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Epidemiology and Outcome Analysis of 470 Patients with Hand Burns: A Five-Year Retrospective Study in a Major Burn Center in Southwest China

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Background: This retrospective study aimed to investigate the epidemiology of burns to the hand, including the causes, demographic data, management, and outcome in a single center in Southwest China between 2012 and 2017.

Material/Methods: A retrospective study included 470 patients with hand burns who were treated at a single hospital in Southwest China between 2012 and 2017. Demographic, injury-related, and clinical data were obtained from the clinical electronic data collection system.

Results: In 470 patients, men were more commonly admitted to hospital with hand burns (73.62%). Children under 10 years (29.57%) were the main patient group. Hospital admissions occurred in the coldest months, from December to March (55.11%). In 60.21% of cases, hand burns occurred outside the workplace. Fire (40.42%), electricity (30.85%), and hot liquids (20.21%) were the main causes of hand burns. Data from 428 patients showed that burns with a larger total body surface area and deeper burns were associated with surgery and amputation. Burn depth was a risk factor for skin grafting, and lack of burn cooling before hospital admission increased the risk of amputation. Data from 117 patients with localized burns showed that full-thickness burns and lack of cooling before admission were associated with an increased hospital stay.

Conclusions: The findings suggest that in Southwest China, prevention programs for children aged 0–9 years, injuries occurring in winter and non-workplace sites, and fire burns were imperative.

MeSH Keywords: Accident Prevention • Burns • Epidemiologic Studies • Hand Injuries

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Background

Worldwide, burns at different sites and involving different degrees of severity and body area remain a challenge to treat. The lifetime incidence of severe burns is 1%, but the morbidity of burns is significantly increased in developing countries [1–4]. Following healing, burns can lead to dysfunction of an affected limb and to unsightly skin scars. Although many patients recover and leave the hospital after treatment, they may be unable to live a normal life, which may result in both a socioeconomic and psychological burden to society.

The skin of the hand accounts for only 5% of the total body surface area, but the hands are required for most human activities, including eating, writing, and typing. Burns to the hand occur in more than 90% of severe burns [5,6]. Although the mortality rate from localized hand burns is very low, the degree of disability can be high [7,8]. Scar contracture of wounds can seriously affect hand function and may necessitate a reconstructive operation. There are two critical challenges in treating burns to the hand. First, the depth of the burn may be difficult for even the most experienced surgeons to determine precisely [7,9]. Second, postoperative treatment of burns to the hand is critical and requires the assistance of burn surgeons, hand surgeons, and rehabilitation therapists [7,9]. Therefore, these burns require special attention.

Data from epidemiological studies at specific times can guide the prevention of burns injury and clinical treatment. Previously published studies involving burns to the hand have focused on the treatment and management of specific cases [10–13]. Few studies have reported the epidemiology of patients with burns to the hands [8,14,15]. The Institute of Burn Research (IBR), Southwest Hospital of the Army Medical University (AMU), is one of the oldest burn centers in China, one of the largest centers worldwide, and has 107 standard treatment beds and 18 intensive care beds [16]. Approximately 1,300 burn victims from Southwest China, including Chongqing, Sichuan, and Guizhou provinces, are admitted each year [17]. Although there have been previously published studies from this center [17–20], no previous epidemiological studies have been reported on patients with burns to the hand.

This retrospective study aimed to investigate the epidemiology of burns to the hand in a single center in Southwest China between 2012 and 2017, including the causes, demographic data, management, and patient outcome.

Material and Methods

Data collection

This study was approved by the Ethics Review Committee of Southwest Hospital of Army Medical University (Chongqing, China) (Approval number, KY201982). Patient information was anonymized before analysis. Because this was a retrospective study, informed consent was not required. This retrospective study included patients (n=470) with burns to the hand who were admitted to the Institute of Burn Research (IBR), Southwest Hospital of the Army Medical University (AMU) between January 2012 and December 2017. Demographic and clinical data, including burn area and depth and patient outcome, were obtained from the hospital electronic medical records. The inclusion and exclusion criteria for the study and the process of patient analysis are shown in Figure 1.

Data from the 470 patients included gender, age, location of the occurrence of the burn (workplace, or other), the month, the cause of the burn (fire, electricity, chemical, hot fluid, hot solid, and others), total body surface area, burn depth, single or double hand burns, the use of skin cooling before hospital admission, and the presence of localized or diffuse burns to the hand were recorded. The palm method was used for assessing the burn area, where the area of the palm is 0.5% of the body surface area in men and 0.4% of the body surface area in women [21,22]. We classified the burn depth as superficial, superficial/deep partial-thickness and full-thickness according to the standards of the International Society for Burn Injuries (ISBI) and the World Health Organization (WHO) [23]. Patients with superficial burn injuries, not requiring hospitalization, were not included in the study.

Following the descriptive statistics of the admission data (n=470), the clinical characteristics were analyzed. Forty-two patients who discontinued treatments were excluded. The remaining 428 patients underwent analysis of the factors associated with surgery, including debridement, skin grafting, and amputation, especially with skin grafting and amputation. Multiple logistic regression analysis was performed on burns due to fire, electrical burns, and hot fluids, as independent factors. The length of hospital stay was analyzed as <1 week, 1–2 weeks, 2–3 weeks, and >3 weeks. The predictors of length of hospital stay were screened among the 117 patients with localized burns to the hand using ordinal logistic regression. Superficial and deep partial-thickness burns were classified as one group to determine whether full-thickness burns increased the length of hospital stay.

Statistical analysis

Statistical analysis was performed using SPSS version 18.0 software (IBM Corp., Armonk, NY, USA) and GraphPad Prism

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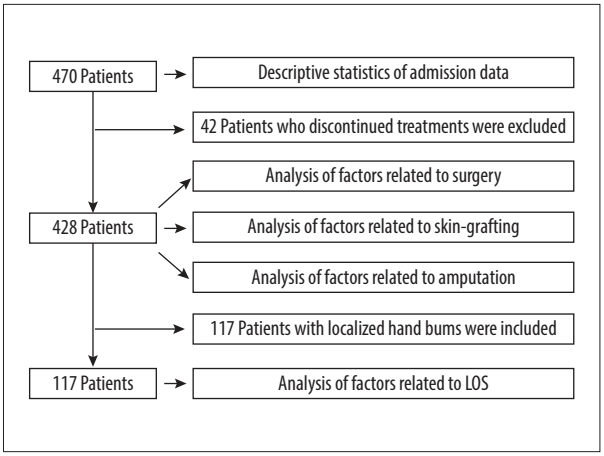

Figure 1. The inclusion and exclusion criteria and the process of patient analysis.

version 6.0 software (GraphPad Software, La Jolla, CA, USA). The chi-squared (χ^2) test and multiple regression analysis were used to identify the risk factors associated with surgery, skin graft surgery, and amputation. Ordinal logistic regression analysis was performed to identify the factors associated with an increased length of hospital stay. A P-value <0.05 was considered to be statistically significant.

Results

General characteristics

The general characteristics of 470 patients with burns to the hand are shown in Table 1 and Figures 2, 3. Males accounted for 73.62% (346/470) of all patients, and the ratio of male to female patients was 2.7: 1. Patients aged 0–9 years represented 29.57% (139/470) of the patients studied. Another peak occurred between the ages of 40 and 49 years (20%, 98/470). Patients aged 10–19 years (4.68%, 22/470) and >60 years (8.51%, 40/470) represented the lowest proportion of patients with hand burns (Figure 2). January (15.74%, 74/470), February (13.83%, 65/470), March (12.13%, 57/470), and December (13.40%, 63/470) were the four most common months during which burns to the hand occurred (Figure 3). A total of 60.21% (283/470) of burns to the hand occurred at non-workplace sites, and 39.78% (187/470) occurred in the workplace. The causes of burns to the hand included those caused by fire (40.43%, 190/470), electricity (30.85%, 145/470), hot fluids (20.21%, 95/470), hot solids (5.96%, 28/470), chemicals (2.13%, 10/470) and others (0.43%, 2/470). Two other cases were due hypothermia (frostbite) and heat vapor injury, respectively.

The total body surface area of hospitalized patients was between 1–2% (38.09%, 179/470) and 2–3% (39.36%, 185/470) groups, and the proportion of patients with a total body surface area <1 (3.62%, 17/470) was the lowest. Most of these patients (41.70%, 196/470) had deep partial-thickness burns on their hands. Patients with full-thickness burns to the hand, and superficial partial-thickness burns, represented 33.62% (158/470) and 24.68% (116/470) of cases, respectively. The single burns to the hand (47.45%, 223/470) and double burns to the hand (52.55%, 247/470) showed no significant difference. A small population of patients (16.17%, 76/470) underwent cooling of their hand burn wounds before attending hospital. Only 31.91% (150/470) of all patients had localized burns to the hand. Most patients (68.09%) had other burn sites in addition to the hand.

Table 1. General characteristics of 470 patients with burns to the hand.

	N	%
Gender		
Male	346	73.62
Female	124	26.38
Location of burn injury		
Workplace	187	39.78
Others	283	60.21
Causes		
Fire	190	40.42
Electricity	145	30.85
Chemical	10	2.13
Hot liquid	95	20.21
Hot solid	28	5.96
Others	2	0.43
TBSA (%)		
T<1	17	3.62
1≤T<2	179	38.0851
2≤T<3	185	39.3617
3≤T<4	46	9.7872
4≤T≤5	43	9.1489
Depth		
Superficial partial-thickness	116	24.68
Deep partial-thickness	196	41.70
Full-thickness	158	33.62
Single hand	223	47.45
Double hands	247	52.55
Pre-hospital cooling	76	16.17
Localized hand burns*	150	31.91

* Be burned only on their hands without other parts. TBSA, total body surface area.

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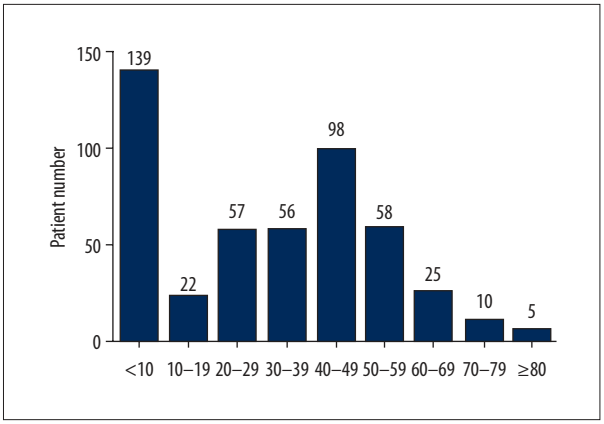

Figure 2. The age groups of the patients with burns of the hands.

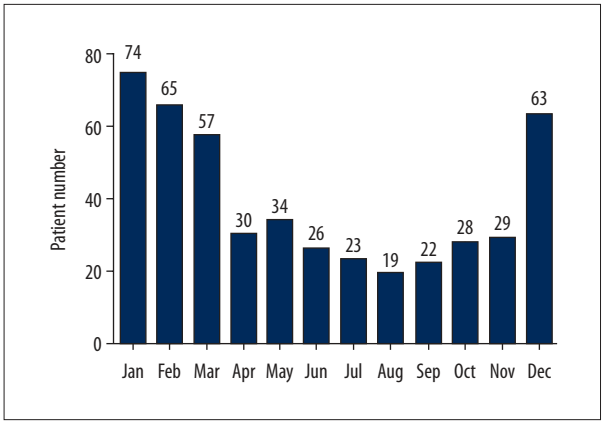

Figure 3. The distribution of injury in months of the patients with burns of the hands.

Table 2. The treatment schedules in the 428 patients in the study.

	N	%
Surgery	149	34.81
Skin graft	143	33.41
Amputation	45	10.51

Surgical procedures

Among 428 patients, the mean duration of surgery following the burn was at 13.64 days. The proportion of patients treated by surgery (debridement, skin grafting, and amputation) was 34.81% (149/428) (Table 2). The chi-squared test showed that the rate of surgery between men and women was similar. Different age groups had different rates of surgery (P<0.05; Table 3). The 0–19 year age group had the lowest rate of surgery (26.90%, 39/145). Burns to the hand occurring in the working environments were more likely to require surgery (P<0.01; Table 3). The cause of electrical burns on the hands was more likely to require surgery than other causes (P<0.001; Table 3). Burns from hot fluid were significantly less likely to require surgery (P<0.001; Table 3). The surgery rates of patients with different total body surface area values and different burn depths were significantly different (P<0.001; Table 3). Patients who cooled their hands with flowing water before attending hospital had a significantly lower rate of surgery compared with patients who did not cool their hands (P<0.05; Table 3). Multiple logistic regression analysis showed that gender, age, place of injury, fire burns, electrical burns, burns from hot fluid, and cooling in cold water before attending hospital were not predictors of the requirement for hand surgery. (Table 4) A larger total body surface area (OR, 1.39; 95% CI, 1.032–1.873; P<0.001) (Table 4) and a deeper burn depth increased the need for hand surgery. (OR, 24.11; 95% CI, 13.080–44.434l P<0.001) (Table 4).

Skin grafting

A total of 33.41% (143/428) of all patients underwent skin grafting (Table 2). The chi-squared test results for the characteristics associated with an increased rate of skin graft surgery on the hands are shown in Table 3. The results were similar to those of surgery on the hands. The genders showed no difference in the rate of skin grafting. Different age groups (P<0.05; Table 3), the place of injury (P<0.01; Table 3), the cause (P<0.001; Table 3), total body surface area (P<0.01; Table 3), burn depth (P<0.001; Table 3) and pre-hospital cooling (P<0.05; Table 3) showed different rates for skin grafting. Multiple logistic regression analysis for the risk factors associated with skin grafting showed that only burn depth was a predictor of skin grafting (OR, 15.33; 95% CI, 8.895–26.425; P<0.001) (Table 5). Other factors were not risk factors for skin grafting.

Amputation

Only a few inpatients (10.5%, 45/428) underwent amputation (Table 2). Of these patients, 39 (86.6%) underwent amputation of the fingers, and 6 (13.3%) underwent amputation of the hands. The chi-squared test was used to determine whether there was a different amputation rate between the different groups, as shown in Table 3. There was no difference between the three groups in terms of gender, age, and place. However, different causes (P<0.05, Table 3), total body surface area values (P<0.05, Table 3), burn depths (P<0.001, Table 3) and pre-hospital cooling (P<0.05, Table 3) were significantly associated with the amputation rate. Multiple logistic regression analysis showed that an increased burn area on the hand (OR, 1.646; 95% CI, 1.058–2.562; P<0.05) (Table 6), deeper burn thickness (OR, 99.817; 95% CI, 12.843–775.769; P<0.001) (Table 6), and a lack of pre-hospital cooling (OR, 0.110; 95% CI, 0.012–0.98; P<0.05) (Table 6) were significantly associated with an increased rate of amputation (Table 6). However, gender, age, place of injury (workplace or other), and

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Table 3. Characteristics of the patients with burns to the hand, with or without surgery, skin grafts, or amputation.

	Surgery		χ^2	P-value	Skin graft		χ^2	P-value	Amputation		χ^2	P-value
	No	Yes			No	Yes			No	Yes		
Gender												
Male	204	115	0.845	0.358	209	110	0.646	0.421	287	32	0.310	0.578
Female	75	34			76	33			96	13		
Age (years)												
0–19	106	39	6.080	0.048	108	37	6.146	0.046	132	13	1.478	0.478
20–49	121	76			123	74			177	20		
≥50	52	34			54	32			74	12		
Location of burn injury												
Workplace	99	73	7.375	0.007	102	70	6.862	0.009	154	18	0.001	0.978
Others	180	76			183	73			229	27		
Cause												
Fire	117	50	28.385	<0.001	121	46	28.424	<0.001	150	17	10.357	0.016
Electrical burn	70	66			72	64			117	19		
Hot fluid	73	15			73	15			86	2		
Others	19	18			19	18			21	5		
TBSA (%)												
T<1	13	2	18.713	0.001	13	2	16.830	0.002	15	0	12.264	0.015
1≤T<2	119	38			120	37			149	8		
2≤T<3	96	77			99	74			148	25		
3≤T<4	28	16			29	15			36	8		
4≤T≤5	23	16			24	15			35	4		
Burn depth												
Superficial partial-thickness	102	0	201.751	<0.001	101	1	179.478	<0.001	102	0	85.149	<0.001
Deep partial-thickness	144	30			144	30			173	1		
Full-thickness	33	119			40	112			108	44		
Pre-hospital cooling												
No	227	135	6.361	0.012	233	129	5.220	0.022	318	44	6.716	0.010
Yes	52	14			52	14			65	1		

TBSA – total body surface area.

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Table 4. Multiple logistic regression analysis to identify prognostic indicators for surgery.

	B	SE	P-value	OR	95% CI
Gender	–0.447	0.372	0.230	0.640	0.309–1.327
Age	0.204	0.217	0.347	1.226	0.801–1.876
Location	0.052	0.359	0.884	1.054	0.521–2.131
Fire	–0.246	0.564	0.663	0.782	0.259–2.364
Electrical burn	–0.394	0.533	0.46	0.674	0.237–1.918
Hot fluid	–0.097	0.664	0.884	0.908	0.247–3.339
TBSA	0.330	0.152	**0.030**	1.39	1.032–1.873
Burn depth	3.183	0.312	**<0.001**	24.108	13.080–44.434
Pre-hospital cooling	–0.290	0.468	0.536	0.748	0.299–1.874

-21og likelihood=312.173; TBSA – total body surface area; SE – standard error; OR – odds ratio; CI – confidence interval.

Table 5. Multiple logistic regression analysis to identify the predictors of skin grafting.

	B	SE	Wald	P-value	OR	95% CI
Gender	–0.322	0.349	0.851	0.356	0.724	0.365–1.437
Age	0.171	0.206	0.690	0.406	1.186	0.793–1.776
Location	0.121	0.344	0.124	0.724	1.129	0.575–2.215
Fire	–0.534	0.531	1.013	0.314	0.586	0.207–1.659
Electrical burn	–0.410	0.500	0.671	0.413	0.664	0.249–1.769
Hot fluid	–0.311	0.620	0.252	0.615	0.732	0.217–2.468
TBSA	0.269	0.144	3.516	0.061	1.309	0.988–1.735
Burn depth	2.730	0.278	96.579	**<0.001**	15.331	8.895–26.425
Pre-hospital cooling	–0.218	0.442	0.242	0.622	0.805	0.338–1.912

-21og likelihood=312.173; TBSA – total body surface area; SE – standard error; OR – odds ratio; CI – confidence interval.

Table 6. Multiple logistic regression analysis to identify the predictors of amputation.

	B	SE	Wald	P-value	OR	95% CI
Gender	–0.014	0.448	0.001	0.975	0.986	0.410–2.374
Age	0.383	0.283	1.825	0.177	1.467	0.841–2.556
Location	1.102	0.482	5.230	0.022	3.010	1.171–7.738
Fire	–0.928	0.718	1.672	0.196	0.395	0.097–1.614
Electrical burn	–0.841	0.613	1.883	0.170	0.431	0.130–1.434
Hot fluid	–1.634	1.016	2.587	0.108	0.195	0.027–1.429
TBSA	0.499	0.226	4.886	**0.027**	1.646	1.058–2.562
Burn depth	4.603	1.046	19.360	**<0.001**	99.817	12.843–775.769
Pre-hospital cooling	–2.207	1.115	3.914	**0.048**	0.110	0.012–0.98

-21og likelihood=312.173; TBSA – total body surface area; SE – standard error; OR – odds ratio; CI – confidence interval.

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Table 7. Ordinal logistic regression analysis of the predictors of the length of hospital stay.

	SE	Wald	P-value	OR	95% CI
Burn depth					
Superficial and deep partial-thickness (reference)					
Full-thickness	0.400	17.715	<0.001	5.383	2.458–11.788
Pre-hospital cooling					
No	0.523	5.693	0.017	3.481	1.250–9.698
Yes (reference)					

LOS – length of hospital stay; SE – standard error; OR – odds ratio; CI – confidence interval.

the three main causes of burn injury were not significant risk factors for amputation.

Predictors of the length of hospital stay for inpatients with localized burns to the hand

Of 428 patients, 117 inpatients experienced localized burns to the hand. Two factors were analyzed that might be predictors of the length of hospital stay from the nine potential associated factors of gender, age, location of injury, fire burn, electrical burn, hot fluid, total body surface area, burn depth and pre-hospital cooling. Compared with superficial partial-thickness and deep partial-thickness burns, full-thickness burns significantly increased the length of hospital stay (OR, 5.383; 95% CI, 2.458–11.788; P<0.001) (Table 7). Also, patients who experienced cooling of their burns before admission to hospital had a significantly reduced length of hospital stay (OR, 3.481; 95% CI, 1.250–9.698; P<0.05) (Table 7). The length of hospital stay was not affected by other factors.

Discussion

Studies on the epidemiology of burns to the hand are important to assess the current prevention measures for burn injuries in society and the workplace and for the development of tailored preventive and treatment strategies that reduce the socio-economic burden from burns injury. However, there have been few studies on the epidemiology of burns in Southwest China. Therefore, this retrospective study aimed to investigate the epidemiology of burns to the hand, including the causes, demographic data, management, and outcome in a single center in Southwest China between 2012 and 2017. This study differed from previous studies on burns in several ways [14,15,24]. First, the data used were more current and complete and more representative of the epidemiological characteristics of hand burn patients. Second, the findings identified the importance of pre-hospital care, particularly the cooling of the burn injury before hospital admission. Also, the present study included a detailed statistical analysis to compare the data.

Previous studies have shown that men have a higher risk of burn injuries [25,26]. Regarding hand burn patients, we also found that more men (73.62%) experienced burns to the hand, which was similar to the results of other studies [15,27]. These findings may be because men generally perform more jobs with a higher burn risk (electricity, chemical, and mechanic work) and might be more exposed to burns than women [28,29]. Therefore, workers engaging in dangerous jobs deserve special attention regarding safety education, standardized work protocols, and protection from injury due to burns [30,31].

The age distribution of burn patients varies from region to region. Several studies have shown that adults are more likely to suffer from burn injuries [27,32,33]. However, other studies have shown that children are most likely to suffer from burn injuries [34,35], and the most common burn site is the hands [36]. A previously reported study from Shanghai, China on burns to the hands showed that the age group from 20–49 years was the major age group of patients with hand burn injuries (61.91%), and that children aged between 0–9 years represented 12.17% of all patients with burns to the hands [15]. Another study conducted in Albania showed that half of the patients with hand burns were aged between 20–60 years [24]. However, in the present study, study, children <10 years represented 29.57% of the total cases, and young and middle-aged adults (20–59 years) represented 57.23% of the cases. There are four possible reasons why this study showed a larger proportion of children with burns on their hands. First, children in the poorer areas of Southwest China lack parental care because their parents usually work outside [17]. Second, children are usually curious about their surroundings and are unaware of the dangers close to them [16]. Third, the skin barrier of children is thin and weak, making them more vulnerable to injury [37,38]. Also, the occupations and educational levels of parents or guardians and knowledge of burn prevention might also play a role [39]. People of young age and middle age (20–59

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years) were more likely to be exposed to the dangers of accidents in the workplace and during daily activities [40,41]. However, these individuals usually lack safety awareness and knowledge about safety procedures [42]. Therefore, community doctors should receive relevant training on burn prevention and inform the community on hand burn prevention, especially for children and their parents or guardians. Also, companies or factories are advised to pay more attention to the safety of workers and to equip them sufficiently for hand protection. Education should be provided, and workplace protective measures should be checked regularly [43–45]. Also, monitoring the running condition of domestic appliances or equipment in the kitchen and bathroom and removing safety risks should be performed in daily life [46,47].

About 60% of burn injuries on the hands occurred in non-working conditions in this study, which was much higher than previously reported in studies conducted in Shanghai [15,25] and Albania [24]. A reason for this difference may be that people aged from 0–20 years who did not work made up a more significant proportion of all hand burn patients in our study. Another possibility is that people who are not working may be prone to be careless and less alert to dangers [48,49]. Also, different life experiences, types of work, safety awareness, and safety facilities vary by region [50–52].

The findings from this study showed that the coldest months, between December and March, were high-risk months for hand burn injuries. This finding is similar to the results of a previously published Swiss study [41], but was different from a study previously performed in East China [15]. Burn injuries more frequently occur in winter because of the increased use of electricity, fire, and boiling water, which increases the risk of burn injury. For example, many people use wood, charcoals, electric, or hot water heating equipment to keep warm during winter in Southwest China, which may cause burns to the hand, scalds, or electrical injuries. Therefore, it is recommended that public health institutions strengthen safety education measures for burn prevention in winter [53]. Also, people at risk should pay attention to using safety equipment to prevent burns [54]. Safety strategies that protect against burns include the installation of fencing or guards around the heating equipment, the use of nonconductive caps on electrical sockets, and improvements in methods of heating and cooking [55–57].

In the present study, the proportion of fire and scalding injury in the patients with burns to the hand were similar to those in other studies [25,58]. However, the proportion of electric burns (30.85%) in the present study was approximately 1.5–2 times greater than in previous studies (8–20%) [25,58]. This discrepancy may be because the hands of our patients were more prone to be exposed to electricity and damaged by it. Therefore, while preventing burns caused by fire and hot liquids, there is also a need to pay close attention to the safe use of electricity and the prevention of electrical injuries [59,60].

The findings from the present study showed that most patients with hand burns had a total body surface area of the burn of less than 3%, which was similar to the findings from a previous study conducted in Shanghai, China [15]. However, our patients with the total body surface area between 4–5% accounted for only 9.15%, which was much less than the 23.28% surface area reported in the previous study [15]. Different causes, duration of the burns, first aid after burns, and age may have contributed to this difference. Also, the proportion (33.62%) of full-thickness burns to the hand of the patients was lower (53.97%) than that of the previous study from Shanghai. The rate of surgery (34.81%) in the present study was also lower than that of the previously reported study (56.35%) [15].

Cool water can be used to irrigate burn wounds for 10–20 minutes to provide the best intradermal cooling effect to assist in wound repair [61–63]. Importantly, the results of this study suggested that cooling could also reduce the need for surgery and amputations. A study in South Africa [64] previously showed that 25.6% of patients received cooling after burn injury. A study in Beijing, China, showed that 46.0% of patients experienced cold rinsing or cold compress after a burn [39]. However, only 16.17% of the patients in the present study cooled their hands after the burn injury. Populations in different regions or countries may have a different awareness of the need for cooling after burns to reduce thermal injury, pain, and the extent of tissue damage [65,66]. Also, the use of ice and very cold water should be avoided because these interventions may lead to vasoconstriction, local edema, or frostbite [67,68].

Some deep burn injuries may require surgery, including debridement, skin grafting, and amputation [69–71]. Previous studies have shown that surgery can improve outcomes, shorten hospital stay, and reduce hospital costs [16,72–75]. In the present study, we analyzed the predictors of surgery and found that a larger total body surface area and deeper wounds often required surgery. However, the previously reported study conducted in Shanghai, China [15] showed that male gender and deep burns were risk factors for surgery. One possibility is that a larger total body surface area is always accompanied by deep-partial or full-thickness burns [76]. A further possibility is that different distributions by age, location of the injury, burn site, the wishes of the patient, or other factors may have resulted in this difference. For example, burns on the back of the hands tend to be treated by surgery because the dorsal skin tissues are thin and easily damaged [7,66,77,78].

Within five days after the burn, the burn wound may be optimal for surgical coverage, but after five days, infection and

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the graft failure rate significantly increase [37,66]. In the present study, the proportion of patients treated by surgery within five days after the burn was 16.11% (24/149), and the rest (83.89%) received surgery after the five days. Although we had taken a positive attitude towards early surgery for burns to the hand at our center, the surgery timepoint still had been delayed by many factors, for example, economic conditions, systemic conditions, attitudes of patients, admission time after injury. Skin grafting is an important treatment for wound coverage [79,80]. Early excision and the use of skin graft result in more rapid healing, reduced scar formation, and improved recovery of function [81–87]. The findings from the present study showed that the depth of hand burn wounds was increased the likelihood of skin grafting. Recently, we have taken a positive attitude towards surgery for deep burns in our center. However, nonsurgical methods are also recommended in the treatment of deep partial-thickness hand burns [88]. The most rapid epithelialization of burn wounds has been reported in patients with deep partial-thickness hand burns treated with hydrocolloid dressings [88]. The patients also had fewer scars and better hand function [88]. In fact, burn wound management, especially wound management in burns to the hand, is controversial. Therefore, strategies based on evidence for hand burn management should be explored and implemented in the future.

Amputation is a severe clinical outcome for hand burn patients [89]. Amputation of the hands seriously affects patient quality of life and brings a heavy burden to the family and society [89–91]. The results from this study showed that deeper hand burn wounds might lead to the amputation of the patient hands or fingers, which was similar to the finding of a previous study [15]. Also, this study showed that the prevalence of amputation increased with total body surface area for hand burn patients, which was not found in the previous study conducted in Shanghai [15]. The possible reasons may be similar to those for surgery. Also, electrical burns were not a risk factor for amputation after burns to the hand, contrary to previous studies [92–95]. The main reason may be the different causes of injury associated with amputations in different studies. For example, in the present study, the amputation rate of electrical burns was 13.97%, which was nearly as high as that of fire burns (10.18%). However, the difference in the rates was significant (11.46% *vs.* 3.57%) in a previous study [15]. Also, in our center, burn rehabilitation has been adopted as an effective strategy to prevent physical and mental disabilities caused by amputations following hand burns. Since 2011, a professional team has been established for the early rehabilitation of burn patients in our center. The team consists of two doctors, two nurses, ten rehabilitation therapists, one psychological counselor, and one music therapist [96]. However, several issues should still be addressed, including education on rehabilitation, awareness of rehabilitation, professional training, follow-up assessments, and investment for specialized facilities [43,97,98].

A previous study has shown that the length of hospital stay had a positive correlation with the depth of hand burns [17]. Similarly, we also found that patients with full-thickness burns required significantly longer stays than those with partial-thickness burns to the hand. Deep burns often require a series of comprehensive therapies, including surgery, anti-scar treatment, function rehabilitation, which can delay discharge [17,99]. Also, our results showed that pre-hospital cooling of burn wounds could shorten the length of hospital stay of patients with burns of the hand, which was also reported in previous studies [62,63]. Suitable and adequate cooling can reduce or stop the thermal effect so that the damage is mitigated [61–63]. Consequently, it is highly recommended to educate at-risk individuals on the prevention of further deepening of wounds. Also, if the condition of the patient allows it, early surgery should be advised to reduce the length of hospital stay [17,77,78].

This study had several limitations. First, this was a retrospective study of patients treated in hospital and did not include patients treated as outpatients in our center, or patients being treated at other hospitals, and those who never sought medical care due to social, economic, or other reasons. Therefore, this study did not identify the total population prevalence, surgery rates, and amputation rates associated with burns of the hand. Also, the severity of burns to the hand in this study might have been greater than the average severity of hand burns of the whole population. Second, in this study, the long-term psychological effects, restoration of function, quality of life, patterns of rehabilitation, and costs were not assessed. However, from a long-term perspective, the common and principal concerns of medical staff, patients, and society were studied. Third, the relationships between the general conditions of the patients, the total body surface area, and patient outcomes were not assessed in this study. Fourth, the survival rate, disability rate, and complication rate were not assessed in this retrospective study, due to the loss or inaccessibility of patient data. Fifth, the effects of different treatment methods, including conservative therapy and the surgical procedures used, including debridement, skin grafting, flap grafting, and amputation on the prognosis and outcomes of hand burns were not assessed in this study. Sixth, the severity and outcome of burns in different anatomic sites were not analyzed in detail. Seventh, this study was conducted in a single center, which only partly reflected the epidemiological characteristics of burns to the hand in Southwest China. Therefore, future large-scale and multicenter studies should be performed with long-term follow-up to overcome the limitations of the present study.

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Conclusions

This retrospective study aimed to investigate the epidemiology of burns to the hand, including the causes, demographic data, management, and outcome in a single center in Southwest China between 2012 and 2017. The findings suggest that in Southwest China, prevention programs for children aged 0–9 years, injuries occurring in winter and non-workplace sites, and fire burns were important, and a collaborative effort involving government, companies, medical staff, and society may reduce the morbidity from burns to the hand.

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Conflict of interest

None.

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