Risk Factors of Postoperative Septic Cardiomyopathy in Perioperative Sepsis Patients

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Research Article

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Abstract

Objective: This study aimed to clarify the relevant risk factors of septic cardiomyopathy (SCM) in perioperative sepsis patients.

Methods: This retrospective study evaluated patients who were diagnosed with sepsis during the perioperative period and postoperatively admitted to the ICU in the Second Affiliated Hospital of Soochow University, the First Affiliated Hospital of Soochow University, and the Suzhou Municipal Hospital between January 2017 and November 2020. They were divided into 2 groups as the septic cardiomyopathy group (SCM group) and non-septic cardiomyopathy group (NSCM group). Significant factors in the multivariate logistic regression analysis (i.e., P<0.1) were used to establish a model and screen risk factors for SCM. The area under the receiver operating characteristic curve was used to reflect the discriminative capability of the model. The Hosmer-Lemeshow goodness of fit test was used to evaluate the calibration capability of the model.

Result: Among the 269 patients, 49 patients had SCM. Sequential Organ Failure Assessment (SOFA) score (adjusted odds ratio [AOR]=2.535, 95% confidence interval (CI): 1.186-1.821, P=0.000]) and endoscopic surgery (AOR=3.154, 95% CI: 1.173-8.477, P=0.023]) were identified to be independent risk factors for SCM. Patients with a SOFA score ≥7 had a 46.831-fold higher risk of SCM (AOR =46.831, 95% CI: 10.511-208.662, P<0.05). The model had good discriminative capability (area under the curve: 0.902 [95% CI: 0.852-0.953]) and calibration capability (c^2=4.401, P=0.819). The predictive accuracy was 86.2%. The rates of mechanical ventilation and tracheotomy were significantly higher in the SCM group than in the NSCM group (all P<0.05). The SCM group also had significantly longer duration of mechanical ventilation (P<0.05) and significantly higher rates of continuous renal replacement therapy (CRRT) and CRRT-related mortality (P<0.05). Further, the total length of stay and hospitalization cost were significantly higher in the SCM group than in the NSCM group (P<0.05).

Conclusion: Endoscopic surgery and SOFA score ≥7 during postoperative ICU admission are independent risk factors for SCM within 48 hours postoperatively in patients with perioperative sepsis.

1. Background

Sepsis is defined as life-threatening organ dysfunction caused by a dysregulated host response to infection (1). Sepsis remains a major health problem worldwide, with high morbidity and mortality rates (2). Septic cardiomyopathy (SCM) is sepsis-associated acute syndrome of cardiac dysfunction unrelated to ischemia with one or more of the main characteristics: (1) left ventricular dilatation with normal- or low-filling pressure; (2) reduced ventricular contractility; and (3) right ventricular dysfunction or left ventricular (systolic or diastolic) dysfunction with a reduced response to volume infusion (3), which is reversible and can be restored at the early stage of sepsis (4). There is no uniform diagnostic criteria for SCM, and thus, the incidence of SCM varies widely, ranging from 10% to 70% (5). SCM increases the

mortality rate of patients with sepsis by two to three times, making sepsis treatment more difficult and significantly increases the economic burden (6).

The pathogenesis of SCM remains unclear to date. However, previous studies have shown that it is not associated with myocardial ischemia and hypoxia, but rather cardiac inhibition caused by multiple substances such as tumor necrosis factor-alpha and interleukin-1 beta (3,7). Latest research show that the pathogenesis of SCM include the following aspects. First, pathogen-associated molecular patterns (lipopolysaccharide) and damage-related molecular patterns (heparin sulfate) can interact with the corresponding receptors (toll-like receptors) and eventually activate nuclear factor-κB, leading to the production of a large number of inflammatory factors that cause cardiac suppression (8). Second, nitric oxide produced by neuronal and endothelial nitric oxide synthase may cause early cardiac dysfunction, while nitric oxide produced by inducible nitric oxide synthase may cause late cardiac dysfunction, due to mechanisms including changes in preload and afterload, decrease in sensitivity of myocardial filaments to calcium ions, downregulation of adrenaline receptors, and increase in mitochondrial permeability (9). Third, mitochondrial dysfunction including abnormal mitochondrial structure, mitochondrial DNA damage, increased mitochondrial membrane permeability, and inhibition of cytochrome C oxidase activity, all of which can lead to the increase of reactive oxygen species and abnormal energy metabolism, thus causing myocardial dysfunction (3). Fourth, calcium dysregulation in cardiomyocytes due to SR Ca^{2+}-ATPase (SERCA2) inhibition also plays an important role in SCM (10).

Previous studies have shown that a history of heart failure/coronary heart disease, high lactic acid levels, chronic health assessment system II scores, vasoactive drug use, male sex, and young age were associated with SCM (11). However, research on relevant risk factors of SCM in perioperative patients is lacking. We previously found that patients undergoing endoscopic surgery are at risk of SCM. Thus, this study aimed to clarify the relevant risk factors of SCM in perioperative sepsis patients. Further, we established a predictive model of SCM within 48 hours after intensive care unit (ICU) admission in surgical patients with perioperative sepsis, to provide a reference for improving the quality of perioperative management in critically ill patients.

2. Methods

2.1 Study design and patients

The Ethics Committee of the Second Affiliated Hospital of Soochow University approved this observational retrospective study and granted a waiver of written consent(JD-HG-2020-16). All methods were performed in accordance with the guidelines set forth by the the Second Affiliated Hospital of Soochow University.

This multicenter retrospective study evaluated patients who were admitted to the ICU after a definitive perioperative diagnosis of sepsis in the Second Affiliated Hospital of Soochow University, the First Affiliated Hospital of Soochow University, and Suzhou Municipal Hospital from January 2017 to

November 2020. The inclusion criteria were (1) admission to the ICU after a definitive perioperative diagnosis of sepsis and (2) age ≥18 years. The exclusion criteria were as follows: (1) previous heart disease with cardiac insufficiency; (2) preoperative SCM; (3) advanced malignant tumor; (4) acute cardiac dysfunction occurred more than 48 hours after ICU admission; (5) postoperative cardiopulmonary resuscitation; (6) incomplete patient data, including basic data, surgical data, and data during ICU admission; (7) ≥2 surgeries within the same hospitalization.

2.2 Study protocol

The patients were divided into 2 groups according the development of SCM within 48 hours after ICU admission as the SCM group and the non-SCM (NSCM) group. Septic cardiomyopathy was diagnosed according to the following two conditions. First, acute cardiac dysfunction in patients with sepsis or septic shock was confirmed within 48 hours of ICU admission, using one of three methods. (1) Bedside ultrasound performed by the ICU intensive care physician showed a visual decrease in systolic function of the left ventricle or right ventricle（18 out of 49（36.7%） (12).(2) Ejection fraction (EF) measured on echocardiography was lower than 50%（24 out of 49（48.9%）. The echocardiography was performed by a professional physician in the Department of Ultrasound. (3) PICCO monitoring showed a global ejection fraction of <15% or a cardiac function index of <3/min （7 out of 49（14.4%）(13).Second, acute cardiac dysfunction improved within 2 weeks after sepsis control. The results of relevant cardiac inspection data were confirmed by two independent high-qualified doctors in the ICU who did not participate in this study. The presence of acute reversible cardiac function concerns, such as diagnostic classification results, was discussed by another deputy director of the physician.

2.3 Data collection

The patients' basic information, preoperative status indicators, surgical type, postoperative ICU admission indexes, and the incidence of SCM within 48 hours after admission to the ICU were collected from the electronic medical record system and the medical record room. Basic information included age, sex, height, weight, body mass index (BMI), history of hypertension, diabetes, and admission route. Intraoperative conditions included preoperative shock, type of operation, method of operation, and source of infection.

ICU admission data included the SOFA score, initial lactic acid value, maximum lactic acid value, initial platelet value, minimum platelet value, maximum procalcitonin value, maximum body temperature, and maximum noradrenaline dose. The timing of SCM (within 48 hours or later) after ICU admission was also determined.

2.4 Variable definitions

Admission was categorized as emergency admission and non-emergency admission. Septic shock was diagnosed based on data from the medical chart and nurse's chart, with reference to *the Third International Consensus Definitions for Sepsis and Septic shock (1)*. The types of surgery were classified

as emergency surgery or non-emergency surgery. The surgical site was divided into the gastrointestinal tract, liver and gallbladder, urinary system, pelvic cavity, and others. The norepinephrine dosage (ug/kg*min) was determined according to the maximum sustained pump of norepinephrine in the detailed nursing medication record sheet during ICU admission.

2.5 Assessments

The SOFA score was determined following the SEPSIS 3.0 diagnostic criteria, and the laboratory findings during ICU were used. The initial lactic acid value and the maximum lactic acid value during the ICU stay were determined according to the lactic acid value in the blood gas analysis report. The initial platelet value and minimum platelet value during ICU admission were determined.

2.6 Statisticalanalysis

Normally distributed data were compared using the independent sample t test, with average ± standard deviation ($\bar{x}$ ± s). Meanwhile, non-normally distributed data were analyzed using two independent samples and presented as the median (quaternary interval) (M [Q1, Q3]). Enumeration data were presented as example (%) and analyzed using either C ² test or Fisher's exact probability test. Univariate statistical analysis was used to identify potential influencing factors (P<0.1) that were then included in the multivariate logistic regression analysis to screen independent risk factors. The area under ROC curve was used to evaluate the discriminating capability of the model. The Hosmer-Lemeshow goodness of fit test was used to determine the calibration capability of the model. All statistical analyses were performed using IBM SPSS Statistics 24. P<0.05 was considered statistically significant.

3. Results

3.1 Patient characteristics

A total of 269 patients were included in this study. Among them, 49 and 220 patients were categorized to the SCM group and the NSCM group, respectively. The patient inclusion flowchart is shown in Figure 1. The baseline patient characteristics are shown in Table 1. The median age was 66.0 (52.0, 77.0) years, and there were 149 males (55.4%) and 120 females (44.6%). There were no significant between-group differences in age, sex ratio, BMI, history of hypertension, history of diabetes, and proportion of emergency admission (all P>0.05).

3.2 Surgical information

The proportion of patients who underwent endoscopic surgery was significantly higher in the SCM group than in the NSCM group (P<0.05). However, there were no significant between-group differences in the incidence of preoperative shock, the proportion of emergency operation, and the site of operation (all P<0.05) (Table 2). There were no significant between endoscopic surgery group and Non-endoscopic surgery group differences in age, sex ratio, BMI, history of hypertension and history of diabetes (all P>0.05) (Table 7).

3.3 ICU stay

As shown in Table 3, the SCM group had a significantly higher SOFA score and maximum norepinephrine dose and a significantly lower minimum platelet value (all P<0.05). The SCM group also included a significantly higher proportion of patients with initial lactic acid value ≥4 mmol/L, maximum lactic acid value ≥4 mmol/L, maximum procalcitonin (PCT) value ≥10 ng/mL, and maximum body temperature ≥38.5°C (all P<0.05).

3.4 Predictors of postoperative septic cardiomyopathy

The SOFA score and endoscopic surgery were identified to be risk factors for postoperative SCM in patients with sepsis (P<0.05; Table 4, Figure 2). The receiver operating characteristic curve indicated that the model had a good discriminative capability. The area under the curve was 0.912 (95% CI: 0.8744-0.952, Figure 3). The Hosmer-Lemeshow test also indicated that the model had certain calibration capability, with C^2=3.363 (P=0.888>0.05). The predictive accuracy of the model was 88.6% (Figure 4).

3.5 Relationship between SOFA score and postoperative septic cardiomyopathy

To explore the relationship between SOFA score at ICU admission and postoperative SCM was investigated by determining the maximum corresponding truncation value of the Youden index, which was identified by analyzing the receiver operating characteristic curve. The SOFA score was divided into two groups as ≥7 points and <7 points (control). Multivariate logistic regression analysis showed that SOFA score ≥7 was associated with a 34.273-fold higher risk of SCM (AOR 34.273, 95% CI: 10.299-114.069, P<0.05) (Table 5). There were no significant between SOFA7 group and SOFA≥7 group differences in age, sex ratio, BMI, history of hypertension and history of diabetes (all P>0.05) (Table 8).

3.6 Influence of SCM occurrence on prognosis, length of stay, and medical cost

The prognostic indicators, length of ICU admission, and total cost of treatment were compared between patients the SCM and NSCM groups. The rates of mechanical ventilation, tracheotomy, and continuous renal replacement therapy (CRRT) were significantly higher in the SCM group than in the NSCM group (P<0.05). The duration of mechanical ventilation was also significantly longer in the SCM group (P<0.05). In addition, the length of ICU admission, total hospitalization cost, and mortality rate were significantly higher in the SCM group than in the NSCM group (P<0.05) (Table 6).

4. Discussion

SCM is an sepsis-related acute cardiac insufficiency syndrome unrelated to ischemia (5). SCM has a high incidence rate and is associated with a long length of hospital stay and high mortality (14). Importantly, it is a crucial factor affecting the prognosis of perioperative sepsis patients. Sato et al. (14) was the first to report the epidemiological characteristics of SCM, with the hospitalization and ICU duration of SCM patients being significantly longer than in patients without SCM (median, 43 days vs. 26 days, P=0.04; 9

days vs. 5 days, P<0.01, respectively). The in-hospital and 30-day mortality of SCM patients were 24.1% and 20.7%, respectively. Song et al. (15) also reported an ICU mortality rate of 24.5% for SCM patients.

In the current study, the 30-day mortality in the SCM group was as high as 32.4%, and this was significantly higher than in the NSCM group (24.1%). This is also higher than the in-hospital mortality reported in previous studies. Further, the results also showed that SCM significantly increased the utilization rate of mechanical ventilation during ICU hospitalization and the duration of mechanical ventilation, the incidence of tracheotomy, the utilization of CRRT, and the mortality during hospitalization. In addition, SCM significantly increased the length of ICU admission and the total cost of hospitalization. To our best knowledge, this study is the first to report the epidemiological data of postoperative SCM in patients with perioperative sepsis, providing a basis for its early prevention and treatment.

With the introduction of minimally invasive surgery, endoscopic surgery has become widely used in various clinical specialties (16). However, we found that most cases of postoperative SCM occurred after endoscopic surgery. Therefore, we conducted this study to determine whether endoscopic surgery is a risk factor for postoperative SCM in patients with sepsis. Multivariate logistic regression analysis confirmed that endoscopic surgery is a risk factor for postoperative SCM in sepsis patients. This could be because of the need to build artificial pneumoperitoneum endoscopy surgery (17) that in turn leads to increased abdominal pressure, increased intra-abdominal infection lesions by factors such as blood flow to the risk of further proliferation. The increased systemic inflammatory response causes enhances the release of inflammatory factors, and these factors can inhibit myocardial function and cause heart failure (3). Another cause is patient positioning during endoscopic surgery, which results in the decrease of functional residual capacity. The pneumoperitoneum pressure also increases the airway peak pressure increase and reduces respiratory compliance, leading to inadequate ventilation. Moreover, oxygenation after abdominal surgery might further aggravate the acid-base imbalance (18). Overall, several factors possibly influence the higher risk of SCM in endoscopic surgery than in open surgery. However, research on the specific mechanism of SCM from endoscopic surgery is still lacking, and further experimental studies are needed to establish the relevant factors or mechanisms.

Our results showed that a SOFA score ≥7 is a risk factor for postoperative SCM in patients with sepsis. Patients with a SOFA score ≥7 had a 46.831-fold higher risk of SCM than those with a score of <7. A SOFA score of ≥7 indicates significant dysfunction of at least one organ, which indirectly reflects the severity of sepsis at the systemic level. Bergenzaun et al. first demonstrated in a prospective, observational, cohort study that the SOFA score (OR: 1.6 (95% CI: 1.1-2.3), P=0.018) is an independent predictor of mortality in patients with septic shock (19). A subsequent prospective study involving 48 sepsis patients confirmed that the SOFA score is a good predictor of mortality in sepsis patients (20). Similar findings were obtained in this study, but we further showed that a SOFA score ≥7 increased the risk of SCM, providing more accurate data for the early prevention and treatment of SCM. However, compared with these two previous studies, this is only a retrospective study, and further prospective studies are needed to validate our findings.

Previous studies have shown that hyperlactic acid is a risk factor for SCM (14). An elevated lactic acid level is a manifestation of impaired systemic microcirculation and tissue insufficiency. A serum lactic acid value of >4 mmol/L at admission is associated with a high mortality rate, and patients with persistently high lactic acid levels for more than 24h have poor prognosis (21). In this study, there was a significant difference in the proportion of patients with high lactic acid value (≥4 mmol/L) between the SCM group and the NSCM group during the screening process, but there was no significant correlation between the lactic acid level and postoperative SCM in the multivariate logistic regression.

The differences in the results between studies may be due to the differences in the included population, and the results of previous studies cannot be generalized in the patient population targeted in this study. Meanwhile, we found that a high SOFA score is an independent risk factor for SCM in patients with sepsis, suggesting that multi-organ failure and lactic acidosis may be the result of systemic dysfunction, rather than the direct cause of SCM.

Age is considered to be an independent risk factor for SCM (9). Aging-related physiological changes lead to decreased organ function and immune function, and these are usually accompanied by various chronic diseases. Resistance to systemic inflammatory response in sepsis is weakened, leading to an increased risk of SCM (20). However, the influence of age is still controversial. Sato et al. (9) reported a significant increase in the incidence of SCM in young and male patients in their study. In the current study, multivariate logistic regression analysis showed that the incidence of SCM was correlated with younger age (OR, 0.96; 95% CI: 0.94-0.99), but the mechanism is still unclear and needs further analysis. Further, unlike previous studies, although the SCM group in our study was older than the NSCM group (median age: 70 years vs. 66 years), the difference was not significant. This conflicting findings between the current and previous studies may be due to the retrospective nature of the study and the limitation of the overall sample size. Further investigations are needed to confirm that age as a risk factor for SCM after sepsis.

We also found that the maximum dose of norepinephrine was significantly higher in the SCM group than in the NSCM group, while the minimum platelet value was significantly lower ($P<0.05$). The proportion of patients with high initial lactic acid value, maximum lactic acid value, maximum PCT value, and maximum body temperature was significantly higher in the SCM group than in the NSCM group ($P<0.05$). However, multivariate logistic regression analysis showed that these indicators were not independent risk factors for perioperative SCM. This could be due to the limitations of this study. First, this was a retrospective study. Although the results indicate a correlation between the risk factors and outcome, the relationship is not causal. Second, because this was a retrospective study, cardiac function was measured using different methods including echocardiography and Picco hemodynamic monitoring. This difference can lead to biases in the population that may affect the study results. However, studies have shown the consistency between cardiac ultrasound and Picco for cardiac function assessment (13). Third, a unified diagnostic standard for SCM is yet to be established. At present, SCM is diagnosed according to the following clinical characteristics: (1) decreased ventricular systolic force; (2) left ventricular dilation under normal or low filling pressure; and (3) right ventricular dysfunction and/or left

ventricular dysfunction with reduced infusion response. However, we used a more stringent diagnostic criteria for SCM, and required the identification of reduced cardiac systolic function to exclude patients with primary cardiac dysfunction. Fourth, because most of our patients had decreased cardiac function on admission, some patients who might have abnormal basic cardiac function combined with sepsis were included in the SCM group. To reduce the influence of this limitation, we included improvement of cardiac function after sepsis treatment in the diagnostic criteria for SCM. Finally, only 269 patients were included in this study. From the perspective of risk factors, a larger sample size is needed to obtain more reliable results. Further prospective studies are needed to verify the results in this study.

5. Conclusion

Endoscopic surgery and a SOFA score ≥7 during postoperative admission to the ICU are independent risk factors for SCM within 48 hours postoperatively. For sepsis patients who need surgery, open surgery may lower the occurrence of SCM. Further, patients with a SOFA score of ≥7 points on ICU admission need to be closely monitored for SCM to provide timely diagnosis and treatment.

6. Abbreviations

1. SCM septic cardiomyopathy
2. ICU intensive care unit
3. NSCM non-septic cardiomyopathy group
4. SOFA Sequential Organ Failure Assessment
5. CI confidence interval
6. CRRT continuous renal replacement therapy
7. SERCA2 SR Ca^{2+}-ATPase
8. BMI body mass index
9. PCT procalcitonin

7. Declarations

7.1 Ethics approval and consent to participate .

The Ethics Committee of the Second Affiliated Hospital of Soochow University approved this observational retrospective study and granted a waiver of written consent. Ethical review Decision No. : JD-HG-2020-16..

7.2 Consent for publication

Not applicable

7.3 Availability of data and materials

All data generated or analysed during this study are included in this published article.

7.4 Competing interests

The authors have declared that no conflict of interest exists.

7.5 Funding

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7.6 Authors' contributions

YC and LC analyzed and interpreted the patient data regarding the SCM group and the NSCM group. YG collected the original data of all patients. All authors read and approved the final manuscript.

7.7 Acknowledgements

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7.8 Statement

All methods were performed in accordance with the guidelines set forth by the the Second Affiliated Hospital of Soochow University.

8. References

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Tables

Table 1 Baseline patient characteristics

Variable	The total number of cases(n=269)	SCM-group (n=49)	NSCM-group (n=220)	Test value	P value comparing SCM and NSCM
Age, years M(Q1,Q3)	66.0 [52.0, 77.0]	70.0 [52.5, 80.0]	66.0 [51.3, 75.8]	-1.158	0.247
Male sex	149(55.4)	29(59.2)	120(54.5)	0.349	0.555
BMI[Kg/m^2]	22.8±3.6	23.2±3.5	22.7±3.7	-0.862	0.390
Medical history					
Hypertension	107(39.8%)	19(38.8%)	88(40.0%)	0.025	0.874
Diabetes mellitus	37(13.8%)	7(14.3%)	30(13.6%)	0.014	0.905
Emergency admission	185(68.8%)	34(69.4%)	151(68.6%)	0.011	0.918

Note: SCM:septic cardiomyopathy, NSCM:non-septic cardiomyopathy, P value less than 0.05 was statistically significant

Table 2 Baseline patient characteristics

Variable	The total number of cases(n=269)	SCM-group (n=49)	NSCM-group (n=220)	Test value	P value comparing SCM and NSCM
Preoperative shock	111(41.3)	21(42.9)	90(40.9)	0.063	0.802
emergency operation	166(61.7)	32(65.3)	134(60.9)	0.288	0.591
Endoscopy surgery	76(28.3)	23(46.9)	53(24.1)	10.32	0.001
operative region				4.235	0.375
Gastrointestinal	153(56.9)	32(65.3)	121(55.0)		
liver and gall	48(17.8)	5(10.2)	43(19.5)		
urinary	55(20.4)	11(22.4)	44(20.0)		
arms and legs	6(2.2)	0(0)	6(2.7)		
Others	7(2.6)	1(2.0)	6(2.7)		

Note: SCM:septic cardiomyopathy, NSCM:non-septic cardiomyopathy, , P value less than 0.05 was statistically significant

Table 3 Baseline patient characteristics

Variable	The total number of cases(n=269)	SCM-group (n=49)	NSCM-group (n=220)	Test value	P value comparing SCM and NSCM
SOFA score **M(Q1,Q3)**	6[4□8]	10[8□12]	5[4□7]	-8.332	0.000
Primary lactic acid number **M [Q1,Q3] (mmol/L)**	1.95[1.1□3.68]	4.1[2.1□6.6]	1.8[1.0□2.9]	-5.78	0.000
Maximum lactic acid value **M [Q1,Q3] (mmol/L)**	2.2[1.42□4.1]	5.2[3.0□8.25]	2.0[1.3□3.4]	-6.469	0.000
Primary platelet value **M[Q1,Q3] (*10^9/L)**	176.0[116□236]	164.0[106.5□233.5]	184.0[118.3□239.3]	-1.398	0.162
The lowest platelet value **M[Q1,Q3] (*10^9/L)**	98.0[51.5□156.5]	33.0[16.5□95.5]	108.5 [67.5□172.0]	-6.469	0.000
Maximum procalcitonin value **M [Q1,Q3] (mmol/L)**	27.0[6.0, 77.4]	71.5[33.7, 100]	19.0 [4.3, 65.2]	-5.228	0.000
Noradrenaline dosage **M[Q1,Q3] (ug/kg*h)**	0.13[0.0, 0.4]	1.1[0.35, 1.69]	0.06[0.0, 0.26]	-8.119	0.000
body temperature M[Q1,Q3] (°C)	38.3[37.6□39.0]	38.6[38.0□39.3]	38.2[37.5□39.0]	-1.898	0.058

Note: SCM:septic cardiomyopathy, NSCM:non-septic cardiomyopathy, , P value less than 0.05 was statistically significant

Table 4 Multivariate logistic regression analysis results of sepsis patients complicated with septic cardiomyopathy

predictive factor	aOR (95%CI)	P value
SOFA score	1.345(1.093, 1.656)	.005
Primary lactic acid number	.817(.573, 1.166)	.265
Maximum lactic acid value	1.334(.942, 1.889)	.104
The lowest platelet value	.992(.983, 1.001)	.100
PCT	1.002(.990, 1.015)	.718
The highest temperature	.941(.612, 1.448	.782
Noradrenaline dosage	1.650(.839, 3.244)	.147
Endoscopy surgery	3.506(1.435, 8.562	.006

Note: AOR: adjusted odds ratio, CI: confidence interval, P value less than 0.05 was statistically significant

Table 5 Influence of SOFA score on septic patients complicated with septic cardiomyopathy

SOFA score	multiple-factor analysis	
	aOR(95%CI)	P value
<7	**reference group**	-
≥7	34.273 (10.299-114.069)	0.000

Note: AOR: adjusted odds ratio;CI: confidence interval."-" : SOFA score <7 was divided into the reference group

Table 6 Baseline characteristics of patients in SCM group and NSCM group

factor		SCM-group	NSCM-group	test value	P value
case load	269	49	220		
Mechanical ventilation time**[h, M(Q1,Q3)]**	12.0 [0, 71.5]	100.0 [11.0, 240.0]	8.0 [0, 29.5]	-5.444	0.000
Length of ICU stay**[d, M(Q1,Q3)]**	6.0 [3.0, 10.0]	12.0 [8.0, 19.25]	5.0 [3.0, 8.0]	-6.557	0.000
Hospitalization cost**[yuan, M(Q1,Q3)]**	72486.64 [44364.5 114640.1]	143472.5 [84220.1 242806.6]	60049.8 [42021.0, 96306.2]	-6.285	0.000
mechanical ventilation (%)	171 63.6	39 79.6	132 60.0	6.642	0.010
CRRT(%)	35 13.0	18 36.7	17 7.7	29.792	0.000
tracheotomy(%)	10 3.7	6 12.2	4 1.8	12.172	0.000
death(%)	29(10.8)	16(32.6)	13(5.9)	29.618	0.000

Note: SCM:septic cardiomyopathy, NSCM:non-septic cardiomyopathy, , P value less than 0.05 was statistically significant

Table 7 Baseline characteristics of patients in endoscopic surgery group and Non-endoscopic surgery group

Variable	The total number of cases(n=269)	endoscopic surgery (n=76)	Non-endoscopic surgery (n=193)	Test value	P value comparing SCM and NSCM
Age, years **M(Q1,Q3)**	66.0 [52.0, 77.0]	62.5 [48.5, 75.8]	66.0 [53.0, 77.0]	-1.679	0.093
Male sex	149(55.4%)	40(52.6%)	109(56.5%)	0.326	0.568
BMI[Kg/m^2]	22.8±3.6	23.4±3.6	22.5±3.6	-1.705	0.090
Medical history					
Hypertension	107(39.8%)	29(38.9%)	78(40.4%)	0.116	0.734
Diabetes mellitus	37(13.8%)	14(18.4%)	23(11.9%)	1.944	0.163

Table 8 Baseline characteristics of patients in SOFA<7 group and SOFA≥7 group

Variable	The total number of cases(n=269)	SOFA<7 (n=155)	SOFA≥7 (n=114)	Test value	P value comparing SCM and NSCM
Age, years M(Q1,Q3)	66.0 [52.0, 77.0]	65.0 [50.0, 77.0]	67.0 [55.0, 77.0]	-1.161	0.246
Male sex	149(55.4%)	80(51.6%)	69(60.5%)	2.112	0.146
BMI[Kg/m^2]	22.8±3.6	22.7±3.9	22.9±3.3	-2.040	0.839
Medical history					
Hypertension	107(39.8%)	61(39.4%)	46(40.4%)	0.027	0.869
Diabetes mellitus	37(13.8%)	20(18.4%)	17(11.9%)	0.224	0.636

Figures

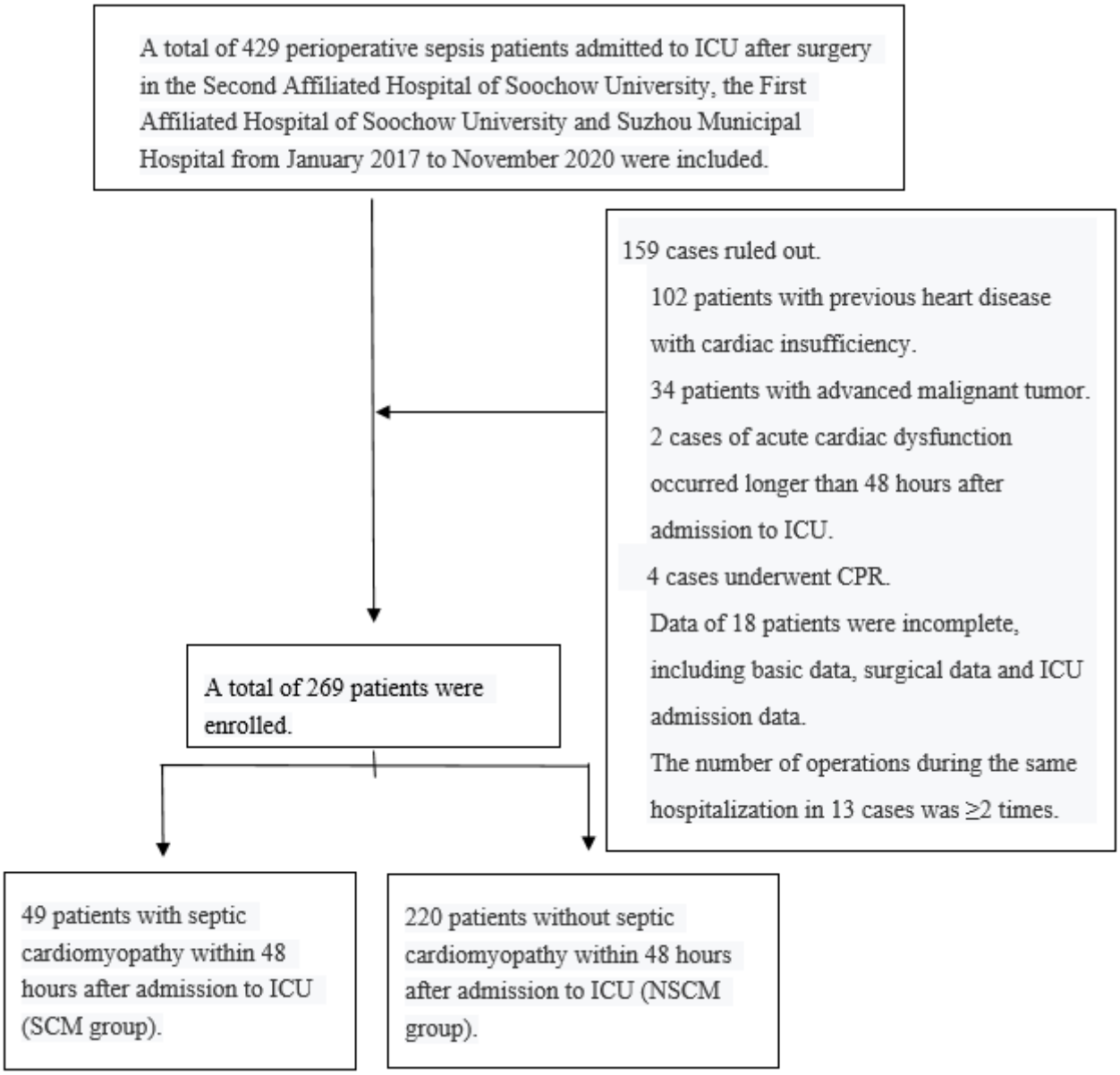


Figure 1

Flowchart of clinical study

Note: SCM:septic cardiomyopathy, NSCM:non-septic cardiomyopath

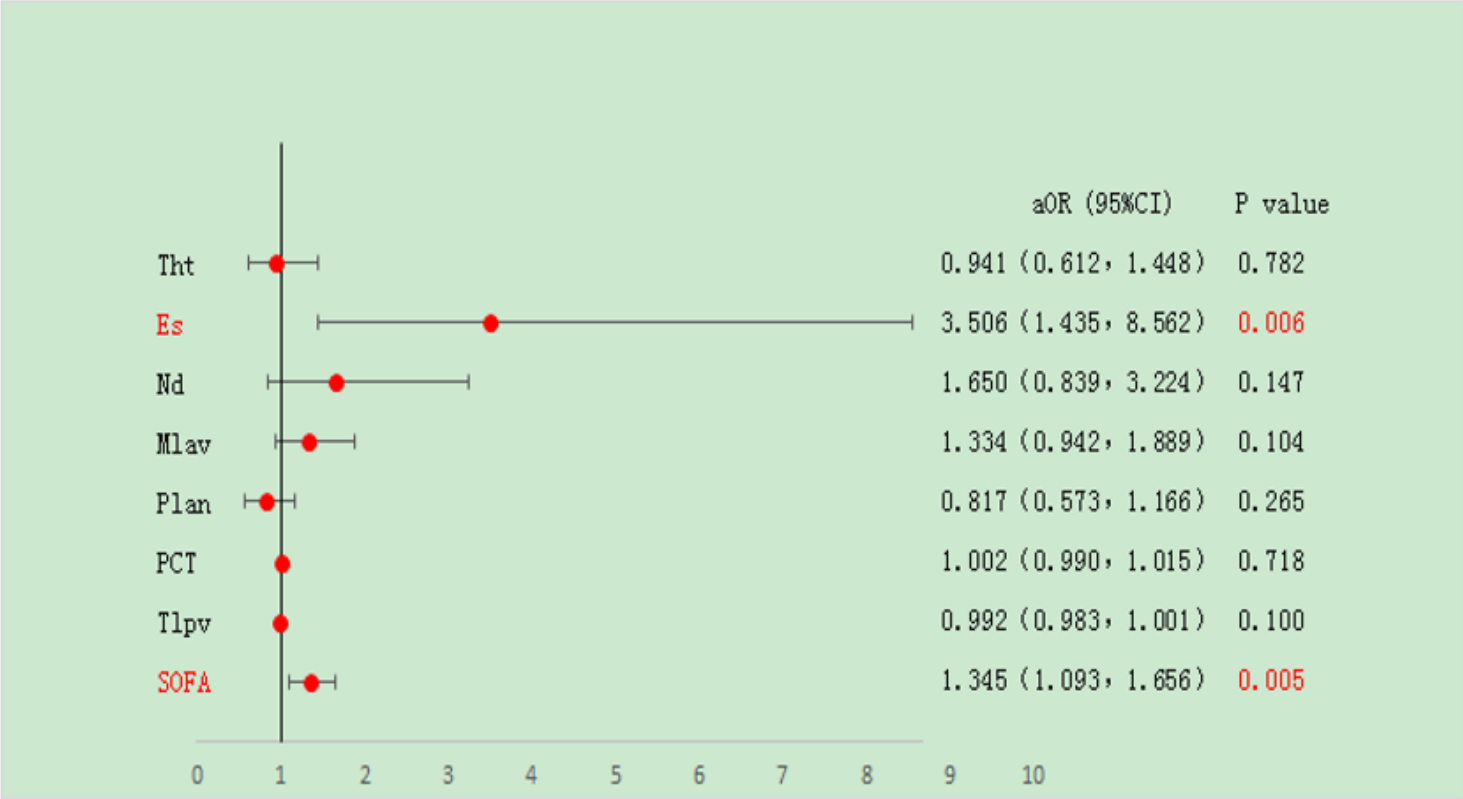
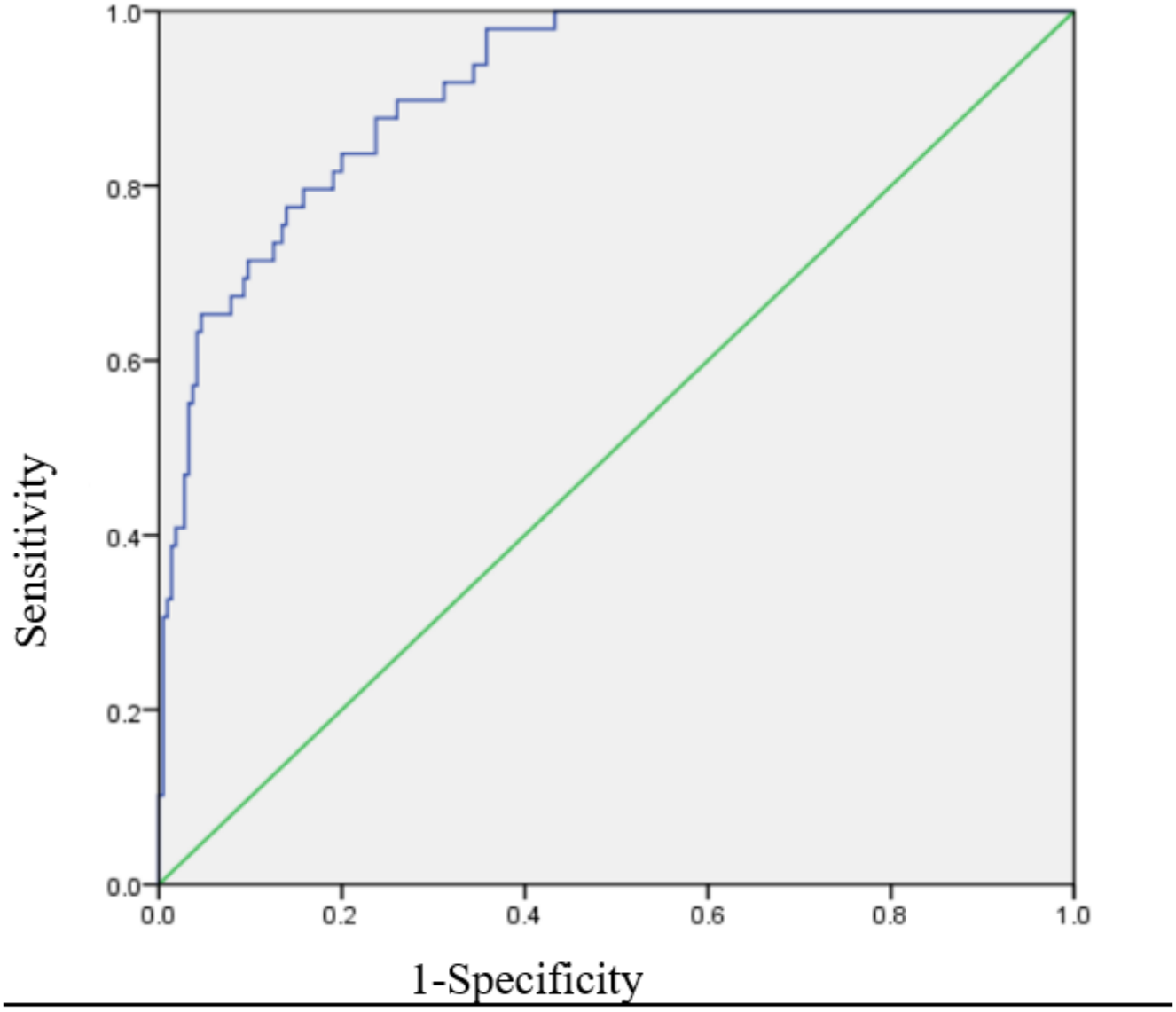


Figure 2

Multivariate correction results of sepsis patients with septic cardiomyopathy

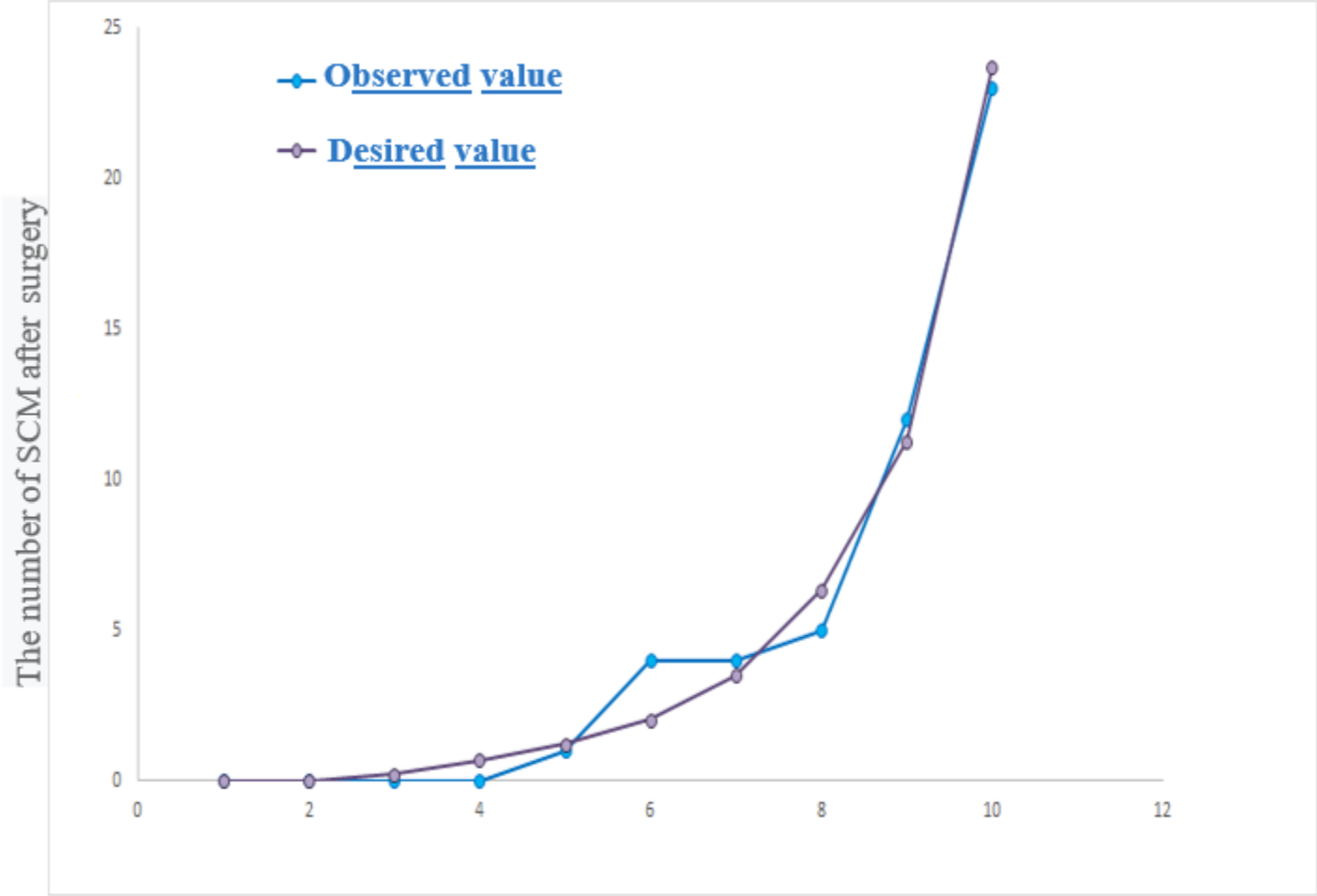
Note: AOR: adjusted odds ratio; CI: confidence interval; Tht: The highest temperature; Es: Endoscopy surgery; Nd: Noradrenaline dosage; Mlav: Maximum lactic acid value; Plan: Primary lactic acid number; Tlpv: The lowest platelet value, P value less than 0.05 was statistically significant.



The area under the curve was 0.902, 95%CI: 0.863-0.941

Figure 3

Logistic regression model ROC curve of sepsis patients complicated with septic cardiomyopathy



χ^2=7.560, P=0.478>0.05, the accuracy probability of model prediction is 87.0%.

Figure 4

Logistic regression model Hosmer-Lemeshow test of sepsis patients complicated with septic cardiomyopathy