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Research article

Independent predictors of mortality for critically ill patients with polytrauma: A single center, retrospective study

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ABSTRACT

Independent predictors of mortality and transfusion therapy in polytrauma patients from the Chinese population remain unknown. Here, we aimed to identify these predictors by retrospectively collecting and analyzing vital signs and laboratory results for 408 critically ill patients suffering from polytrauma who were treated in Affiliated Kunshan Hospital of Jiangsu University, Jiangsu Province, China from January 2020 to December 2021. We identified risk factors for mortality and transfusion therapy using logistic regression analysis. As a results, we enrolled a total of 408 polytrauma patients, with a male-to-female ratio of 2:1, a mean age of 49.02 ± 16.84 years, a mortality rate of 15.9 %, and a blood transfusion rate of 45.8 %. The multivariate logistic regression showed that decreased Glasgow Coma Scale (GCS) score (Odds ratio (OR) = 0.72, 95 % confidence interval (95%CI): 0.63–0.83, $P < 0.001$), decreased base excess (BE) (OR = 0.77, 95%CI: 0.67–0.87, $P < 0.001$), and increased Injury Severity Score (ISS) (OR = 1.12, 95%CI: 1.06–1.17, $P < 0.001$) were independent risk factors for the mortality. In addition, increased GCS score (OR = 1.17, 95%CI: 1.03–1.35, $P = 0.020$), increased heart rate (OR = 1.05, 95%CI: 1.04–1.07, $P < 0.001$), decreased systolic blood pressure (SBP) (OR = 0.97, 95%CI: 0.96–0.99, $P < 0.001$), increased peripheral oxygen saturation (SpO2) (OR = 1.10, 95%CI: 1.04–1.16, $P = 0.002$), decreased serum lactate (OR = 0.58, 95%CI: 0.42–0.79, $P = 0.001$), decreased BE (OR = 0.49, 95%CI: 0.39–0.62, $P < 0.001$), and increased ISS (OR = 1.25, 95%CI: 1.18–1.33, $P < 0.001$) were independent risk factors for blood transfusion. The area under receiver operating characteristic curves (AUROCs) of the model to predict mortality and blood transfusion were 0.976 (95%CI: 0.960–0.992, $P < 0.001$) and 0.973 (95%CI: 0.958–0.987, $P < 0.001$). In conclusion, decreased BE level was significantly associated with all-cause mortality in polytrauma patients. BE, ISS, and GCS might be independent important predictors for mortality and blood transfusion of polytrauma patients.

1. Introduction

Polytrauma remains one of the leading causes of death among emergency department patients under 45 years of age, causing the deaths of millions of people around the world [1–4]. Traffic accident, falling from height, fall, and heavy object injury are common causes of polytrauma [5,6]. Severe polytrauma patients lose a large amount of blood and suffer from various types of injuries. Thus, identifying indicators and risk factors that can determine the condition of patients early on admission is particularly important.

Previous studies have primarily used the Injury Severity Score (ISS) to assess severity in trauma patients [7]. ISS is an anatomically based scoring system for patients with polytrauma [8,9]. It divides the patient's body into six areas (head and neck, face, chest, abdomen, extremities, and exterior) and calculates the abbreviated injury scale (AIS) score for each area [7,10]. The sum of squares of the top three AIS scores is then calculated as the ISS. However, ISS is subjective, and a single scoring system may be difficult to accurately predict patient prognosis and death [7,11].

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In this study, we collected data from 408 critically ill patients with polytrauma, measuring a series of vital signs and blood gas analysis parameters in the early stages of hospitalization. The primary objective was to identify the risk factors influencing the mortality rate of patients with polytrauma. Additionally, we employed logistic regression to construct a prognostic model for these patients, aiming to formulate more effective strategies in the early stages of hospital admission to reduce the mortality rate associated with polytrauma.

2. Materials and methods

2.1. Study design and setting

This was a single center, retrospective study. We collected critically ill patients with polytrauma in the emergency department of Affiliated Kunshan Hospital of Jiangsu University, Jiangsu Province, China, from January 2020 to December 2021. The Affiliated Kunshan Hospital of Jiangsu University is a Class III general hospital, rather than a trauma center. Kunshan, situated in the southeast coastal area of China, is a county-level city. The hospital primarily serves patients from nearby districts and counties. These cases were admitted to the emergency department for traffic accidents, falls, and other reasons. We counted the demographic parameters (age and sex), patient classification (reasons for admission), and observational indicators (systolic blood pressure (SBP), heart rate, respiratory rate, peripheral oxygen saturation (SpO2), Glasgow Coma Scale (GCS) score, shock index (SI), and Injury Severity Score (ISS)).

Blood samples was collected for blood gas analysis within 30 min of arrival at the emergency department. The laboratory results, including serum lactate and base excess (BE), were measured by ABL90FLEX blood gas analyzer of Radiometer Company in Denmark. White blood cell count (WBC), hemoglobin, platelet, prothrombin time, and international normalized ratio (INR) were measured by the emergency clinical laboratory. Damage control surgery is generally adopted for open or closed chest trauma and abdominal trauma. Intervention or pelvic tamponement should be taken for patients with peritoneal hemorrhagic shock trauma after pelvic fracture.

We excluded cases under the age of 18 years. We excluded the cases transferred to other hospitals after admission (5), discharged against medical advice (6), and transferred from another hospital with fluid resuscitation (12). We also excluded cases with missing data (12). Finally, a total of 408 cases were included in this study.

Patient consent was waived due to the retrospective nature of the study. The study was approved by the Ethics Review Committee of The Affiliated Kunshan Hospital of Jiangsu University (No.2021-03-015-H01).

Table 1
Baseline characteristics of polytrauma patients.

	Median (Min-Max)	Mean ± SD/n (%)
Age (years)	50 (18–90)	49.02 ± 16.84
Gender		
Male		272 (66.7 %)
Reasons for admission		
Traffic injury		263 (64.5 %)
Fall from height		92 (22.5 %)
Crush injury		29 (7.1 %)
Slip and fall injury		13 (3.2 %)
Knife wound		11 (2.7 %)
GCS	13.50 (3.0–15.0)	11.93 ± 4.05
SBP, mmHg	115 (35–215)	114.02 ± 31.53
Heart rate, bpm	91 (35–169)	94.56 ± 23.69
Respiratory rate, breaths/min	21 (0–42)	21.74 ± 6.15
SpO2, %	96 (50–100)	92.70 ± 8.25
Serum lactate, mmol/l	2.20 (0.4–16.0)	3.36 ± 3.23
Prothrombin time, sec	11.80 (0–25.3)	12.25 ± 2.91
Hemoglobin, g/l	131 (29–187)	126.77 ± 27.86
Platelet, x10^9/l	213 (20–429)	217.28 ± 82.39
WBC, x10^9/l	13.27 (3.65–41.10)	14.99 ± 6.92
BE, mmol/l	−3.80 (−25.60–8.70)	−5.00 ± 5.52
Glucose, mmol/l	8.90 (1.10–38.4)	9.87 ± 4.43
ISS	21 (11–72)	25.61 ± 13.56
SI	0.84 (0.31–2.88)	0.92 ± 0.42
INR	1.01 (0–2.23)	1.06 ± 0.25
Blood transfusion		
Yes		187 (45.8 %)
No		221 (54.2 %)
Mortality Rate		65 (15.9 %)

GCS: Glasgow Coma Scale, INR: international normalized ratio, ISS: Injury Severity Score, SBP: systolic blood pressure, SI: shock index, SpO2: peripheral oxygen saturation, WBC: White blood cell count.

2.2. Outcome measures

The primary outcome was in-hospital mortality. Secondary outcome was whether blood transfusion was given.

2.3. Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics software for Windows (IBMCorp., Armonk, N.Y., USA). The distributions of the continuous and categorical variables were presented as mean ± standard deviation and median (minimum-maximum), and frequency/percentages respectively. Shapiro-Wilk test was used to test whether the quantitative data conformed to the normal distribution. Student-t test and Mann-Whitney *U* test were used to compare the quantitative variables with or without normal distribution between groups. The Pearson chi-square tests were used to compare the qualitative data between groups. Sensitivity, specificity, and receiver operating characteristic (ROC) curves were used to determine the diagnostic critical value for the parameters. Univariate logistic regression was used to explore the associations between predictor factors and outcomes. Multivariate logistic regression analysis was performed to assess the independent risk factors and all-cause death/blood transfusion of critically ill patients. The likelihood ratio (LR) method was used to input the independent variables, and the significance level for removal from the model was set at 0.1. In order to avoid multicollinearity, we deleted relevant variables in the multivariable model. Statistical significance was defined as $P < 0.05$.

3. Results

3.1. Demographics and outcomes

The patient characteristics were given in Table 1. A total of 408 polytrauma patients were enrolled in this study, with a male-to-female ratio of 2:1, mean age of 49.02 ± 16.84 years, mortality rate of 15.9 %, and number of blood transfusion of 187 (45.8 %). Among them, 263 (64.5 %) were injured by traffic accidents, 92 (22.5 %) were injured by falling from heights, 29 (7.1 %) were injured by heavy objects, 13 (3.2 %) were injured by falling, and 11 (2.7 %) were injured by knives. All-cause mortality at 30 days was 15.9 % (65/408). A total of 187 (45.8 %) patients received blood transfusions. Patients were divided into a 30-day survival group (n = 343) and a 30-day death group (n = 65) or a blood transfusion group (n = 187) and a non-blood transfusion group (n = 221). Other detailed physiological parameters and laboratory results of the cases were shown in Table 1.

3.2. Comparison of clinical data between the death group and the survival group

As shown in Table 2, age, heart rate, serum lactate, glucose, prothrombin time, INR, ISS, and SI in the death group were significantly higher than those in the survival group. The proportion of GCS, respiratory rate, SBP, SpO_2, BE, hemoglobin, and platelet in the

Table 2
Vital signs and laboratory tests upon presentation.

	Survival group (n = 343)	Death group (n = 65)	Mortality	Non-blood transfusion group (n = 221)	Blood transfusion group (n = 187)	Blood transfusion
	Mean ± SD/n (%)	Mean ± SD/n (%)	*P* value			*P* value
Age	48.15 ± 16.49	53.57 ± 18.03	**0.015**	50.52 ± 16.80	47.24 ± 16.76	0.054
Gender			0.104			0.779
Male	223 (81.99 %)	49 (18.01 %)		146 (53.68 %)	126 (46.32 %)	
Female	120 (88.24 %)	16 (11.76 %)		75 (55.15 %)	61 (44.85 %)	
GCS	13.15 ± 2.83	5.52 ± 3.39	<**0.001**	13.43 ± 3.05	10.17 ± 4.36	<**0.001**
Heart rate	93.64 ± 21.86	99.38 ± 31.42	**0.046**	85.72 ± 18.95	105.01 ± 24.51	<**0.001**
Respiratory rate	22.50 ± 5.07	17.72 ± 9.16	<**0.001**	21.42 ± 4.83	22.12 ± 7.42	**0.011**
SBP	118.48 ± 28.63	90.52 ± 35.69	<**0.001**	125.72 ± 28.40	100.20 ± 29.43	<**0.001**
SpO_2	94.45 ± 6.23	83.48 ± 11.08	<**0.001**	94.79 ± 7.04	90.24 ± 8.89	<**0.001**
Serum lactate	2.41 ± 1.67	8.33 ± 4.65	<**0.001**	1.90 ± 1.56	5.08 ± 3.81	<**0.001**
BE	−3.43 ± 3.67	−13.27 ± 6.27	<**0.001**	−1.77 ± 3.17	−8.81 ± 5.28	<**0.001**
Glucose	9.55 ± 3.86	11.56 ± 6.45	**0.003**	8.91 ± 3.45	11.00 ± 5.14	<**0.001**
Hemoglobin	130.37 ± 24.24	107.82 ± 36.92	<**0.001**	134.51 ± 20.27	117.63 ± 32.52	<**0.001**
Platelet	224.78 ± 78.13	177.71 ± 93.06	<**0.001**	217.29 ± 70.53	217.27 ± 94.72	0.764
WBC	14.99 ± 6.74	14.99 ± 7.87	0.701	13.41 ± 5.33	16.87 ± 8.05	<**0.001**
Prothrombin time	11.97 ± 1.85	13.71 ± 5.72	<**0.001**	11.71 ± 2.05	12.89 ± 3.57	<**0.001**
INR	1.03 ± 0.15	1.19 ± 0.50	<**0.001**	1.01 ± 0.16	1.11 ± 0.32	<**0.001**
ISS	21.54 ± 8.82	47.11 ± 13.97	<**0.001**	17.53 ± 7.57	35.17 ± 12.85	<**0.001**
SI	0.85 ± 0.35	1.26 ± 0.57	<**0.001**	0.72 ± 0.23	1.15 ± 0.47	<**0.001**

GCS: Glasgow Coma Scale, INR: international normalized ratio, ISS: Injury Severity Score, SBP: systolic blood pressure, SI: shock index, SpO2: peripheral oxygen saturation, WBC: White blood cell count.

death group were significantly lower than those in the survival group. There were no significant differences in gender and WBC between the two groups ($P > 0.05$).

3.3. Comparison of clinical data between the blood transfusion group and the non-blood transfusion group

As shown in Table 2, heart rate, respiratory rate, serum lactate, glucose, WBC, prothrombin time, INR, ISS, and SI in the blood transfusion group were significantly higher than those in the non-blood transfusion group. The proportion of GCS, SBP, SpO_2, BE, hemoglobin and platelet in the blood transfusion group were significantly lower than those in the non-blood transfusion group. There were no significant differences in age, gender, and platelet between the two groups ($P > 0.05$).

3.4. Risk factors for the mortality of critically ill patients with polytrauma

The univariate logistic regression showed that age, GCS, respiratory rate, SBP, SpO_2, serum lactate, BE, glucose, hemoglobin, platelet, prothrombin time, INR, ISS, and SI were risk factors for the mortality of patients with polytrauma ($P < 0.05$) (Table 3).

The area under ROC curves (AUCs) of ISS, serum lactate, prothrombin time, SI, INR, and glucose predicting mortality were found to be 0.935, 0.891, 0.724, 0.720, 0.717, and 0.618, respectively (95%CI: 0.903–0.967, $P < 0.001$; 95%CI: 0.839–0.943, $P < 0.001$; 95% CI: 0.645–0.802, $P < 0.001$; 95%CI: 0.635–0.804, $P < 0.001$; 95%CI: 0.638–0.796, $P < 0.001$; 95%CI: 0.535–0.701, $P = 0.003$) (Fig. 1A–F). The sensitivity and specificity values were shown in Supplementary Table 1. The cut-off points obtained for serum lactate, ISS, and SI were identified as $\geq$ 3.85, 38.50, and 1.119.

The multivariate logistic regression showed that decreased GCS (OR = 0.72, 95%CI: 0.63–0.83, $P < 0.001$), decreased BE (OR = 0.77, 95%CI: 0.67–0.87, $P < 0.001$), and increased ISS (OR = 1.12, 95%CI: 1.06–1.17, $P < 0.001$) were independent risk factors for the mortality of polytrauma patients (Table 3). The logistic regression was constructed as follows:

$$logit(p) = -4.100 + (-0.331) * GCS + (-0.266) * BE + 0.108 * ISS$$

The predicting model had a good value in identifying the mortality of patients [sensitivity = 83.1 % (54/65), and specificity = 98.8 % (339/343)]. The AUC of the model to predict mortality was 0.976 (95%CI: 0.960–0.992, $P < 0.001$).

3.5. Risk factors for patients requiring transfusion therapy

The univariate logistic regression showed that age, GCS, heart rate, SBP, SpO_2, serum lactate, BE, glucose, hemoglobin, WBC, prothrombin time, INR, ISS, and SI were risk factors for patients requiring transfusion therapy ($P < 0.05$) (Table 4). The AUCs of ISS, serum lactate, SI, heart rate, prothrombin time, INR, glucose, and WBC predicting blood transfusion were found to be 0.933, 0.849, 0.801, 0.734, 0.714, 0.712, 0.682, and 0.620, respectively (95%CI: 0.907–0.959, $P < 0.001$; 95%CI: 0.812–0.885, $P < 0.001$; 95%CI: 0.758–0.845, $P < 0.001$; 95%CI: 0.685–0.783, $P < 0.001$; 95%CI: 0.662–0.765, $P < 0.001$; 95%CI: 0.661–0.763, $P < 0.001$; 95%CI: 0.628–0.735, $P < 0.001$; 95%CI: 0.565–0.676, $P < 0.001$) (Fig. 2A–F). The sensitivity and specificity values were shown in Supplementary Table 2. The critical values obtained for ISS, serum lactate, SI, heart rate, prothrombin time, INR, glucose, and WBC were identified as $\geq$ 21.50, 2.550, 0.959, 101.50, 12.450, 9.050, and 13.640.

The multivariate logistic regression showed that increased GCS (OR = 1.17, 95%CI: 1.03–1.35, $P = 0.020$), increased heart rate

Table 3
Logistic regression analysis for the mortality of polytrauma patients.

	Univariate			Multivariate		
	Beta	**OR**	***P***	**Beta**	**OR**	***P***
Age	0.019	1.02 (1.00–1.04)	0.018			
Male	0.500	1.65 (0.90–3.02)	0.106			
GCS	−0.491	0.61 (0.56–0.68)	<0.001	−0.331	0.72 (0.63–0.83)	<0.001
Heart rate	0.010	1.01 (1.00–1.02)	0.074			
Respiratory rate	−0.134	0.87 (0.83–0.92)	<0.001			
SBP	−0.033	0.97 (0.96–0.98)	<0.001			
SpO_2	−0.151	0.86 (0.83–0.89)	<0.001			
Serum lactate	0.576	1.78 (1.56–2.04)	<0.001			
BE	−0.394	0.67 (0.62–0.74)	<0.001	−0.266	0.77 (0.67–0.87)	<0.001
Glucose	0.080	1.08 (1.03–1.14)	0.002			
Hemoglobin	−0.026	0.97 (0.97–0.98)	<0.001			
Platelet	−0.008	0.99 (0.99–1.00)	<0.001			
WBC	0	1.00 (0.96–1.04)	0.998			
Prothrombin time	0.198	1.22 (1.11–1.34)	<0.001			
INR	2.283	9.80 (3.48–27.60)	<0.001			
ISS	0.174	1.19 (1.15–1.24)	<0.001	0.108	1.12 (1.06–1.17)	<0.001
SI	2.014	7.49 (4.00–14.03)	<0.001			

GCS: Glasgow Coma Scale, INR: international normalized ratio, ISS: Injury Severity Score, SBP: systolic blood pressure, SI: shock index, SpO2: peripheral oxygen saturation, WBC: White blood cell count.

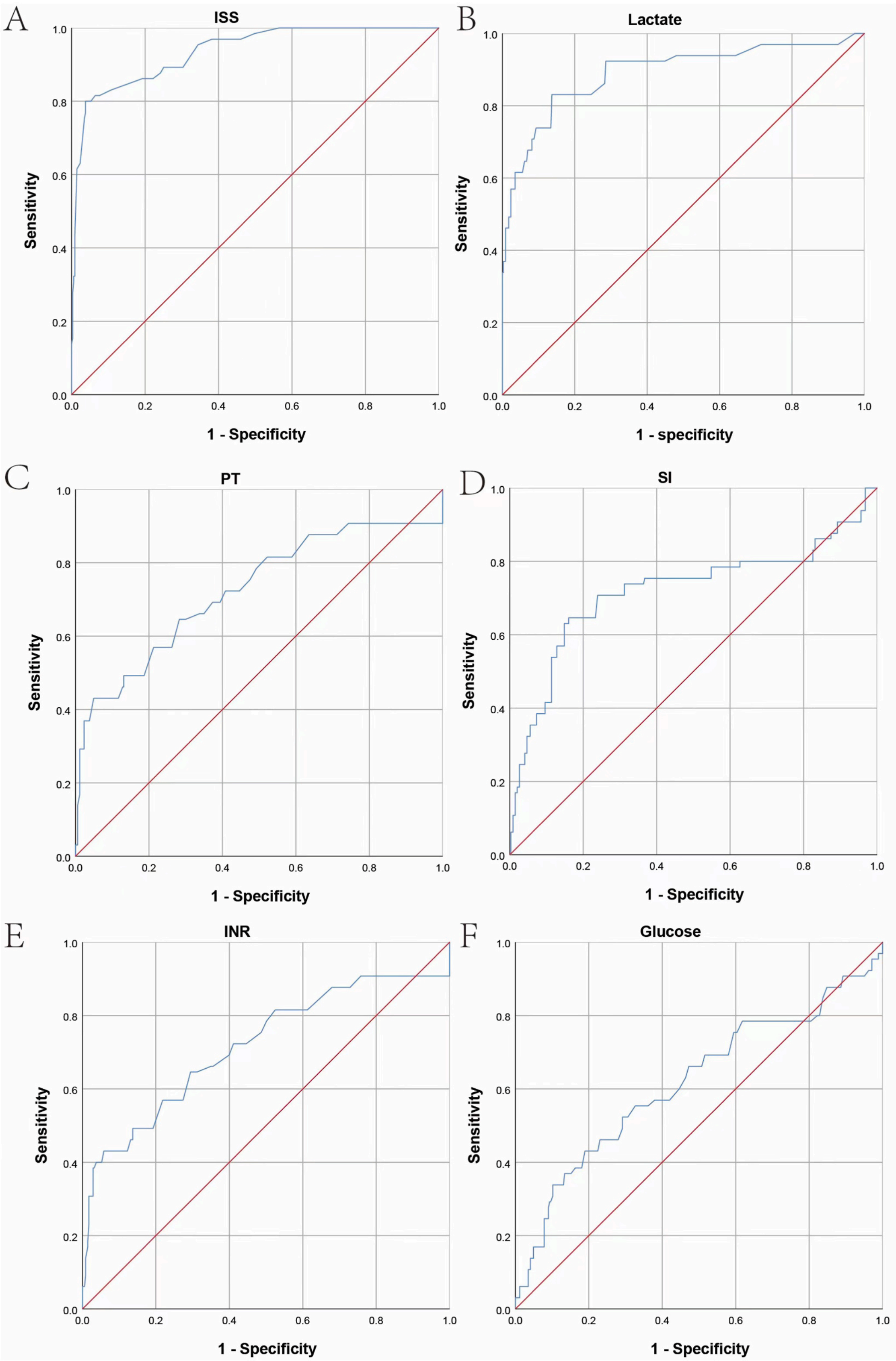

Fig. 1. Receiver operating characteristic (ROC) curves for predicting the mortality of polytrauma patients.

Table 4
Logistic regression analysis for blood transfusion of polytrauma patients.

	Univariate			Multivariate		
	Beta	**OR**	***P***	**Beta**	**OR**	***P***
Age	−0.012	0.99 (0.98–1.00)	0.05			
Male	0.059	1.06 (0.70–1.60)	0.779			
GCS	−0.231	0.79 (0.75–0.84)	<0.001	0.161	1.17 (1.03–1.35)	0.020
Heart rate	0.041	1.04 (1.03–1.05)	<0.001	0.053	1.05 (1.04–1.07)	<0.001
Respiratory rate	0.019	1.02 (0.99–1.05)	0.248			
SBP	−0.031	0.97 (0.96–0.98)	<0.001	−0.030	0.97 (0.96–0.99)	<0.001
SpO_2	−0.075	0.93 (0.90–0.95)	<0.001	0.093	1.10 (1.04–1.16)	0.002
Serum lactate	0.726	2.07 (1.73–2.47)	<0.001	−0.554	0.58 (0.42–0.79)	0.001
BE	−0.598	0.55 (0.49–0.62)	<0.001	−0.719	0.49 (0.39–0.62)	<0.001
Glucose	0.134	1.14 (1.08–1.22)	<0.001			
Hemoglobin	−0.024	0.98 (0.97–0.98)	<0.001			
Platelet	0	1.00 (1.00–1.00)	0.998			
WBC	0.077	1.08 (1.05–1.11)	<0.001			
Prothrombin time	0.168	1.18 (1.08–1.29)	<0.001			
INR	1.87	6.50 (2.4217.44)	<0.001			
ISS	0.213	1.24 (1.19–1.29)	<0.001	0.225	1.25 (1.18–1.33)	<0.001
SI	4.036	56.60 (23.24–137.80)	<0.001			

GCS: Glasgow Coma Scale, INR: international normalized ratio, ISS: Injury Severity Score, SBP: systolic blood pressure, SI: shock index, SpO2: peripheral oxygen saturation, WBC: White blood cell count.

(OR = 1.05, 95%CI: 1.04–1.07, $P < 0.001$), decreased SBP (OR = 0.97, 95%CI: 0.96–0.99, $P < 0.001$), increased SpO2 (OR = 1.10, 95% CI: 1.04–1.16, $P = 0.002$), decreased serum lactate (OR = 0.58, 95%CI: 0.42–0.79, $P = 0.001$), decreased BE (OR = 0.49, 95%CI: 0.39–0.62, $P < 0.001$), and increased ISS (OR = 1.25, 95%CI: 1.18–1.33, $P < 0.001$) were independent risk factors for blood transfusion (Table 4). The logistic regression was constructed as follows:

$$logit(p) = -19.659 + 0.161 * GCS + (-0.030) * SBP + 0.093 * SpO_2 + (-0.554) * serum\ lactate + (-0.719) * BE + 0.225 * ISS + 0.053 * heart\ rate$$

The predicting model had a good value in identifying blood transfusion [sensitivity = 88.8 % (166/187), and specificity = 93.7 % (207/221)]. The AUC of the model to predict blood transfusion was 0.973 (95%CI: 0.958–0.987, $P < 0.001$).

4. Discussion

Major biochemical and physiological imbalances in patients with critical polytrauma may contribute to high morbidity and mortality. Previous studies have identified a series of potential biomarkers (lactate, BE, pH, and blood glucose) and physiological parameters (GCS score, diastolic blood pressure (DBP), and SBP) that may predict mortality in polytrauma patients [1,5,12–15]. However, these studies focused on either elderly or non-Chinese cohorts, and risk factors for mortality of polytrauma patients in China's general population remain unknown.

In this retrospective study of critically ill patients with polytrauma based on a Chinese cohort, we found that the following factors were independently associated with mortality: decreased GCS (OR = 0.72, 95%CI: 0.63–0.83, $P < 0.001$), decreased BE (OR = 0.77, 95%CI: 0.67–0.87, P < 0.001), and increased ISS (OR = 1.12, 95%CI: 1.06–1.17, $P < 0.001$); the following parameters were independently predictive of the need for transfusion therapy: GCS, heart rate, SBP, SpO_2, serum lactate, BE, and ISS. We further used logistic regression to construct a mortality prediction model for patients with polytrauma, and found that it had excellent performance, with an AUC of 0.976 (95%CI: 0.960–0.992).

Most of the previous studies to predict the predictors of polytrauma were based on Dryad database and consisted mainly of Swiss participants. Chen et al. conducted a secondary analysis of 3075 trauma patients in Dryad database to determine a predictive model for mortality within 72 h of admission [16]. The results showed that age, GCS, ISS, and lactate level were independent prognostic factors associated with mortality. Similarly, Xie et al. included 2315 patients with polytrauma aged 18–65 years in Dryad database and found that lactate (OR = 1.36, 95%CI: 1.29–1.42, $P < 0.001$), GCS (OR = 0.76, 95%CI: 0.73–0.79, $P < 0.001$), and age >55 years (OR = 1.92, 95%CI: 1.37–2.66, $P < 0.001$) were risk factors for death in polytrauma patients [17]. Qi et al. conducted a secondary analysis in Dryad database including 2441 trauma patients who were treated in at the Level 1 trauma center of the University Hospital Zurich from 1996 to 2013, and found that BE (OR = 0.872, 95%CI: 0.854–0.890) and lactate level (OR = 1.353, 95%CI: 1.296–1.413) were the most likely predictors [12]. Our results replicated three independent predictors (GCS, ISS, and BE) of mortality in previous studies. However, lactate level may not be an independent predictor of polytrauma in the Chinese population. In addition to the European population, Torabi et al. investigated the blood gas indexes of polytrauma patients who visited the Bahonar academic Hospital, Level II Trauma Center, in Iran from September 1, 2015 to September 1, 2016 at the time of admission and 3 h after admission [1]. The results showed that in multivariable analysis, only the change of blood glucose within 3 h after admission, INR, and heart rate were significantly related to mortality. In addition, da Costa et al. analyzed a prospective cohort of 200 trauma patients in Sao Paulo, Brazil, from 2010 to 2013, and found that arterial hemoglobin oxygen saturation, lactate level, and GCS were independent predictors of early

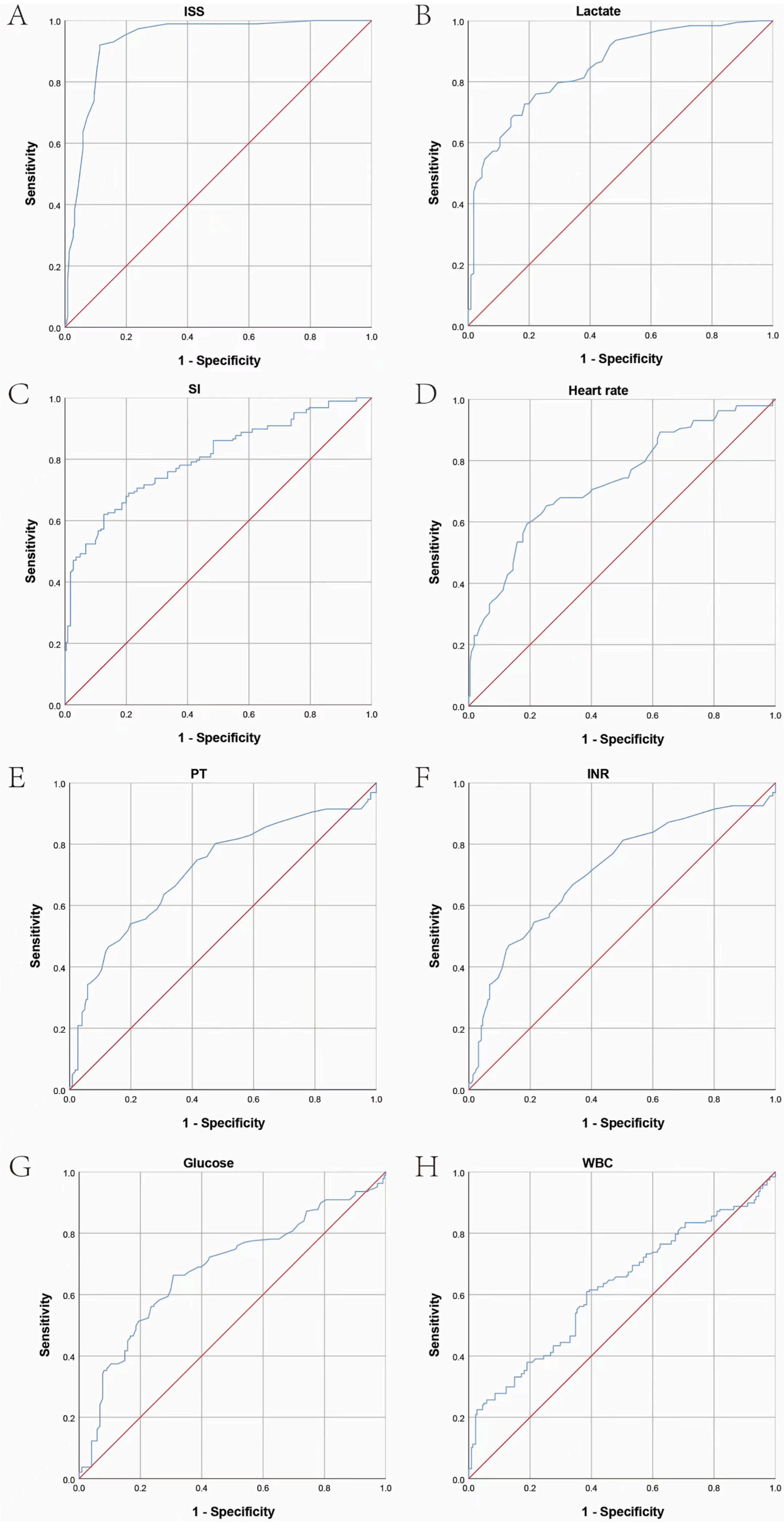

Fig. 2. Receiver operating characteristic (ROC) curves for predicting the blood transfusion of polytrauma patients.

mortality [5]. Similarly, lactate, INR, SpO_2, and blood glucose were significantly associated with patient mortality in the univariate model in our results, but did not pass the threshold of the multivariate model.

According to the critical value of blood gas analysis reported by the European guideline 2019, the body score temperature, BE, and pH were 35 °C, −5 mmol/L, 7.2, respectively [18]. The critical values of ISS and lactate in Dryad database were 25 and 2.33 mmol/L, respectively [16]. In this study, the cut-off points for serum lactate, ISS, and SI were identified as ≥ 3.85 mmol/L, 38.50 points, and 1.119 units respectively. These values were generally higher than those in previous studies and might be more accurate in determining the prognosis of patients. However, the prognostic power of a single indicator might be weak; therefore a prognostic model containing multiple indicators could have a better prognostic effect.

In addition, for the first time, we constructed a predictive model for the need for transfusion therapy in polytrauma patients. In critically ill patients with polytrauma, massive blood transfusions were required if they developed hemorrhagic shock. However, the need for blood transfusion in other polytrauma patients was difficult to determine. If large amounts of blood were transfused carelessly, it might cause inflammatory disease, infection, multi-organ failure, and sepsis [19,20]. Juste et al. investigated the association between SI and the need for heavy transfusion in 184 polytrauma patients treated at Belvich University Hospital between 2012 and 2016 and showed that SI was a valid predictor for identifying the need for early transfusion for optimal treatment [21]. However, the association between other physiological markers and transfusion has not been investigated in previous studies. Our results replicated those of Juste et al. and increased GCS, increased heart rate, increased SpO_2, decreased serum lactate, decreased BE, and increased ISS were also risk factors for the need for transfusion.

The study has several limitations. First, this is a single-center retrospective study, and the conclusions of this study are limited to the southeast Chinese population. Secondly, we select easily assessable vital signs and blood gas analysis parameters to construct a mortality prediction model for polytrauma patients. Other indicators such as systemic inflammation, organ damage or hemostasis are difficult to measure. Thirdly, unlike other countries and regions in the world, due to the strict control of guns and knives in our country, we rarely receive penetrating injury patients. Therefore, there may be some differences in the causes of injury among the hospitalized patients in this study and previous studies. Additionally, in logistics analysis, the effect sizes of univariate analysis and multivariate analysis are opposite. We speculate that multicollinearity may lead to instability of estimated coefficients when there is a high correlation between independent variables. Finally, in our predictive model, ISS is a parameter that requires subjective evaluation and is difficult to determine in the first hour of admission, so these may affect the performance of the model and require improved ISS indicators to be applied in clinical practice.

In conclusion, we identified the independent predictors of mortality and blood transfusion in polytrauma patients and constructed a logistic regression prediction model based on these predictors. Our results indicated that besides the traditional GCS and ISS, BE was also a valid and easily measured predictor.

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Informed consent statement

Patient consent was waived due to the retrospective nature of the study.

Data availability statement

Data will be made available on request.

CRediT authorship contribution statement

Ping Zhou: Writing – original draft, Project administration, Formal analysis, Data curation. **Lijing Ling:** Project administration, Formal analysis, Conceptualization. **Xiaohua Xia:** Writing – original draft, Project administration, Formal analysis, Conceptualization. **Hua Yuan:** Software, Methodology, Investigation. **Zhiqiang Guo:** Writing – original draft, Formal analysis, Data curation. **Qiupeng Feng:** Visualization, Software, Resources, Methodology, Formal analysis, Data curation. **Jin Ma:** Writing – review & editing, Writing – original draft, Project administration, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e25163.

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