Original Article

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The Intensive Care Unit Admission Predicting the Factors of Late Complications in Trauma Patients: A Prospective Cohort Study

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Abstract

Background: Organ failure (OF) and sepsis are important causes of late death in trauma. Previous studies reported the methods that could predict OF at the time of patient arrival. However, most of the evidence is from high-income countries, where health-care systems were different from developing countries. This research aimed to identify the factors to predict late complications in trauma patients in surgical intensive care units (SICUs). **Methods:** This study was a secondary data analysis from the THAI-SICU study, which was a prospective cohort study in nine university-based-SICUs in Thailand. Late complications were defined as any OF or sepsis that occurred after 48 h of ICU admission. Multivariable logistic regression was conducted to identify the significant factors. **Results:** Three hundred and fourteen patients were eligible for the analysis. Late complications occurred in 60 patients (19%). Patients who had complications had higher Acute Physiology and Chronic Health Enquiry (APACHE II) (15.8 vs. 12.4, $P = 0.02$) and Sequential OF Assessment (SOFA) scores on admission (6.7 vs. 3.8, $P < 0.001$). Multivariable analysis showed that current smoking (odds ratio [OR] =1.9, 95% confidence interval [CI]; 1.03–3.67, $P = 0.04$) and SOFA score on admission (OR = 1.2, 95% CI; 1.12–1.29, $P < 0.001$) increased the risk of late complications. Late complications had hazards ratio of mortality of 5.9 (95% CI; 2.53–13.88, $P < 0.001$). **Conclusions:** The incidence of late complications in trauma patients in the SICU was 19%. Current smoking and SOFA score might be valuable in future prediction of late complications during admission.

Keywords: Critical care, multiple organ failure, sepsis

Introduction

The Centers for Disease Control and Prevention reported trauma was the most common cause of death in the age group of 1–44 years in the US.[1] Seventy percent of late death in trauma was caused from multiorgan failure (MOF) and sepsis.[2]

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MOF occurred in 20% of multiple trauma patients admitted in the hospital and in 47% of trauma patients who admitted in the trauma intensive care unit (ICU).[3,4] Single organ failure (OF) occurred in 28% of trauma ICU admission.[4] Previously, many studies have reported predictions of MOF using various forms of clinical information or advanced laboratory results.[5,6] However, most of the reported studies were conducted in developed countries that had well-established trauma system which do not exist in developing countries such as Thailand. However, previous studies showed that an effective trauma system can affect to clinical outcomes.[7] This study aimed to study the incidence and risk factors of late complications which included OF and sepsis in trauma patients admitted to the surgical ICUs (SICUs) in Thailand.

Methods

Study design and setting

This was an analysis of the THAI-SICU study. The details of the methodology of the THAI-SICU were previously published.[8] In summary, the THAI-SICU study was a prospective cohort study that aimed to collect the complications that occurred in the SICUs of nine university-based SICUs in Thailand. The data collection was started in April 2011. Five SICUs were located in Bangkok, and four SICUs were located in other main provinces of the country.

Data collection

Data collection was done by research assistants who had been trained, and data were verified by site principal investigators. In patients who could not give information, the personal data such as a history of smoking were obtained from the relatives. The data collection period was between April 18, 2011 and November 30, 2012. The complication data collection was done only when patients were admitted in the SICUs. The mortality was followed for 28 days after admission. The ethic committees at all participated sites approved the study before the data were collected.

Population

The THAI-SICU study included all patients admitted to the SICUs that participated during the study. Patients admitted to the SIUCs <6 h or younger than 18-year-old were excluded. The only patients analyzed were those who were admitted to the SICU with a primary diagnosis of trauma due to trauma mechanism. Patients who had nontraumatic mechanism such as burn were excluded from the study.

Outcomes

After SICU admission, the patients were screened daily for complications such as sepsis, respiratory failure, or acute kidney injury. Respiratory failure was defined as $PaO_2/FiO_2 \leq 300$. Acute kidney injury was defined as a rising serum creatinine >0.3 from the baseline. In this study, OF was defined as the failure of respiratory or kidney function 48 h or more after hospital admission. Sepsis was defined when patients presented with systemic inflammatory response syndrome (SIRS) with infection. SIRS was defined when patients had 2 of 4 of these criteria: (1) pulse rate >90; (2) respiratory rate >20 or PaCO2 <32 mmHg; (3) body temperature <36C or >38C; and (4) white blood cell count <4000 or >12,000 cells/ml. Infection was reported when patients had suspected signs or symptoms and received antibiotics or had a positive culture from sterile sites. The late complication group was defined as patients who had the onset of OF or sepsis after 48 h of SICU admission.

Risk factors

Individual parameters and clinical parameters before ICU admission were collected. The individual parameters were age, gender, and ICU severity scores. Clinical parameters such as blood transfusion, intravenous fluid, and blood loss were also collected.

Statistical methods

Continuous parameters were demonstrated by the mean and standard deviation or median and interquartile range (IQR) and were compared with the *t*-test or rank-sum test. Categorical parameters were demonstrated with percentage and were compared with Chi-square test. Univariable analysis was performed to identify the potential predicting factors. All the factors that had $P < 0.2$ were included in the multivariable logistic regression. Multivariable logistic regression with backward elimination was performed to identify the final model of late complication. Cox proportional-hazards model was conducted to identify the effect of late complication to time to mortality. Only patients who survived in the hospital at least 48 h were included in the survival analysis.

Results

Among 314 trauma patients, late complications occurred in 60 patients (19%) and OF was reported in 31 patients (9.9%). Acute kidney injury occurred in 25 patients (7.9%), and the median (IQR) time of developing AKI was 2 (1–4) days. The respiratory failure occurred in 10 patients (3.2%), and the median (IQR) time of developing of ARDS was 2 (1–4) days. Sepsis occurred in 42 patients (13.4%), and the median (IQR) time was 3 (1–5) days.

The group that had late complications had significantly higher Acute Physiology and Chronic Health Enquiry (APACHE II) and Sequential OF Assessment (SOFA) scores on admission compared with the group that did not have late complications. The patient characteristics are given in Table 1.

In the univariable analysis, current smoking had the strongest effect on late complications; however, it was not statistically significant (odds ratio [OR] 1.81 95% confidence interval [CI] 0.99-3.31, $P = 0.051$). SOFA and APACHE II scores on admission were significantly associated with late complications. The results of the univariable analysis are given in Table 2.

After the multivariable logistic regression analysis with backward elimination of age, sex, history of

exposure to contrast media in 48 h before ICU admission, smoking, APACHE II, and SOFA, the results showed that current smoking (OR 1.9, 95% CI 1.03–3.67, $P = 0.04$) and SOFA on admission (OR 1.2, 95% CI 1.12–1.29, $P < 0.001$) were statistically significant. The group with late complications had an average smoking history of 15.9 (20.6) pack-years, and the group that did not have late complications had an average smoking history of 10.8 (14.1) pack-years. The results of the multivariable analysis are given in Table 3.

Table 1: Characteristics of the patients

	Late complications ($n=60$)	No complications ($n=254$)	*P*
Age (years), mean (SD)	46.9 (21.8)	46.4 (22.6)	0.9
Male, *n* (%)	48 (80)	176 (69.3)	0.09
APACHE II on admission, mean (SD)	15.8 (9.9)	12.4 (9.4)	0.02
SOFA on admission, mean (SD)	6.7 (4.1)	3.8 (3.9)	<0.0001
PRC at the 1st day (mL), mean (SD)	847.3 (189.6)	765.6 (1321.7)	0.67
FFP at the 1st day (mL), mean (SD)	876.3.1 (1535.8)	671.3 (1174.4)	0.25
Operative blood loss (mL), mean (SD)	2426.3 (4737.5)	1742.1 (2720.7)	0.26
Exposed with contras media in 48 h, *n* (%)	23 (41.8)	78 (33.6)	0.25
Underlying hypertension, *n* (%)	14 (23.33)	52 (20.47)	0.63
Underlying DM, *n* (%)	6 (10)	22 (8.5)	0.74
Current smoking	24 (43.6)	70 (29.9)	0.05
ICU stay (days), median (IQR)	2 (1-4)	8 (4-13.5)	<0.001

SD: Standard deviation, APACHE: Acute Physiology and Chronic Health Enquiry, SOFA: Sequential organ failure assessment, PRC: Packed red cells, FFP: Fresh-frozen plasma, DM: Diabetes mellitus, ICU: Intensive care unit, IQR: Interquartile range

Table 2: Univariable analysis

	OR	95% CI	*P*
Gender: Female	0.56	0.28-1.12	0.10
Age ≥60	1.08	0.59-2.00	0.79
SOFA on admission	1.17	1.09-1.24	<0.001
APACHE II on admission	1.03	1.01-1.063	0.02
Exposed with contras media in 48 h	1.42	0.39-1.29	0.25
Current smoking	1.81	0.99-3.31	0.051

APACHE: Acute Physiology and Chronic health enquiry, SOFA: Sequential organ failure assessment, OR: Odds ratio, CI: Confidence interval

Table 3: Multivariable analysis

	OR	95% CI	*P*
Current smoking	1.9	1.03-3.67	0.04
SOFA on admission	1.2	1.12-1.29	<0.001

SOFA: Sequential organ failure assessment, OR: Odds ratio, CI: Confidence interval

Late complications had hazards ratio of mortality of 5.9 95% CI 2.53–13.88, $P < 0.001$). The Kaplan–Meier is shown in Figure 1.

Discussion

The incidence of OF from our study was 10%, which was lower than a previous report from Durham *et al*.[9] who reported the incidence of OF as 23.8%. The study from Durham *et al*. was conducted in a university-based hospital, which was the same as our study. The reason the incidence results were different was probably caused from the definitions of OF. Our study could identify only respiratory and kidney injury because of the databases limitations, whereas the study from Durham *et al*. identified OF in more organs such as liver failure or cardiovascular failure.

The incidence of AKI in our study was 7.9%, which was lower than a study from Haines *et al*.[10] that was done in trauma patients admitted in the ICU and reported the AKI incidence as 19.6%. Between these two studies, the definition of AKI was almost similar. Our study identified AKI patients when the creatinine increased > 0.3 from the baseline, whereas the study from Haines *et al*. used the same criteria as AKI Stage 1 and added more criteria for more advance stages. The median time to develop AKI was not different, but the incidence in our study was lower. The occurrence of respiratory failure in our study was lower than the report from a systematic review by Pfeifer *et al*. (3.2% vs. 8%)[11] Overall, the incidence of complications in our study was lower than reported in the literature. The explanation may be the differences in the inclusion criteria of the studies. Our study included only patients who developed OF after 48 h from admission and those complications had to occur during admission in the SICUs. Our overall median (IQR) ICU stay was 2 (1–5) days, whereas other studies reported an overall median ICU stay of 3.8–27 days.[9,10] One reason for the shorter ICU stay was the insufficient number of ICU beds. If the patients were dynamically stable, they were transferred from the SICUs. If the complications occurred outside the SICUs, they were excluded from the study.

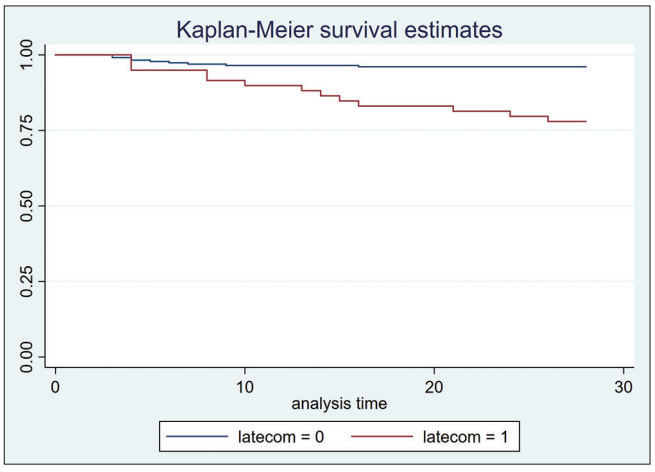

Figure 1: The Kaplan–Meier of late complications and mortality

The predictors of late complications, such as MOF after trauma, have been studied. Most of the studies focused on the initial parameters at the emergency department. However, our study focused on the initial parameters on ICU admission.[12] The SOFA on admission was a good predictor of adverse outcomes. It was the only significant predictor of late complications in our study, and it was also reported to have the strongest correlation of ICU mortality.[13]

Smoking has been reported to impair renal function;[14] however, a previous clinical study found that smoking did not affect ARDS, sepsis, or MOF.[15] Smoking in our study was a significant factor for late complications. It correlated with other studies from the same database that showed smoking was associated with an increased risk of ARDS.[16,17] However, we had a limitation on the accuracy of the amount of smoking. Some of our patients were in critical injuries, and we could not retrieve the data directly from the patients.

The limitation of the study was the lack of details of injury severity. Since this study was an ICU-based study, the injury severity score and the time that injury occurred were not collected.

Conclusions

Current smoking and SOFA score might help to predict the late complications such as OF and sepsis of trauma patients in the SICUs. Patients who have these factors on ICU admission should be monitored for complications.

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THAI-SICU study.

Conflicts of interest

There are no conflicts of interest.

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