity and approximately 45,000 anesthetics are performed annually. Seven point five percent of surgical patients are admitted to surgical intensive care

unit (ICU) postoperatively and attended by staff anesthesiologists and residents in two 7-bed surgical ICUs.

The ICU length-of-stay may reflect an increase in resource use and adverse outcome in the perioperative period and may impact hospital and ICU-mortality.¹ A study in mixed ICUs has shown a predictive value of the cut-point of 5 admission days on patient characteristics, outcomes and mortality.² Pre-admission data and physiologic parameters during ICU admission may associate with length-of-stay and mortality.^{3,4}

Correspondence to: Thitima Chinachoti

E-mail: sitci35@gmail.com, thitima.chn@mahidol.ac.th

Received 3 February 2016

Revised 23 April 2016

Accepted 13 May 2016

This retrospective medical record review was conducted to identify the risk factors associated with prolonged (more than 4 days) ICU admissions and overall mortality in postoperative surgical patients.

MATERIALS AND METHODS

This retrospective case-control study was approved by the Siriraj Institutional Review Board (Si No. 814/2556, 042/2014). Medical records of patients who were admitted in the surgical ICUs between September 2013 and December 2014 were consecutively retrieved from electronic medical record system. Surgical patients were aged more than 15 years and were not operated in cardio-thoracic nor neurological surgery. Patients who were admitted in the ICU more than 5 days prior to surgery, discharged or died within 6 hours of ICU admission were excluded. Medical records without definite ICU length-of-stay were not included. For patients who had more than one ICU admission, the data from the first ICU stay were retrieved for analysis.

Fifteen factors^{3,5-10} were reported to be associated with prolonged ICU admission including age, gender, type of surgery, emergency surgery, admission prior to surgery, unplanned ICU admission, SAPS II score (simplified acute physiology score), chronic kidney disease, acute kidney injury, cirrhosis, alcohol dependence, anemia, carcinoma-related condition, cardiac failure and respiratory failure. The sample size was calculated by using “rule-of-thumb” in the number of 5 to 10 patients for each considered factor. Calculations demanded 75 to 150 patients who had ICU length-of-stay more than 4 days to be sufficient for subsequent multiple logistic regression analysis.

Retrieved medical records were reviewed by the authors according to the inclusion and exclusion criteria. All demographic data, medical diseases, medical condition and studied factors were retrieved from medical records excepted SAPS score were retrospectively calculated from initial condition before operation. Statistical analyses were performed using SPSS 21.0 software (SPSS Inc., Chicago, IL, USA). Categorical data were presented as percentage and continuous data

were presented as mean with standard deviation. Demographic data were summarized by descriptive statistics. Data were divided into two groups of prolonged ICU admission or not and between the group of ICU mortality or not. Univariate analysis was performed to compare between each variable and our two primary outcomes. Student t-test was used for quantitative variables with normal distribution and Mann-Whitney U-test was used for the data that were not normally distributed. The Chi-square test was used for qualitative variables. All significant risk factors of $p < 0.05$ were taken into account in backward multiple logistic regression analyses. Univariate and logistic regression analyses were presented as odds ratio (OR) with 95% confidence interval (CI), which is defined as the ratio of the odds of having a risk factor in patients with prolonged ICU length-of-stay or mortality (case) to the odds of having a risk factor in patients with shorter length-of-stay or no mortality (control).

RESULTS

Patient characteristics

Six-hundred and seventy five patients were admitted to surgical ICUs between September 2013 and December 2014. The number of retrieved medical records was 640 (94.8%), and yielded 527 records for statistical analyses after exclusion criteria were applied. Demographic data are presented in (Table 1). The majority of patients were more than 60 years of age with the overall mean age of 63.8 ± 17.7 years, and BMI of 23.98 ± 6.28 . The most prevalent co-morbidities were hypertension and diabetes. Of all age groups, 15.4 percent had coronary artery disease and 15.2 percent had chronic kidney disease. Only 4.9 percent of patients with chronic kidney disease received preoperative renal replacement therapy.

Prolonged ICU admission

Four-hundred and fifteen patients (78.7%) were admitted less than 4 days whereas 112 patients (21.3%) had prolonged (>4 days) post-operative ICU admissions. Univariate analyses compared between the two groups (Table 2) indicated the statistically significant factors associated

TABLE 1. Baseline characteristics of entire case-control (n=527).

Characteristic		Number (%)
Gender	Male: Female	272:255
		(51.6%:48.4%)
Age (years)	< 60	177 (33.6%)
	60-79	245 (46.5%)
	≥ 80	105 (19.9%)
BMI (n = 497)	<18.5	66 (12.5%)
	18.5-24.9	262 (49.7%)
	25-29.9	120 (22.8%)
	≥30	49 (9.3%)
Smoking (n=526)	Nonsmoker	344 (65.3%)
	Ex-smoker	161 (30.6%)
	Active smoker	21 (4%)
ASA	I	6 (1.1%)
	II	142 (26.9%)
	III	346 (65.7%)
	IV	32 (6.1%)
	V	1 (0.2%)
ICU admission	<4 days	415 (78.7%)
	≥4 days	112 (21.3%)
Death in ICU	No	464 (89.9%)
	Yes	53 (10.1%)

with prolonged ICU admissions were: age more than 60 years (OR 1.02 per-year, $p=0.002$, CI 1-1.03), cirrhosis (OR 4.5, $p=0.003$, CI 1.7-11.8), emergency surgery (OR 7.5, $p<0.001$, CI 4.7-11.9), ASA physical status 4-5 (OR 9.3, $p=0.001$, CI 4-21.5), unplanned ICU admission (OR 1.7, $p=0.03$, CI 1-2.7), remained intubation after surgery (OR 5.1, $p<0.001$, CI 2.9-8.7), inotropic or vasopressor use (OR 10.2, $p<0.001$, CI 6.4-16.4), renal replacement therapy (OR 5.1, $p<0.001$, CI 2.6-10.1), SAPS II score 52-63 (OR 12.3, $p<0.001$, CI 7-21.5) and SAPS II score ≥ 64 (OR 24.1, $p<0.001$, CI 11.8-48.9).

Multivariate analysis

Multiple logistic regression analysis (Table 3) of statistically significant variables ($p<0.05$) indicated factors associated with prolonged postoperative ICU admissions were; emergency surgery (OR 2.9, $p=0.001$, CI 1.6-5.2), remained intubation (OR 2.6, $p=0.007$, CI 1.3-5.4), unplanned ICU admission (OR 2.1, $p=0.03$,

CI 1.1-4.2); SAPS II score >52 (OR 4.8, $p<0.001$, CI 2.5-9.2), SAPS II score >64 (OR 6.1, $p<0.001$, CI 2.7-13.8) and inotrope infusion in ICU (OR 4.5, $p<0.001$, CI 2.5-8).

Mortality

ICU mortality was 10.06 percent (53 patients). Eighty-six percent of patients ($n=46$) who died were older than 60 years and the majority of patients had normal BMI value (18.5-25 kg/m^2) without smoking history. Chronic kidney disease and coronary artery disease were found in 28.3 percent and 11.3 percent of patients, respectively. Univariate analyses were conducted to identify the risk factors associated with post-operative mortality during ICU admission (Table 4). Identified risk factors in the present study were: age more than 60 (OR 1.03, $p=0.001$, CI 1.4-11.7), chronic kidney disease (OR 2.5, $p=0.006$, CI 1.3-4.8), cirrhosis (OR 7.1, $p<0.001$, CI 2.6-19.4), emergency surgery (OR 5.1, $p<0.001$, CI 2.8-9.4), ASA physical status 3 (OR 3.8, $p=0.01$, CI 1.32-10.92), ICU re-admission (OR 7.7, $p<0.001$, CI 3.7-16.4), inotropic or vasopressor use (OR 9.4, $p<0.001$, CI 4.9-18), renal replacement therapy (OR 10.7, $p<0.001$, CI 5.2-22.3), SAPS II score 52-63 (OR 8.1, $p<0.000$, CI 3.9-16.8), SAPS II score ≥ 64 (OR 15.8, $p<0.001$, CI 7.2-34.8) and prolonged ICU admission (OR 6.2, $p<0.001$, CI 3.5-11.3).

Multivariate analysis

The significant factors were taken into account in retrograded regression analysis (Table 5). Mortality during the period of ICU admissions was found to be associated SAPS II score. SAPS II score more than 51 predicted increased risk of death-SAPS II score 52-63 and ≥ 64 represented mortality risk of 3.6 ($p=0.018$, CI 1.2-6.8) and 3.9 ($p=0.006$, CI 1.4-9), respectively. Other risk factors were ASA physical status >3 (OR 8.2, $p=0.003$, CI 2-32.9), ICU readmission (OR 3.9, $p=0.007$, CI 1.5-10.8), inotrope infusion in ICU (OR 3, $p=0.006$, CI 1.4-6.7), renal replacement therapy (OR 3.2, $p=0.007$, CI 1.3-8.2) and cirrhosis (OR 4.9, $p=0.04$, CI 1.1-21).

TABLE 2. Preoperative risk factors for prolonged ICU admission (≥ 4 days) on univariate analyses.

Factors		<4 days (n = 415)	≥ 4 days (n = 112)	p-value	OR (95% CI)
Sex	Male	214 (78.7%)	58 (21.3%)	0.97	1 (0.7 - 1.5)
	Female	201 (78.8%)	54 (21.1%)		
Age gr (yr)				0.002	1 (1 - 1.03)
	<60	153 (86.4%)	24 (13.6%)		1
	60-79	187 (76.3%)	58 (23.7%)	0.01	2 (1.2 - 3.3)
	≥ 80	75 (71.4%)	30 (28.6%)	0.002	2.6 (1.4 - 4.7)
BMI (kg/m ²)	<18.5	52 (78.8%)	14 (21.2%)	0.86	1.1 (0.6-2.1)
	18.5-24.9	209 (79.8%)	53 (20.2%)		1
	25-29.9	93 (77.5%)	27 (22.5%)	0.61	1.2 (0.7 - 1.9)
	≥ 30	40 (81.6%)	9 (18.4%)	0.77	0.9 (0.4-1.9)
Smoke	No	276 (80.2%)	68 (19.8%)		1
	Ex-smoker	122 (75.8%)	39 (24.2%)	0.25	1.3 (0.8-2.0)
	Yes	16 (76.2%)	5 (23.8%)	0.65	1.3 (0.5 - 3.6)
Chronic kidney disease	No	355 (79.4%)	92 (20.6%)		1
	Yes	60 (75%)	20 (25%)	0.38	1.3 (0.7 -2.2)
Heart disease	No	393 (78.4%)	108 (21.6%)		
	Yes	22 (84.6%)	4 (15.4%)	0.46	0.7 (0.2 - 2)
Diabetic mellitus	No	299 (80.8%)	71 (19.2%)		
	Yes	116 (73.9%)	41 (26.1%)	0.08	1.5 (0.9 -2.3)
Hypertension	No	159 (76.8%)	48 (23.2%)		
	Yes	256 (80%)	64 (20%)	0.38	0.8 (0.5 -1.3)
Coronary artery disease	No	349 (78.3%)	97 (21.7%)		
	Yes	66 (81.5%)	15 (18.5%)	0.51	0.8 (0.5 - 1.5)
Cirrhosis	No	407 (79.8%)	103 (20.2%)		
	Yes	8 (47.1%)	9 (52.9%)	0.003	4.5 (1.7 -11.8)
Cancer	No	272 (78.8%)	73 (21.2%)		
	Yes	98 (77.2%)	29 (22.8%)	0.7	1.1 (0.7-1.8)
	Metastatic	45 (81.8%)	10 (18.2%)	0.61	0.8 (0.4 -1.7)
Emergency	No	318 (90.3%)	34 (9.7%)		
	Yes	97 (55.4%)	78 (44.6%)	<0.001	7.5 (4.7 -11.9)
ASA physical status	1-2	127 (85.8%)	21 (14.2%)		
	3	275 (79.5%)	71 (20.5%)	0.1	1.6 (0.9-2.7)
	4-5	13 (39.4%)	20 (60.6%)	<0.001	9.3 (4 -21.5)
Operative time (hrs)	<3	120 (71.9%)	47 (28.1%)		
	≥ 3	293 (81.8%)	65 (18.2%)	0.011	0.6 (0.4-0.9)
Remained intubation	No	192 (91.4%)	18 (8.6%)		
	Yes	194 (67.8%)	92 (32.2%)	<0.001	5.1 (2.9 -8.7)
Unplanned ICU	No	335 (80.7%)	80 (19.3%)		
	Yes	80 (71.4%)	32 (28.6%)	0.034	1.7 (1 -2.7)
Inotrope infusion	No	344 (90.5%)	36 (9.5%)		
	Yes	71 (48.3%)	76 (51.7%)	<0.001	10.2 (6.4 -16.4)
Dialysis	No	398 (81.2%)	92 (18.8%)		
	Yes	17 (45.9%)	20 (54.1%)	<0.001	5.1 (2.6 -10.1)
SAPSII score	<52	350 (91.6%)	32 (8.4%)		
	52-63	40 (47.1%)	45 (52.9%)	<0.001	12.3 (7 -21.5)
	≥ 64	15 (31.2%)	33 (68.8%)	<0.001	24.1 (11.8-48.9)

TABLE 3. Multiple logistic regression of ICU admission more than 4 days.

	p-value	Adjusted OR (95% CI)
Emergency surgery	0.001	2.9 (1.6 - 5.2)
Remained intubation	0.007	2.6 (1.3 - 5.4)
Unplanned ICU	0.03	2.1 (1.1 - 4.2)
SAPSII score 52-63	<0.001	4.8 (2.5 - 9.2)
SAPSII score $\geq$ 64	<0.001	6.1 (2.7 - 13.8)
Inotrope infusion in ICU	<0.001	4.5 (2.5 - 8)

DISCUSSION

Knowledge of specific patients' characteristics and risk factors associated with prolonged ICU length-of-stay are widely studied, but data from previous studies may not be applicable to every institution due to considerable variations in surgical and anesthesia practice among tertiary care centers. This retrospective study was aimed to identify risk factors that were associated with such outcomes on the basis of current practice in a large tertiary hospital in Thailand.

Our findings, in terms of risk factors of prolonged ICU admissions, are similar to several studies^{5,8,11,12} including emergency surgery, unplanned ICU admission, and SAPS II score. Although chronic kidney disease, renal replacement therapy, and cirrhosis appear to be associated with prolonged ICU admissions in several studies, we failed to show the association from multivariate analyses. This might be due to the low prevalence of chronic kidney disease and cirrhosis in this case control study. Interestingly, renal replacement therapy was found to be associated with ICU mortality, but not prolonged ICU admissions.

SAPS II score was widely used in several studies as a predictor for ICU length-of-stay and mortality. Developed from a multi-center study in 1993,¹³ SAPS II score might not reflect and correlate well with current surgical, anesthesia and intensive care practice and the predictive value of the score has been questioned.^{14,15} In a previous study, SAPS II score and Acute Physiology and Chronic Health Evaluation (APACHE) II score have been compared and resulted in satisfactory predictive performances.¹⁶ In our multivariate

analysis, patients who had SAPS II score higher than 52 points had higher risk of ICU mortality as well as prolonged ICU admissions.

The mortality rate in this study is comparable to others' reports,¹⁰ but the authors did not perform subgroup analysis to determine the cause of death due to the limited number of study population.

The present study has limitations. We selected the patient retrospectively from a specific timeframe, which, during which hopefully, there should be no specific change in the practice of anesthesia and intensive care.

The study population may differ from that in other ICUs as postoperative cardio-thoracic and neurosurgical patients were excluded. The study design and the number of population were selected to demonstrate the association between each specific risk factor and the length-of-stay and mortality, but it was not powered to demonstrate the causal relationship. Importantly, the reported odds ratio must be interpreted in the context of case-control study.

Systematic scoring system has not been used in our institution, either to predict ICU length-of-stay or mortality. This study demonstrated that both ASA physical status and SAPS II score could be used as predicting factors for both length-of-stay and risk of death. The result can be used preoperatively as a tool to identify high risk surgical patients prior to ICU admission and could be conveyed to the perioperative care team and patients' relatives.

We believe that predictive scoring system for ICU length-of-stay and mortality should be developed and verified in our institution. The data from the present study could benefit in a future large prospective study with emphasis on integrating different models to predict both length-of-stay and mortality.

CONCLUSION

ASA physical status >3 and SAPS II score >52 were independent predictive factors of both prolonged intensive care unit admission and mortality.

TABLE 4. Preoperative risk factors for mortality on univariate analyses.

Factors		Alive (n = 474)	Death (n = 53)	p-value	OR (95% CI)
Sex	Male	246 (90.4%)	26 (9.6%)	0.69	1.1 (0.6 - 2)
	Female	228 (89.4%)	27 (10.6%)		
Age gr (yr)	<60	170 (96%)	7 (4%)	0.006	3.3 (1.4 - 7.6)
	60-79	216 (88.2%)	29 (11.8%)		
	≥80	88 (83.8%)	17 (16.2%)		
BMI (kg/m ²)	<18	55 (83.3%)	11 (16.7%)	0.07	2.1 (0.9 - 4.5)
	18.5-24.9	239 (91.2%)	23 (8.8%)		
	25-29.9	112 (93.3%)	8 (6.7%)		
	≥ 30	45 (91.8%)	4 (8.2%)		
Smoke	No	308 (89.5%)	36 (10.5%)	0.4	0.7 (0.4 - 1.5)
	Ex-smoker	148 (91.9%)	13 (8.1%)		
	Active smoker	18 (85.7%)	3 (14.3%)		
Chronic kidney disease	No	409 (91.5%)	38 (8.5%)	0.006	2.5 (1.3 - 4.8)
	Yes	65 (81.3%)	15 (18.7%)		
Heart disease	No	453 (90.4%)	48 (9.6%)	0.12	2.2 (0.8 - 6.2)
	Yes	21 (80.8%)	5 (19.2%)		
Diabetic mellitus	No	339 (91.6%)	31 (8.4%)	0.05	1.8 (1 - 3.2)
	Yes	135 (86%)	22 (14%)		
Hypertension	No	189 (39.9%)	18 (34%)	0.4	1.3 (0.7 - 2.3)
	Yes	285 (89%)	35 (11%)		
Coronary disease	No-CAD	399 (89.5%)	47 (10.5%)	0.39	0.68(0.28-1.65)
	CAD	75 (92.6%)	6 (7.4%)		
Cirrhosis	No	464 (91%)	46 (9%)	<0.001	7.1 (2.6 - 19.4)
	Yes	10 (58.8%)	7 (41.2%)		
Cancer	No	311 (90.1%)	34 (9.9%)	0.7	0.9 (0.4 - 1.8)
	Yes	116 (91.3%)	11 (8.7%)		
	Metastatic CA	47 (85.5%)	8 (14.5%)		
Emergency	No	335 (95.2%)	17 (4.8%)	<0.001	5.1 (2.8 - 9.4)
	Yes	139 (79.4%)	36 (20.6%)		
ASA physical status	1-2	144 (97.3%)	4 (2.7%)	0.01	3.80 (1.32-10.92)
	3	313 (90.5%)	33 (9.5%)		
	> 3	17 (51.5%)	16 (48.5%)		
Operative time (hrs)	<3	143 (85.1%)	25 (14.9%)	<0.001	33.9 (10.2 - 113.1)
	≥3	330 (92.2%)	28 (7.8%)		
Remained intubation	No	193 (91.9%)	17 (8.1%)	0.17	1.5 (0.8 - 2.8)
	Yes	252 (88.1%)	34 (11.9%)		
Unplanned ICU	No	377 (90.8%)	38 (9.2%)	0.19	1.5 (0.8 - 2.9)
	Yes	97 (86.6%)	15 (13.4%)		
ICU readmission	No	453 (92.1%)	39 (7.9%)	<0.001	7.7 (3.7 - 16.4)
	Yes	21 (60%)	14 (40%)		
Inotrope infusion	No	366 (96.3%)	14 (3.7%)	<0.001	9.4 (4.9 - 18)
	Yes	108 (73.5%)	39 (26.5%)		
Dialysis	No	454 (92.7%)	36 (7.3%)	<0.001	10.7 (5.2 - 22.3)
	Yes	20 (54%)	17 (46%)		
SAPSII score	< 52	368 (96.3%)	14 (3.7%)	<0.001	8.1 (3.9 - 16.8)
	52 - 63	65 (76.5%)	20 (23.5%)		
	≥ 64	30 (62.5%)	18 (37.5%)		
ICU admission	< 4 days	392 (94.5%)	23 (5.5%)	<0.001	6.2 (3.5 - 11.3)
	≥ 4 days	82 (73.2%)	30 (26.8%)		

TABLE 5. Multiple logistic regression of death (n = 514).

	p-value	Adjusted OR (95% CI)
ASA 4-5	0.003	8.2 (2 - 32.9)
ICU readmission	0.007	3.9 (1.5 - 10.8)
Inotrope infusion in ICU	0.006	3 (1.4 - 6.7)
Dialysis in ICU	0.007	3.2 (1.3 - 8.2)
SAPSII score 52-63	0.018	3.6 (1.2 - 6.8)
SAPSII score ≥64	0.006	3.9 (1.4 - 9)
Cirrhosis	0.035	4.9 (1.1 - 21)

What is already known on this topic?

Several factors have been shown to be associated with intensive care unit length-of-stay and mortality. Variations in surgical and anesthesia practice may pose as limitations for implementing the risk prediction models to individual institutions.

What this study adds?

The present study specifically aimed at identifying risk factors of prolonged length-of-stay and mortality in postoperative intensive care units in a large university hospital in Thailand. Multivariate analyses identified several associated factors such as SAPS II score, ASA physical status and renal replacement therapy. This appropriate scoring system is recommended for categorizing postoperative surgical patients who are admitted to intensive care units.

ACKNOWLEDGMENTS

The authors would like to thank Miss Nichapat Sookri, and Miss Chusana Rungjindamai our research assistants for their great help with retrieval of all medical records and paper work.

REFERENCES

- Moonesinghe SR, Mythen MG, Grocott MP. High-risk surgery: epidemiology and outcomes. *Anesth Analg* 2011; 112:891-901.
- Kramer AA, Zimmerman JE. A predictive model for the early identification of patients at risk for a prolonged intensive care unit length of stay. *BMC Med Inform Decis Mak* 2010;10:1-16.
- Knaus WA, Wagner DP, Zimmerman JE, Draper EA. Variations in mortality and length of stay in intensive care units. *Ann Intern Med* 1993;118:753-61.
- Breslow MJ, Badawi O. Severity scoring in the critically ill: part I--interpretation and accuracy of outcome prediction scoring systems. *Chest* 2012;141:245-52.
- Moran JL, Bristow P, Solomon PJ, George C, Hart GK. Mortality and length-of-stay outcomes, 1993-2003, in the binational Australian and New Zealand intensive care adult patient database. *Crit Care Med* 2008;36:46-61.
- Rosenberg AL, Hofer TP, Hayward RA, Strachan C, Watts CM. Who bounces back? Physiologic and other predictors of intensive care unit readmission. *Crit Care Med* 2001; 29:511-8.
- Rhodes A, Moreno RP, Metnitz B, Hochrieser H, Bauer P, Metnitz P. Epidemiology and outcome following post-surgical admission to critical care. *Intensive Care Med* 2011; 37:1466-72.
- Bagshaw SM, Webb SA, Delaney A, George C, Pilcher D, Hart GK, et al. Very old patients admitted to intensive care in Australia and New Zealand: a multi-centre cohort analysis. *Crit Care (London, England)* 2009;13:R45.
- Clec'h C, Gonzalez F, Lautrette A, Nguile-Makao M, Garrouste-Orgeas M, Jamali S, et al. Multiple-center evaluation of mortality associated with acute kidney injury in critically ill patients: a competing risks analysis. *Crit Care (London, England)* 2011;15:R128.
- Sim YS, Lee JH, Chang JH, Ryu YJ. Clinical Outcome and Prognosis of Patients Admitted to the Surgical ICU after Abdomen Surgery. *Korean J Crit Care Med* 2015; 30:1-7.
- Abelha F, Maia P, Landeiro N, Neves A, Barros H. Determinants of outcome in patients admitted to a surgical intensive care unit. *Arquivos de Medicina* 2007;21:135-43.
- Mallol M, Sabate A, Dalmau A, Koo M. Risk factors and mortality after elective and emergent laparotomies for oncological procedures in 899 patients in the intensive care unit: a retrospective observational cohort study. *Patient Saf Surg* 2013;7:29.
- Le Gall JR, Lemeshow S, Saulnier F. A new Simplified Acute Physiology Score (SAPS II) based on a European/ North American multicenter study. *Jama*. 1993;270(24): 2957-63.
- Le Gall JR, Neumann A, Hemery F, Bleriot JP, Fulgencio JP, Garrigues B, et al. Mortality prediction using SAPS II: an update for French intensive care units. *Crit Care (London, England)* 2005;9:R645-52.
- Sakr Y, Marques J, Mortsch S, Gonsalves MD, Hekmat K, Kabisch B, et al. Is the SAPS II score valid in surgical intensive care unit patients? *J Eval Clin Pract* 2012;18: 231-7.
- Sakr Y, Krauss C, Amaral AC, Rea-Neto A, Specht M, Reinhart K, et al. Comparison of the performance of SAPS II, SAPS 3, APACHE II, and their customized prognostic models in a surgical intensive care unit. *Br J Anaesth* 2008;101:798-803.