

Original Article

Analysis of multiple organ injury and other related complications, and prognostic factors after burns

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Abstract: Objective: The goal of this study was to explore multiple organ injury (MOI) and other related complications of burned patients, and to analyze related prognostic factors, in order to provide an evidence for clinical treatment of burns. Methods: Clinical data of 142 burned patients was retrospectively analyzed, and the patients were divided into the cure group (n = 120) and the failure group (n = 22) according to their healing status. Univariate analysis was performed on the prognosis of MOI and other complications in the two groups, and logistic regression analysis was conducted on the variables with statistical differences. Treatment methods were analyzed on the basis of the degree of MOI and other complications, including prevention. Results: The results of univariate analysis showed that there was statistical differences in age, total burned surface area, shock, number of injured organ, respiratory injury, gastrointestinal bleeding, infection, and renal insufficiency (all $P < 0.05$); logistic regression analysis showed that MOI and infection were the risk factors for the prognosis of burns. The cure rate was 84.51% (120/142) and mortality was 15.49% (22/142). Conclusion: The number of injury organ and infection are the main factors affecting the prognosis of burns. Prevention and treatment of complications such as MOI and infection should be paid attention to in the course of burned patients so as to improve the prognosis and cure rate of burned patients and reduce mortality.

Keywords: Burn, multiple organ injury, complication, prevention and treatment

Introduction

Burns are skin and mucosa tissue damage caused by heat, chemical substance, electric current and radiation. They are often accompanied by a decline of immune function, leading to complex diseases such as inflammatory reactions [1, 2]. In addition to skin or deep tissue damage caused by burns, the body's organs and systems will also experience functional changes or metabolic deterioration [3], accompanied by shock, infection and other complications [4]. A large number of studies have been conducted both at home and abroad on the incidence, pathogenesis, and mortality of burns [5], and relevant studies have shown that management of inhalational injury in burned patients can reduce mortality [6]. With deepening of medical research, scholars have discussed pathological factors of burned patients, and studies have indicated that some hormones are related to the healing of burned patients [7, 8]. However, there are few studies

on the prognostic factors of multiple organ injuries (MOI) after burns. This study retrospectively analyzed clinical data of burned patients and related risk factors affecting prognosis, in order to provide valuable information for the improvement of cure rate of burns.

Materials and methods

General information

A total of 142 burned patients admitted in Nanfang Hospital, Southern Medical University from April 2008 to March 2018 were included in this study, among which 115 were males and 27 were females, with a male to female ratio of 4.26:1. The average age of the included patients was 37.6 ± 8.5 years (1.0-72.0 years) (**Figure 1**), and the mean total burned surface area (%TBSA) was $70.54 \pm 12.51\%$ (40.00-100.00%) (**Figure 2**). The main causes of burn injury were flame burn (65.40%), hydrothermal burn (12.50%), chemical burn (9.10%), current and ray (5.60%), and others (7.40%) (**Figure 3**).

Group by age

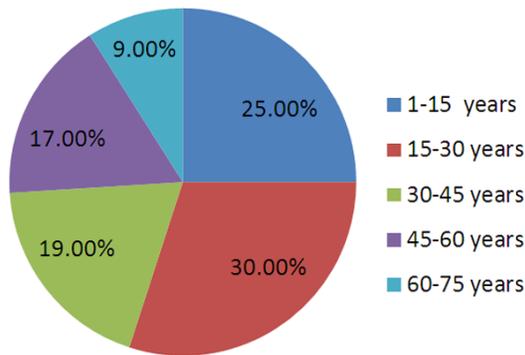


Figure 1. Age profile of burned patients.

Group by TBSA

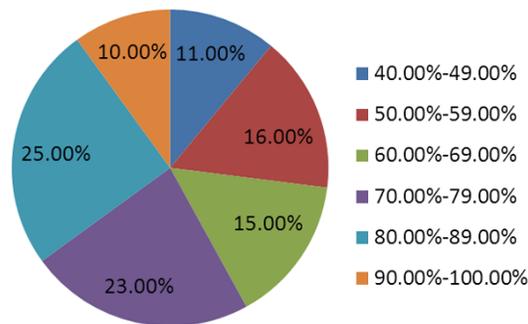


Figure 2. Profile of total burned surface area in burned patients (%TBSA).

Inclusion criteria: All patients met the diagnostic criteria of the eighth edition of *Surgery*; TBSA \geq 40.00%; no abnormality was found in the examination such as abdominal ultrasound scan, hepatic and renal function, electrocardiogram, and others.

Exclusion criteria: Patients with severe hepatorenal dysfunction and major organ failure before burns; patients with severe chronic diseases; patients who were allergic to antibiotics; pregnant or lactating women; patients who had transferred to another hospital or gave up therapy in the course of treatment; patients with incomplete data.

This study was reviewed and approved by the Ethics Committee of Nanfang Hospital, Southern Medical University. All patients or their family members signed the informed consent.

Therapeutic methods

All patients were treated systematically according to the severity of burns after admission. In the early stage of burns, if the patients had shock after burns, liquid resuscitation treatment was adopted according to the domestic general formula, and the treatment was adjusted at any time depending on the actual clinical situation of burned patients [9, 10]. Patients with inhalation injury were treated with tracheotomy to prevent suffocation caused by airway obstruction. Close attention was paid to the prevention and treatment of infection and complications in the middle stage of burns, and maintenance of all organ functions and external and parenteral nutrition support should be strengthened [11, 12]. During hospitalization, proper broad-spectrum antibiotics were selected according to clinical experience.

Research methods

All patients were divided into the cure group (n = 120) and the failure group (n = 22) according to their healing status. Univariate analysis was conducted in age, gender, total burned surface area, hospital stay, shock, number of injured organs, airway injury, renal insufficiency, gastrointestinal bleeding, systemic infection, tracheotomy, pneumonia, etc. Additionally, logistic regression analysis was conducted on those indicators with statistical significance, to screen the risk factors that affect prognosis.

Statistical methods

Statistical analysis was performed by SPSS17.0 software. The independent variables were screened by univariate analysis. Measurement data are expressed as mean \pm standard deviation ($\bar{x} \pm sd$) and t test was used in group comparison. Enumeration data are expressed as number and percentage (n, %) and tested by χ^2 test. Logistic regression analysis was performed for variables with statistical differences. $P < 0.05$ indicates a statistical difference.

Results

Comparison of general information

A total of 142 burned patients were divided into the cure group (n = 120) and the failure group (n = 22) according to their healing status. The cure rate was 84.51% (120/142) and mortality

Analysis of MOI and other complications, and prognostic factors after burns

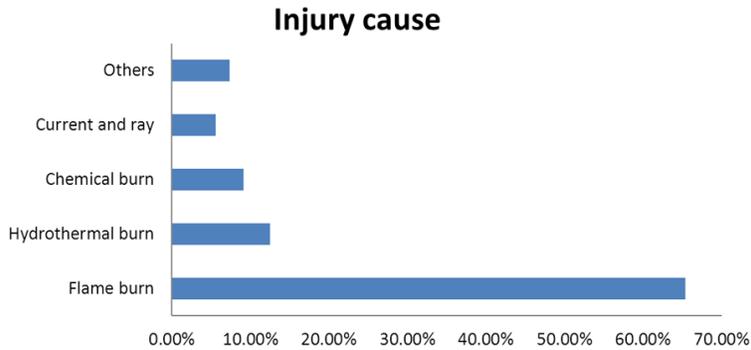


Figure 3. Profile of the cause of injury in burned patients.

Table 1. Comparison of general information

Group	Age (year)	Gender (male/female)	Total burned surface area (%TBSA)	Hospital stay (h)
Cure group (n = 120)	36.8±7.6	100/20	68.95±10.65	50.12±98.25
Failure group (n = 22)	39.9±9.7	15/7	89.35±12.63	18.45±23.17
t/χ ²	-1.704	2.722	-8.018	1.500
P	0.091	0.096	<0.001	0.136

Table 2. Comparison of total burned surface area (n, %)

Group	<50.00% TBSA	50.00-79.00% TBSA	≥80.00% TBSA
Cure group (n = 120)	24 (20.00)	67 (55.83)	29 (24.17)
Failure group (n = 22)	0	4 (18.18)	18 (81.82)
t/χ ²	3.967	10.542	27.906
P	0.046	<0.001	<0.001

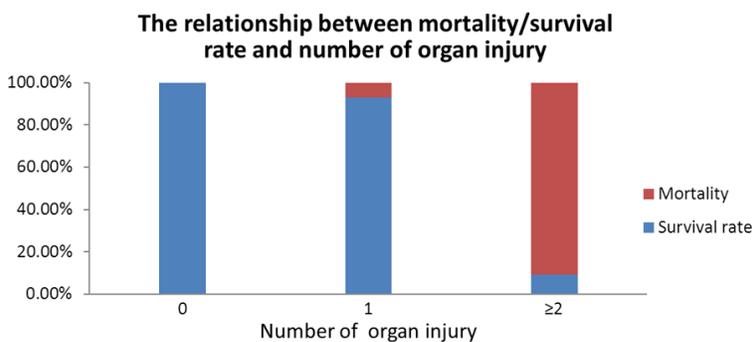


Figure 4. The relationship between mortality/survival rate and number of organ injury.

was 15.49% (22/142). In the cure group, there were 100 males and 20 females, with an average age of 36.8±7.6 years old and mean TBSA of 68.95±10.65%; in the failure group, there were 15 males and 7 females, with an average

age of 39.9±9.7 years old and mean TBSA of 89.35±12.63%. There was no statistical difference in age, gender and hospital stay between the two groups (all P>0.05), while TBSA had a statistical difference in two groups (P<0.05) as shown in **Table 1**.

Comparison of total burned surface area

The patients with TBSA <50.00% and 50.00-79.00% (20.00% and 55.83%) in the cure group were higher than those in the failure group (0% and 18.18%; P = 0.046, P<0.001); while the patients with TBSA ≥80.00% (24.17%) in the cure group was significantly lower than that in the failure group (81.82%, P<0.001) as shown in **Table 2**.

Comparison of MOI and its relationship with mortality/survival rate

Two patients had injuries in two or more organs in the cure group and 20 patients in the failure group (χ² = 113.928, P<0.001). Fifty patients out of 142 burned patients had organ injury, and only 28 patients were cured (mortality of 44.00%). Twenty-six cases with 1 organ injury were cured and 2 were failed (mortality of 7.14%). Two cases with injuries in two or more organs were cured and 20 cases were failed (mortality of 90.91%) as shown in **Figure 4**.

Comparison of complications

There were statistical differences in the incidences of shock, airway injury, renal insufficiency, gastrointestinal bleeding, and infection between the two groups (all P<0.05), while there was no significant difference in the inci-

Analysis of MOI and other complications, and prognostic factors after burns

Table 3. Comparison of complications (case)

Complication	Cure group (n = 120)	Failure group (n = 22)	X ²	P
Shock			14.500	<0.001
Yes	28	14		
No	92	8		
Airway injury			63.420	<0.001
Yes	10	18		
No	110	4		
Renal insufficiency			4.547	0.033
Yes	42	13		
No	78	9		
Gastrointestinal bleeding			19.337	<0.001
Yes	30	16		
No	90	6		
Infection			31.022	<0.001
Yes	23	17		
No	97	5		
Pneumonia			1.836	0.175
Yes	32	9		
No	88	13		

Table 4. Logistic regression analysis of prognostic factors

Factor	Regression coefficient	Wald	P	OR	95% CI
Age	0.125	0.455	0.500	1.325	0.578-2.889
Total burned surface area	0.621	9.175	0.211	1.435	1.113-2.564
Shock	0.418	1.765	0.182	1.521	0.817-3.642
Multiple organ injury	1.972	16.265	0.000	7.526	0.872-55.463
Airway injury	0.327	0.379	0.181	1.319	0.825-2.808
Renal insufficiency	0.415	0.476	0.596	2.073	1.085-3.417
Gastrointestinal bleeding	0.623	0.742	0.101	1.264	0.576-1.980
Infection	0.855	9.734	0.007	3.235	3.012-67.174
Constant term	-2.214	46.876	0.003	0.035	1.735-95.418

dence of pneumonia (P = 0.175) as shown in **Table 3**.

Analysis of prognostic factors

The results of t test and Chi-square test showed that there was no statistical difference in gender, hospital stay, pneumonia (all P>0.05), while there were statistical differences in age, total burned surface area, shock, MOI, airway injury, renal insufficiency, gastrointestinal bleeding, and infection (all P<0.05), which was related to the prognosis of burns. Logistic regression analysis was performed in these assigned factors. The results show that the num-

ber of injured organ and infection were the risk factors influencing the prognosis of burns as shown in **Tables 4** and **5**.

Discussion

Mortality is still one of the important evaluation parameters for the treatment of burns [13]. The mortality is still high in burned patients, although the treatment of burns has been improved in recent years [14, 15], such as fluid resuscitation [16], early excision of eschar, infection control, and application of antibiotics, which effectively reduced the mortality [17, 18]. The causes of mortality in burned patients are complicated, and related studies have shown that inhalation injury, infection, and visceral complications are the main causes of death [19-21]. Burn complications are accompanied through the entire course of burn. Therefore, active treatment as early as possible should be conducted to reduce complications. In this study, the number of injury organ

and infection were found to be independent factors affecting the prognosis of burned patients.

Organs of burned patients may have different degrees of injury, resulting in functional disorders. There are varieties of reasons causing complications of MOI, including shock, infection, severe inhalation injury, etc. [22]. The main reasons are the varying degrees of ischemia and hypoxia of the organs after burns [23]. Proper fluid resuscitation of body can maintain the function of organs, and the stabilization of blood circulation and oxygen supply [24]. Results of this study indicate that there

Analysis of MOI and other complications, and prognostic factors after burns

Table 5. Explanation of assignment

Age	<15 = 1, 15-45 = 2, >45 = 3	
Total burned surface area	40.00-60.00% = 1, 60.00-80.00% = 2, 80.00-100.00% = 3	
Shock	No = 0	Yes = 1
Multiple organ injury	One or less = 0	Two or more = 1
Airway injury	No = 0	Yes = 1
Renal insufficiency	No = 0	Yes = 1
Gastrointestinal bleeding	No = 0	Yes = 1
Infection	No = 0	Yes = 1

was a relationship between TBSA and prognosis of burns. As the proportion of TBSA increased, the failure rate increased. This study found that with the increase of the number of injured organs, the mortality increased significantly. If injuries occurred in two or more organs, development into multiple organ dysfunction syndrome was possible. Thus, active treatment should be conducted at an early period to allow the patient to get through the shock period smoothly. The infection control and wound treatment should be treated properly, as well as the maintenance of visceral function, especially the prevention and treatment of pulmonary complications.

Systemic infection, also known as sepsis, is a life-threatening organ dysfunction caused by a maladjusted host response induced by infection [25]. Serious burn infection mainly includes wound infection and subsequent systemic infection. Although with the effective treatment of new and efficient broad-spectrum antibiotics [26-28] and liquid resuscitation, systemic infection still remains a common complication in burned patients and a major risk factor for death. In this study, data show that the incidence of infection in burned patients was 28.16%, of which the incidence of infection in the failure group was 77.27%, indicating that the incidence of infection is still extremely high. In the process of burns, the occurrence of infection can start from the destruction of skin and respiratory mucosa to the healing of wound surface, with a long affected time. Therefore, the prevention and control of infection should be carried out throughout the whole process of burn treatment.

Insufficient sample size is a deficiency in this study. Because the 142 burned patients were all admitted and treated in our hospital, and the sample size was relatively small, they could not fully reflect the purpose of this study. Thus,

larger sample size should be investigated in future research. In addition, other related factors and pathological factors of the risk factors of organ injury complications were not discussed in this study, such as the relationship between antibiotic use and infection and the explorative analysis of prognosis. It should be discussed in the following research.

In conclusion, multiple factors are related to prognosis of burns. Early prevention and treatment of MOI and infection and other related complications after burns should be regarded, so as to reduce mortality and improve cure rate.

Disclosure of conflict of interest

None.

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Analysis of MOI and other complications, and prognostic factors after burns

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