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ORIGINAL RESEARCH

Risk Factors for 28-Day Mortality in a Surgical ICU: A Retrospective Analysis of 347 Cases

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Purpose: Advances in surgical techniques and intensive care over the past decades have significantly reduced the mortality rates of critically ill surgical patients. However, evaluations of risk factors associated with mortality in surgical intensive care units (ICUs) are limited. The aim of this study was to analyze the independent risk factors for 28-day mortality of surgical ICU patients.

Patients and Methods: The clinical data of adult patients who were admitted to the surgical ICU in the First Affiliated Hospital of Xi'an Jiaotong University from June 2013 to June 2017 were collected. Univariate and multivariable logistic regression analyses were performed to examine risk factors associated with 28-day mortality.

Results: A total of 347 patients were included in this analysis. The overall 28-day mortality rate was 32.6%. The major causes of surgical ICU admission were gastrointestinal diseases (46.7%), infection (20.5%), trauma (8.9%), respiratory diseases (8.9%) and cardiovascular diseases (6.6%). The univariate analysis showed age, total bilirubin, prothrombin time, international normalized ratio, arterial lactate level, APACHE II and SOFA score at ICU admission were significantly associated with 28-day mortality. In the multivariate analysis, however, age [Odds Ratio (OR): 2.899, 95% CI: 1.427–5.890, P=0.003], hypertension [OR: 3.630, 95% CI: 1.545–8.531, P=0.003], platelet count [OR: 1.004, 95% CI: 1.001–1.007, P=0.015], arterial lactate level [OR: 1.186, 95% CI: 1.088–1.293, P<0.001] and SOFA score [OR: 1.289, 95% CI: 1.131–1.469, P<0.001] were identified as the independent risk factors for 28-day mortality of patients in the surgical ICU.

Conclusion: In patients admitted to the surgical ICU, age 65 and older, a high arterial lactate level and SOFA score at ICU admission were associated with increased 28-day mortality.

Keywords: critical care, surgical intensive care units, 28-day mortality, clinical characteristics

Introduction

The surgical intensive care unit (ICU) provides perioperative care to critically ill patients. Advances in surgical techniques and intensive care over the past decades have significantly reduced the mortality rates of critically ill surgical patients.[1,2] However, the burden of critically ill surgical patients is increasing as more and more elderly patients seeking surgical treatment.[3] A better understanding of risk factors associated with mortality of surgical ICU patients is of great importance for treatment evaluation, patient triage and resource allocation.

The Sequential Organ Failure Assessment (SOFA) score and the Acute Physiology and Chronic Health Evaluation II (APACHE II) score are two

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commonly used scoring systems for risk assessment in critically ill patients. However, their predictive power in surgical ICU patients varies in previous studies.[4] Comorbidities such as hypertension, diabetes mellitus, cardiovascular and respiratory diseases are often associated with poor outcomes in critically ill patients.[5,6] Due to improvement in the management of these conditions, however, several recent studies have indicated that serious comorbidities are not independent risk factors for mortality in the ICU.[7,8] The elderly patients are expected to consume more ICU resources in the future.[9] However, very few studies have specifically investigated the impact of age on outcomes of patients admitted to surgical ICU.[9] An elevated lactate level is a poor indicator of survival in critically ill patients.[10,11] However, whether it is an independent risk factor for mortality in surgical ICU remains unknown. Thus, there is an urgent need for evaluations of risk factors associated with mortality in surgical ICU.

Several previous studies have investigated risk factors associated with mortality in surgical ICUs. However, different studies appeared to have different conclusions. Toufen et al showed that infection is an independent risk factor for mortality in SICU.[12] A study from Thailand suggested that the development of AKI is associated with higher mortality in elderly SICU patients.[13] The First Affiliated Hospital of Xi'an Jiaotong University is located in northwest China, a relatively underdeveloped region of China. The surgical ICU has 15 beds. In this surgical ICU, patients are managed by critical care doctors with 24/7 in-house ICU coverage. The surgeons were usually consulted by the critical care doctors when the patients they operated on stayed in the surgical ICU. The aim of this study, therefore, was to analyze the independent risk factors for 28-day mortality of surgical ICU patients in northwest China.

Materials and Methods

Patients

This is a retrospective observational study. The cohort was composed of 347 adult patients who were admitted to the surgical ICU at the first affiliated hospital of Xi'an Jiaotong University from June 2013 to June 2017. Patients admitted to the surgical ICU for anesthesia recovery only or who underwent organ transplantation were excluded. Our study complied with the provisions of Declaration of Helsinki, and the protocol was approved by the Ethics Committee of the First Affiliated Hospital of Xi'an Jiaotong University. The patient's informed written consent was waived due to the retrospective nature of this study. Patient data were anonymized and de-identified prior to analysis.

Data Collection

The electronic medical records of all patients were viewed retrospectively. The patients' age, sex, primary ICU diagnosis, coexisting conditions, vital symptom, vital signs, laboratory data, ICU care and clinical outcomes were collected in details. Laboratory data included the blood routine test, liver function test, renal function test, electrolyte, blood coagulation and arterial blood gas tests. The severity of disease was assessed using the Acute Physiology and Chronic Health Evaluation II (APACHE II) score and the Sequential Organ Failure Assessment (SOFA) score. The ICU mortality was recorded. After leaving the surgical ICU, the patients were followed for 28 days to record the 28-day mortality.

Statistical Analysis

The distribution of the continuous variables was checked for normality using the Kolmogorov–Smirnov test. Normally distributed variables were expressed as mean ± SD, and differences between the two groups were analyzed by two-tailed Student *t*-test. Nonnormally distributed variables were expressed as medians (interquartile range) and differences between the two groups were compared by Wilcoxon rank sum test. Categorical variables were expressed as absolute numbers and percent frequencies and differences between the two groups were compared by Chi-square test or Fisher's exact test. Univariate and multivariate analysis by logistic regression models were performed for the analysis of risk factors. All variables that were found to be significant or almost significant ($P<0.20$) in the univariate analysis were entered into a multivariate analysis. PASW (18.0) software (SPSS Inc., Chicago, Illinois, USA) was used for statistical analyses. A two-tailed p value <0.05 was considered statistically significant.

Results

Demographic Data

The clinical data of 347 patients admitted to the surgical ICU at our hospital between June 2013 and June 2017 were analyzed. The overall 28-day mortality rate was 32.6%. Demographic data of survivors and nonsurvivors are shown in Table 1. The average age of the patients was

Table 1 Demographic Data of the Patients Admitted to the Surgical ICU

Variables	Overall (n=347)	Survivors[a] (n=234)	Nonsurvivors[b] (n=113)	*P* value
Age (years)	60.88 ± 18.01	59.80 ± 17.71	61.13 ± 16.3	0.106
Sex (male/female)	219/128	146/88	73/40	0.689
Primary ICU diagnosis				
Gastrointestinal, n (%)	162 (46.69)	114 (48.72)	48 (42.48)	0.275
Infection, n (%)	71 (20.46)	47 (20.09)	24 (21.24)	0.803
Trauma, n (%)	31 (8.93)	25 (10.68)	6 (5.31)	0.100
Respiratory, n (%)	31 (8.93)	20 (8.55)	11 (9.73)	0.716
Cardiovascular, n (%)	23 (6.63)	10 (4.27)	13 (11.50)	**0.011**[#]
Neurologic, n (%)	17 (4.90)	11 (4.70)	6 (5.31)	0.805
Orthopedic, n (%)	7 (2.02)	3 (1.28)	4 (3.54)	0.161
Renal*, n (%)	5 (1.44)	4 (1.71)	1 (0.88)	0.546
Coexisting conditions				
Smoking, n (%)	110 (31.70)	80 (34.19)	30 (26.55)	0.152
Chronic alcohol consumption, n (%)	80 (23.05)	59 (25.21)	21 (18.58)	0.169
Hypertension, n (%)	96 (27.67)	70 (29.91)	26 (23.01)	0.178
Diabetes mellitus, n (%)	44 (12.68)	28 (11.97)	16 (14.16)	0.565
Cirrhosis, n (%)	29 (8.36)	15 (6.41)	14 (12.39)	0.059
Ischemic heart disease, n (%)	33 (9.51)	19 (8.12)	14 (12.39)	0.204
Stroke, n (%)	44 (12.68)	30 (12.82)	14 (12.39)	0.910
Malignant diseases, n (%)	73 (21.04)	45 (19.23)	28 (24.78)	0.235
COPD, n (%)	39 (11.24)	22 (9.40)	17 (15.04)	0.119
Surgery, n (%)	109 (31.41)	73 (31.20)	36 (31.86)	0.901
Gastrointestinal surgery, n (%)	26 (7.49)	17 (7.26)	9 (7.96)	0.817
Thoracic Surgery, n (%)	9 (2.59)	6 (2.56)	3 (2.65)	0.960
Hepatobiliary and pancreatic Surgery, n (%)	58 (16.71)	37 (15.81)	21 (8.97)	0.517
Neurosurgery, n (%)	1 (0.29)	1 (0.43)	0 (0.00)	0.486
Orthopedic surgery, n (%)	11 (3.17)	10 (4.27)	1 (0.88)	0.091
Urologic surgery, n (%)	2 (0.58)	1 (0.43)	1 (0.88)	0.598
Gynecologic surgery	2 (0.58)	1 (0.43)	1 (0.88)	0.598
Emergency surgery, n (%)	16 (4.61)	11 (4.70)	5 (4.42)	0.909

Notes: [a]Patients survived longer than 28 days after leaving surgical ICU; [b]Nonsurvivors included ICU mortality and 28-day mortality after leaving surgical ICU. *"Renal" means acute kidney injury (AKI). [#]*P*-value <0.05.
Abbreviation: COPD, chronic obstructive pulmonary disease.

60.88 ± 18.01 years. The patients were predominantly males (63.11%). However, there were no statistically significant differences in age and gender between survivors and nonsurvivors. The major causes of surgical ICU admission were gastrointestinal diseases (46.7%), infection (20.5%), trauma (8.9%), respiratory diseases (8.9%) and cardiovascular diseases (6.6%). There were no major differences in causes for surgical ICU admission between survivors and nonsurvivors, except that the incidence of cardiovascular diseases was higher in nonsurvivors than that in survivors (11.5% vs 4.27%, $p<0.05$). In terms of coexisting conditions, there were no significant differences between survivors and nonsurvivors. Of the 347 patients, 109 underwent surgery, including 16 for emergency surgery. The other 238 patients were managed non-operatively. There were no significant differences in the type of procedures between survivors and nonsurvivors.

Clinical Characteristics

The clinical characteristics of the patients are shown in Table 2. At surgical ICU admission, nonsurvivors were more likely to have jaundice and disturbance of consciousness than survivors. They also had higher levels of total bilirubin, prothrombin time, INR, arterial lactate, APACHE II and SOFA scores than survivors. There were no significant differences in other symptoms, signs and lab values at surgical ICU admission between the two groups.

Table 2 Clinical Characteristics of the Patients Admitted to the Surgical ICU

Variables	Overall (n=347)	Survivors (n=234)	Nonsurvivors (n=113)	*P* value
Symptoms at ICU admission				
Fever, n (%)	34 (9.80)	25 (10.68)	9 (7.96)	0.425
Jaundice, n (%)	32 (9.22)	16 (6.84)	16 (14.16)	0.027[#]
Hematemesis and hematochezia, n (%)	12 (3.46)	7 (2.99)	5 (4.42)	0.493
Nausea and vomiting, n (%)	6 (1.73)	4 (1.71)	2 (1.77)	0.968
Oliguria, n (%)	6 (1.73)	5 (2.14)	1 (0.88)	0.402
Disturbance of consciousness*, n (%)	89 (25.65)	45 (19.23)	44 (38.94)	<0.001[##]
Signs at ICU admission				
Body temperature (°C)	37.2 ± 0.97	37.2 ± 0.89	37.3 ± 1.12	0.136
Pulse rate (times per minute)	104 ± 26.2	103 ± 25.8	107 ± 27.7	0.173
Respiratory rate (times per minute)	24 ± 8.6	24 ± 9.0	25 ± 7.9	0.568
MAP (mmHg)	90 ± 17.9	91 ± 16.9	88 ± 19.8	0.101
Lab values at ICU admission				
WBC (10^9/L)	12.9 ± 9.05	12.9 ± 9.53	12.7 ± 7.97	0.823
PLT (10^9/L)	146.8 ± 111.58	153.3 ± 112.44	132.8 ± 108.92	0.112
ALT (U/L)	186.8 ± 504.05	185.1 ± 489.98	233.4 ± 569.65	0.243
AST (U/L)	289.3 ± 934.09	255.4 ± 907.49	361.6 ± 988.98	0.328
TB (μmol/L)	79.6 ± 124.67	64.0 ± 102.40	112.9 ± 157.86	0.001[##]
Albumin (g/L)	29.0 ± 6.81	29.4 ± 7.12	28.0 ± 6.03	0.085
PT (s)	18.5 ± 8.96	17.3 ±5.41	21.3 ± 13.72	<0.001[##]
INR	1.6 ± 0.91	1.5 ± 0.63	1.9 ± 1.31	<0.001[##]
Creatinine (μmol/L)	127.0 ± 131.52	128.0 ± 133.96	124.8 ± 126.66	0.836
Na^+ (mmol/L)	137.3 ± 7.78	136.9 ± 8.70	138.0 ± 9.65	0.218
K^+ (mmol/L)	4.0 ± 1.35	3.9 ± 0.71	4.1 ± 2.15	0.417
PaO_2/FiO_2 [a]	3.4 ± 2.92	3.5 ± 2.35	3.1 ± 3.88	0.256
Arterial lactate (mmol/L)	3.4 ± 4.14	2.4 ± 2.76	5.7 ± 5.55	<0.001[##]
Procalcitonin (ng/mL)[b]	16.1 ± 36.22	15.6 ± 36.90	17.4 ± 34.49	0.703
Positive blood bacterial culture[c], n (%)	52 (27.66)	34 (26.26)	18 (30.51)	0.555
APACHE II at ICU admission	16.39 ± 7.61	14.18 ± 8.15	20.96 ± 8.31	<0.001[##]
SOFA score at ICU admission	7.67 ± 4.87	8.18 ± 3.57	10.76 ± 5.71	<0.001[##]

Notes: [a]Survivors (n = 214), nonsurvivors (n = 99); [b]Survivors (n = 205), nonsurvivors (n = 76). [c]Survivors (n = 129), nonsurvivors (n = 59). *"Yes" in "disturbance of consciousness" was given when the patient has difficulty maintaining wakefulness and/or has impaired awareness of him/herself and his/her environment. [#]*P*-value <0.05, [##]*P*-value <0.01.

Abbreviations: HCT, hematocrit; WBC, white blood cell count; PLT, platelet count; ALT, alanine aminotransferase; AST, alanine aminotransferase; TB, total bilirubin; PT, prothrombin time; INR, international normalized ratio; PaO_2/FiO_2, oxygen partial pressure/oxygen concentration; MAP, mean arterial pressure; APACHE II, acute physiology and chronic health evaluation; SOFA score, sequential organ failure assessment score.

Risk Factors of 28-Day Mortality by Univariate and Multivariate Analyses

To investigate the association of patients' demographic data and clinical characteristics with 28-day mortality, we firstly conducted univariable logistic regression analysis. As shown in Table 3, patients' age, total bilirubin (TB), prothrombin time (PT), international normalized ratio (INR), arterial lactate, APACHE II and SOFA score at ICU admission were associated significantly with 28-day mortality of surgical ICU patients. Noticeably, gender, causes for ICU admission and coexisting conditions were not associated with 28-day mortality. We further conducted a multivariate logistic regression analysis using the parameters shown to be significant or almost significant (P<0.20) in the univariate analysis. As a result, age [Odds Ratio (OR): 2.899, 95% CI: 1.427–5.890, P=0.003], hypertension [OR: 3.630, 95% CI: 1.545–8.531, P=0.003], platelet count [PLT, OR: 1.004, 95% CI: 1.001–1.007, P=0.015], arterial lactate level [OR: 1.186, 95% CI: 1.088–1.293, P<0.001] and SOFA score [OR: 1.289, 95% CI: 1.131–1.469, P<0.001] at ICU admission were significantly associated with 28-day mortality of patients

Table 3 Univariate and Multivariate Analyses of 28-Day Mortality

Parameters	Univariate Analysis		Multivariate Analysis		
	OR (95% CI)	*P* value	OR (95% CI)	*P* value	VIF
Age (≥65y/<65y)	1.627(1.036–2.557)	**0.035**[#]	2.899(1.427–5.890)	**0.003**[##]	1.300
Sex (male/female)	1.100(0.689–1.756)	0.690	–	–	
Smoking (yes/no)	1.447(0.880–2.379)	0.146	1.003(0.507–1.986)	0.993	1.044
Chronic alcohol consumption (yes/no)	1.477(0.845–2.581)	0.171	1.148(0.515–2.562)	0.736	1.079
Hypertension (yes/no)	1.428(0.849–2.402)	**0.179**	3.630(1.545–8.531)	**0.003**[##]	1.236
Diabetes mellitus (yes/no)	0.824(0.426–1.594)	0.565	–	–	
Cirrhosis (yes/no)	0.484(0.225–1.042)	**0.064**	0.558(0.185–1.683)	0.300	1.222
Ischemic heart disease (yes/no)	0.625(0.301–1.297)	0.207	–	–	
Stroke (yes/no)	1.040(0.528–2.049)	0.910	–	–	
Malignant diseases (yes/no)	0.723(0.423–1.236)	0.236	–	–	
COPD	0.586(0.298–1.154)	**0.122**	0.907(0.348–2.367)	0.842	1.188
Bacterial culture of blood (yes/no)[a]	0.812(0.439–1.503)	**0.508**	–	**–**	–
SOFA score at ICU admission	1.310(1.222–1.405)	**<0.001**[##]	1.289(1.131–1.469)	**<0.001**[##]	3.234
APACHE II at ICU admission (w/o age)*	1.139(1.099–1.181)	**<0.001**[##]	1.028(0.967–1.093)	0.378	2.347
Surgery	0.970(0.598–1.572)	0.901	–	–	
Emergency surgery	1.065(0.361–3.143)	0.909	–	–	
PLT (10^9/L)	0.998(0.996–1.000)	0.114	1.004(1.001–1.007)	**0.015**[#]	1.357
WBC (10^9/L)	0.997(0.972–1.023)	0.822	–	–	
TB	1.003(1.001–1.005)	**0.001**[##]	1.000(0.997–1.003)	0.961	1.477
Creatinine	1.000(0.998–1.002)	0.836	–	–	
Albumin	0.969(0.935–1.004)	**0.086**	0.970(0.920–1.022)	0.251	1.124
PT	1.064(1.025–1.105)	**0.001**[##]	0.966(0.882–1.059)	0.461	7.166
Na^+	1.019(0.989–1.049)	0.220	–	–	
K^+	1.069(0.905–1.262)	0.432	–	–	
INR	1.742(1.256–2.415)	**0.001**[##]	1.210(0.438–3.340)	0.713	7.045
PaO_2/FiO_2 [b]	0.940(0.843–1.048)	0.265	–	–	
Arterial lactate	1.253(1.156–1.358)	**<0.001**[##]	1.186(1.088–1.293)	**<0.001**[##]	1.301
Procalcitonin [c]	1.001(0.994–1.008)	0.702	–	–	
Blood transfusion (yes/no)	0.838(0.529–1.327)	0.450	–	–	

Notes: *Since age is a factor in calculating APACHE II scores, they cannot be used together with age in multivariable analysis. Therefore, APACHE II scores without age were used here. [a]Survivors (n =129), nonsurvivors (n = 59); [b]Survivors (n = 214), nonsurvivors (n = 99); [c]Survivors (n = 205), nonsurvivors (n = 76). [#]*P*-value <0.05, [##]*P*-value <0.01.

Abbreviations: COPD, chronic obstructive pulmonary disease; SOFA score, sequential organ failure assessment score; PLT, platelet count; WBC, white blood cell count; TB, total bilirubin; INR, international normalized ratio; PaO_2/FiO_2, oxygen partial pressure/oxygen concentration.

in the surgical ICU. However, as the OR for PLT was so close to 1, the clinical significance of PLT for predicting mortality in a surgical ICU appeared to be very limited.

Clinical Outcomes for Young and Elderly SICU Patients

The clinical outcomes for young and elderly SICU patients are summarized in Table 4. The maximum APACHE II (without the age point) and SOFA score during their ICU stay as well as at discharge exhibited no differences between the young and elderly. The most common complications were multiple organ dysfunction syndrome (MODS), acute kidney injury (AKI), sepsis and acute respiratory distress syndrome (ARDS), accounting for 16.14%, 15.27%, 12.39% and 11.24%, respectively. The elderly were more likely to develop septic shock (0.10% vs 7.69%, p=0.002), ARDS (6.28% vs 17.31%, p=0.001) and acute coronary syndrome (ACS, 2.62% vs 17.95, p=<0.001) than the young. The length of hospital and ICU stay as well as the incidence of ICU re-admission showed no difference between the two groups. The elderly patients had a slightly higher ICU mortality rate than the young patients. However, the difference did not reach statistical significance. Consistent with results in Table 3,

Table 4 Clinical Outcomes for Young and Elderly SICU Patients

Variables	Overall (n=347)	The Young (<65y, n=191)	The Elderly (≥65y, n=156)	*P* value
Maximum APACHE II	18.53 ± 8.56	16.97 ± 8.20	20.44 ± 8.64	**<0.001[##]**
Maximum APACHE II (w/o age)	13.20 ± 9.34	13.02 ± 9.30	13.42 ± 9.40	0.691
Maximum SOFA score	8.75 ± 5.66	8.42 ± 6.00	9.158 ± 5.21	0.237
APACHE II at discharge	16.61 ± 9.64	14.70 ± 9.45	18.9 ± 9.38	**<0.001[##]**
APACHE II at discharge (w/o age)	15.12 ± 8.35	15.29 ± 8.10	14.90 ± 8.67	0.670
SOFA score at discharge	8.44 ± 5.79	8.06 ± 6.08	8.91 ± 5.40	0.173
Complications				
Sepsis, n (%)	43 (12.39)	24 (12.57)	19 (12.18)	0.914
Sepsis shock, n (%)	14 (4.03)	2 (0.10)	12 (7.69)	**0.002[##]**
AKI, n (%)	53 (15.27)	30 (15.71)	23 (14.74)	0.804
ALI, n (%)	32 (9.22)	21 (10.99)	11 (7.05)	0.207
ARDS, n (%)	39 (11.24)	12 (6.28)	27 (17.31)	**0.001[##]**
ACS, n (%)	33 (9.51)	5 (2.62)	28 (17.95)	**<0.001[##]**
DIC, n (%)	5 (1.44)	3 (1.57)	2 (1.28)	0.822
MODS, n (%)	56 (16.14)	27 (14.14)	29 (18.59)	0.262
Length of hospital stay (days)	14.12 ± 14.38	14.72 ± 14.30	14.39 ± 14.48	0.392
Length of ICU stay (days)	10.85 ± 12.82	11.91 ± 13.34	9.56 ± 12.08	0.091
ICU re-admission, n (%)	48 (13.83)	22 (11.52)	26 (16.66)	0.167
ICU mortality, n (%)	61 (17.58)	29 (15.18)	32 (20.51)	0.194
28-day mortality, n (%)[a]	113 (32.56)	53 (27.75)	60 (38.46)	**0.034[#]**

Notes: [a]28-day overall mortality included ICU mortality and 28-day mortality after leaving ICU. [#]*P*-value <0.05, [##]*P*-value <0.01.
Abbreviations: APACHE II, acute physiology and chronic health evaluation; SOFA score, sequential organ failure assessment score; AKI, acute kidney injury; ALI, acute liver injury; ARDS, acute respiratory distress syndrome; ACS, acute coronary syndrome; DIC, disseminated intravascular coagulation; MODS, multiple organ dysfunction syndrome; ICU, intensive care unit.

the 28-day overall mortality was significantly higher in the elderly group than the young group (38.46% vs 27.75%, p=0.034).

Discussion

In this study, we identified four independent risk factors for 28-day mortality of patients in the surgical ICU: age 65 or older, hypertension, a high arterial lactate level and a high SOFA score at ICU admission. Although platelet count (PLT) was also significantly associated with 28-day mortality of surgical ICU patients in the multivariate logistic regression analysis, the OR for PLT was so close to 1. The clinical significance of PLT for predicting mortality in a surgical ICU appeared to be very limited. These findings would be useful for treatment evaluation, patient triage and resource allocation in surgical ICUs.

Aging affects many aspects of immune responses and is associated with an increasing vulnerability to many diseases and to death.[14–17] Our current finding on the impact of aging on ICU mortality was consistent with several previous reports.[18,19] Immunosenescence in the elderly contributes to the dysregulation of inflammatory responses.[20] Age-related changes in mitochondria and telomeres cause deterioration in cellular structure and function.[21] As a result of inactivity, functional limitation, and poor or restricted diets, malnutrition is commonplace in elderly patients.[22] Malnutrition can disrupt the function of various immune system components, weaken immune defense, and make elderly people vulnerable to various diseases.[23] Sepsis, ARDS and ACS are common complications of ICU patients. Older age is an independent risk factor of sepsis.[24] The incidence of sepsis increases with increasing age.[25] In the current study, we also found the elderly patients were more likely to suffer other underlying diseases such as hypertension, diabetes mellitus and stroke. The elderly ICU patients had higher risks of developing complications including septic shock, ARDS and ACS. They also had a higher mortality rate. Taken together, these results suggest that compared with young surgical ICU patients, elderly surgical ICU patients were more likely to develop life-threatening complications. The prevention and treatment of age-related diseases is a crucial task for the modern medical.

Lactate and SOFA score mainly reflects the progress and transformation of the disease in real time. Elevated lactate levels indicate some level of shock or tissue malperfusion and have been found to be associated with worse outcomes.[26] Excessive lactate production may give rise to lactic acidosis. However, it is probably not the elevated lactate per se, but the underlying condition that increases the risk for adverse outcomes.[11] The SOFA score is an effective method to assess organ dysfunction in critically ill patients.[27] It has been demonstrated that the SOFA score is a useful predictor of medical ICU mortality.[28] In the current study, the univariate and multivariate analyses by logistic regression models also indicate SOFA scores were one of the independent risk factors for mortality of patients in the surgical ICU.

APACHE II is a severity of disease classification system consisting of acute physiology points, age points and chronic health points.[29] It is widely used for severity evaluation for patients in the ICU.[30] Since the purpose of this study was to investigate the impact of age on surgical ICU outcomes, we calculated the APACHE II score both with and without the age point. The results showed that although old ICU patients had higher overall APACHE II scores than young ones, the differences between the two groups became no significant when the age point were excluded from the calculation. More importantly, the multivariate analysis reveals that APACHE II scores both with (data not shown) and without the age point were not an independent risk factor for mortality of patients in the surgical ICU. This is not surprising. Several other studies have also shown the APACHE II score was not reliable in predicting mortality in the ICU.[31,32] Although there are studies suggesting APACHE II could be used to predict post-ICU mortality,[33] the predicted mortality of an APACHE II score is dependent on ICU admission indications.[30] This discrepancy limits the application of the APACHE II score in a patient population with a variety of disease states, which is the case in our current study. Taken together, our data suggest that SOFA has greater prognostic accuracy for mortality than APACHE II in the surgical ICU. APACHE II may have limited utility for predicting mortality in a surgical ICU setting.

Some limitations need to be noted in the present study. Due to the lack of information, we were unable to calculate the patients' Glasgow Coma Scale (GCS) and body mass index (BMI) in this study. During our study period, there were about 400 patients who underwent organ transplantation in our hospital. The majority of organ transplant patients were younger than 65 years old, and their short-term mortality was relatively low compared with other SICU patients. Due to the unique nature of organ transplant patients, it would confound our analysis. Therefore, we decided to exclude them from the analysis. Like most ICUs, our surgical ICU has a mixed population. The primary ICU diagnosis was organized according to the organ-system in this study. In addition, this study was designed as a single-center retrospective cohort study. Therefore, it might not be effectively controlled and could be subjected to a selection bias, recall bias and some residual confounding. A multiple-center data were needed to validate the effect of age on the surgical ICU patients. Furthermore, this study was only concentrated on the short-term outcomes. This is due to the fact that the young and elderly ICU patients had significantly different underlying conditions, which may affect the long-term outcomes. In the future, a prospective propensity score-matched study is warranted to investigate for the long-term outcomes of surgical ICU patients.

Conclusion

In patients admitted to the surgical ICU, age 65 or older, hypertension, a high arterial lactate level and SOFA score at ICU admission were associated with increased 28-day mortality.

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Disclosure

The authors report no conflicts of interest in this work.

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