

## Characteristics of 1494 pediatric burn patients in Shanghai

Wang Xin<sup>a</sup>, Zhang Yin<sup>a</sup>, Zhang Qin<sup>a,\*</sup>, Liu Jian<sup>a</sup>, Peter Tanuseputro<sup>b</sup>,  
Manuel Gomez<sup>b</sup>, Massey Beveridge<sup>b</sup>, Liao Zhenjiang<sup>a</sup>

<sup>a</sup> Burn Center, Ruijin Hospital, Shanghai Second Medical University, 200025 Shanghai, PR China

<sup>b</sup> Office of International Surgery, Sunnybrook & Women's College Health Sciences Centre,  
University of Toronto, Toronto, Ont., Canada

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### Abstract

To analyze the epidemiological characteristics of pediatric burn patients in Shanghai and to determine the targets for a pediatric burn prevention program, a retrospective review of all medical records of acute pediatric burn patients (age  $\leq 14$  years old) admitted to the Burn Center of the Ruijin Hospital between January 1980 and December 2002 was performed. Patient demographics, etiology of burn, mechanism of injury, extent and anatomical areas burned, number of operations, and length of hospital stay were recorded. A total of 1494 pediatric burn patients were admitted. Six hundred eighty-seven (46%) patients were from the migrant population (non-registered population of temporary workers from rural areas outside of Shanghai). Scalding was the main cause of pediatric burns in the age groups. Children 0–3-year-old were the most common victims of scalding, chemical burns, and contact burns. Domestic burns resulted in 1293 (86.5%) injuries followed by burns occurring while playing in public. The incidence of domestic burns has increased since the beginning of the study period, while the incidence of burns while playing in public has decreased. The median total body surface area was 4% for mild burns, 10% for moderate burns, and 18% for extensive burns. Predominant areas involved were the head, neck, anterior trunk, and right lower limb. Most children received conservative treatment, and their mean hospital stay was  $16.1 \pm 12.2$  days. There were 17 (1.1%) deaths, mostly due to sepsis (82.4%). Migrant children are the majority of burn victims since 1996. The education of burn prevention should focus on the migrant population in an industrializing city.

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*Keywords:* Pediatric burns; Epidemiology; Burn prevention

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### 1. Introduction

Burns are the most frequent injury among pediatric patients [1]. The injury, the treatment, and the rehabilitation process affect children not only physiologically, but psychologically as well [2]. The poor prognosis due to scar contractures, deformities, and functional limitations makes their further life more difficult for victims. In addition, the long and painful scar treatment comes with significant financial burden for parents and society [2]. The objective of this study was to analyze the epidemiological characteristics of pediatric burns in Shanghai, the most

populous city in China, and to establish the criteria for a pediatric burn prevention program. The Burn Center of the Ruijin Hospital, Shanghai Second Medical University, is the oldest burn center in China (established in 1958) and one of the largest burn centers in the world with 60 beds for acute burns and 10 beds for post-burn reconstructive surgery, and had 826 admissions in 2004. It serves a population of more than 13 million registered residents of Shanghai, and roughly 5 million migrant workers who have migrated from rural areas into Shanghai. There are 1.1 million children of registered residents in Shanghai but the precise number of children belonging to migrant families is not known. While the burn center admits patients from other provinces in China the vast majority of patients are from Shanghai city.

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\* Corresponding author. Tel.: +86 21 28336702; fax: +86 21 64333548.  
E-mail address: drzhangqinsh@yahoo.com.cn (Z. Qin).

Table 1  
Gender distribution by age groups

Age group (year)	Gender	Cases no. (%)	Total no. (%)
0–3	Male	577 (61.1)*	945 (63.3) <sup>†</sup>
	Female	368 (38.9)	
4–6	Male	203 (61.3)*	331 (22.1)
	Female	128 (38.7)	
7–14	Male	125 (61.3)*	218 (14.6)
	Female	93 (38.7)	

\*  $p < 0.01$  when genders are compared in each age group.

<sup>†</sup>  $p < 0.01$  when compared to other age groups.

## 2. Materials and methods

All medical records of acute pediatric burn patients (age  $\leq 14$  years old) admitted to the Burn Center of the Ruijin Hospital between January 1980 and December 2002 were reviewed retrospectively. Patient demographics, etiology of burn, mechanism of injury, extent and anatomical areas burned, number of operations, and length of hospital stay were recorded. Information was entered into a database established by one of the authors (MG) from the Ross Tilley Burn Center of the Sunnybrook & Women's College Health Sciences Centre, Toronto, Ont., Canada, and statistical analysis using Student's *t*-test and the Chi-square test was performed with the SAS software. Figures are expressed as averages  $\pm$  standard deviation and ranges.

According to the standards formulated by the Chinese Burn Association, the severity of a pediatric burn was classified in four grades: mild ( $<6\%$  TBSA), moderate (6–15% TBSA), extensive (16–25% TBSA), and critical ( $>25\%$  TBSA or third degree wound  $>5\%$  BSA).

## 3. Results

### 3.1. Age and gender

A total of 1494 acute pediatric burn patients were admitted during the study period. The average age was  $3.5 \pm 2.9$  years with range of 4 days to 14 years. There were 905 males and 589 females, representing a male to female ratio of 1.5:1. The ratio of males to females in China was

Table 2  
Gender distribution by time periods

Period	Gender	Cases no. (%)	Total no. (%)
1980–1987	Male	254 (59.6)*	426 (28.5)
	Female	172 (40.4)	
1988–1995	Male	359 (61.0)*	589 (39.4)
	Female	230 (39.0)	
1996–2002	Male	292 (61.0)*	479 (32.1)
	Female	187 (39.0)	

\*  $p < 0.01$  when genders compared in each period.

Table 3  
Population distribution by age groups

Age group (year)	Local population no. (%)	Migrant population no. (%)	Total no. (%)
0–3	510 (54.0)	435 (46.0)	945 (63.3)*
4–6	185 (55.9)	146 (44.1)	331 (22.2)
7–14	112 (51.4)	106 (48.6)	218 (14.6)
All patients	807 (54.0)	687 (46.0)	1494 (100.0)

\*  $p < 0.01$  when compared to other age groups.

1.1:1.0 in 2000 [3]. Males had a higher rate of admission than females throughout the age groups (Table 1) and the three time periods (1980–1987, 1988–1995, and 1996–2002, Table 2). Among the age groups, the highest incidence (63.3%) appeared in the 0–3 years group (Table 1). There was no statistical difference in the incidence of burns across the time periods examined (Table 2).

### 3.2. Residents and migrants

From 1980 to 2002, 807 (54%) of the 1494 pediatric burn patients admitted to our Burn Center were from the local population, while 687 (46%) cases were from the migrant population (Table 3). Pediatric burns occurred significantly more in the 0–3 years age group in both local and migrant populations (Table 3). There was a significant increase in the number of pediatric burns occurring in the migrant population from 1988–1995 to 1996–2002 (Table 4). The proportion of all pediatric burns occurring in the migrant population rose from 30.0% to 64.3% during this period. In 2002, migrant pediatric burn patients had risen to 92% of the total pediatric burns. The coinciding population increase in the migrant population in Shanghai does not fully account for this increase.

### 3.3. Mechanisms and causes of burns

Scalding caused 84.3% of all pediatric burns (Table 5). The proportion of burns caused by scalds decreased from 91.2% in the 0–3 years age group to 63.8% in 7–14 years age group (Table 6). 0–3-year-old children were the most common victims of scalding (68.5%), chemical burns, and contact burns (47.6%), compared with other age groups (Table 6). Scalds were more common during 1988–1995 and 1996–2002 than during 1980–1987 (Table 7). Flames (16%

Table 4  
Population distribution by time periods

Time period	Local population no. (%)	Migrant population no. (%)	Total no. (%)
1980–1987	271 (63.6)	155 (36.4)	426 (28.5)
1988–1995	365 (70.0)	224 (30.0)	589 (39.4)
1996–2002	171 (35.7)	308 (64.3)*	479 (32.1)
All Periods	807 (54.0)	687 (46.0)	1494 (100.0)

\*  $p < 0.01$  between geographic regions.

Table 5  
Causes of burns

Cause	Frequency	Percentage
Scalding	1259	84.3
Flame	142	9.5
Electrical	51	3.4
Chemical	42	2.8
Contact	10	0.7
Total	1494	100.0

of all burns) were the most common cause of severe pediatric burns.

Domestic burns resulted in the greatest number of injuries (1293 or 86.5%) followed by burns occurred while playing in public (Table 8). The incidence of domestic burns has increased since the start of the study period while the incidence of burns while playing in public has decreased (Table 9). Domestic burns were most common in 0–3-year-old children (66.6% of all domestic burns), and the incidence was lower in older groups (Table 8). There was no relation between the severity and the mechanisms of the burns, but less severe burns happened in domestic places (data not shown). Most burns (63.7%) happened when the children, especially 4–6 year olds, were alone (Table 10).

#### 3.4. Severity (extent and depth) of burns

The median total body surface area (TBSA) burn was 10% with a range of 0.1–95%. For full-thickness burns, the most extensive case had a 38.5% TBSA. The majority of cases did not suffer a full-thickness burn. Patients with burns judged to be lethal are not admitted to the burn center and so were not included in this analysis. The number of pediatric burns with TBSA > 30% has been stable (6.1%) from 1980 to 1995, but it has decreased to 2.9% in the 1996–2002

period (Table 11). From 1980 to 1995 more local children experienced burns > 30% (59.7% versus 40.3%,  $p = 0.03$ ) and their mean burn size was larger than that of migrant children ( $46.1 \pm 16.9\%$  versus  $39.0 \pm 7.2\%$ ,  $p = 0.16$ ) (Table 11). During the most recent period (1996–2002) more migrant's children experienced burns > 30% (71.4% versus 28.6%,  $p = 0.02$ ) and the mean burn size was larger than that of in the residents (46.2% versus 32.8%,  $p < 0.01$ ) (Table 11). A total of seventeen deaths (1.1%) were recorded during the period of the study, three (17.6%) died during the resuscitation phase, and 14 (82.4%) died later from sepsis.

#### 3.5. Anatomical areas burned

The three most frequent areas of burns were the anterior trunk (611 cases, 40.8%), followed by head and neck (566 cases, 37.9%), and the right lower limb (565 cases, 37.8%). There were no significant differences in this pattern between different age groups and different time periods. The most common site involved was the head and neck for mild and moderate burns and the anterior trunk for extensive burns (data not shown). Average total body surface area burn was  $11.8 \pm 9.9\%$ , average body surface area (BSA) of third degree burn was  $1.2 \pm 3.9\%$ . The TBSA of local and migrant people has not significant difference. The TBSA of local patients was  $11.8 \pm 10.4\%$ , with third degree BSA of  $1.3 \pm 4.1\%$  compared with  $11.3 \pm 9.3\%$  TBSA and  $1.2 \pm 3.7\%$  third degree BSA of migrant patients.

#### 3.6. Number of operations

Most pediatric burns (55.4%) had their wound healed without any operations. For these patients, their wounds were dressed with 1% Silver Sulfadiazine Vaseline gauze. The dressings were changed every 1 or 2 days. Six hundred sixty-seven (44.6%) of the 1494 cases underwent surgery,

Table 6  
Causes of burns by age groups

Age group (year)	Scalding no. (%)	Flame	Chemical contact no. (%)	Electrical contact no. (%)
0–3	862 (91.2)*	50 (5.3)	20 (2.1)	13 (1.4)
4–6	258 (77.9)	47 (14.2)	14 (4.2)	12 (3.6)
7–14	139 (63.8)	45 (20.6)	8 (3.7)	26 (11.9)
All patients	1259 (84.3)	142 (9.5)	42 (2.8)	51 (3.4)

\*  $p < 0.01$  compared to other age groups.

Table 7  
Causes of burns by time periods

Time period	Scalding no. (%)	Flame	Chemical contact no. (%)	Electrical contact no. (%)
1980–1987	335 (26.6)	45 (31.7)	28 (66.7)	18 (35.3)
1988–1995	516 (41.0)	48 (35.8)	7 (16.7)	18 (35.3)
1996–2002	408 (32.4)	49 (34.5)	7 (16.7)	15 (29.4)
All periods	1259 (84.3)	142 (9.5)	42 (2.8)	51 (3.4)

Table 8  
Mechanisms of burns by age groups

Age group (year)	Domestic no. (%)	While playing no. (%)	At school or hospital no. (%)	Public total no. (%)	Total no. (%)
0–3	861 (66.6)*	69 (39.2)	15 (60.0)	84 (41.8)	945 (63.3)
4–6	273 (21.1)	50 (28.4)	8 (32.0)	58 (28.9)	331 (22.2)
7–14	159 (12.3)	57 (32.4)	2 (8.0)	59 (29.4)	218 (14.6)
All patients	1293 (86.5)	176 (11.8)	25 (1.7)	201 (13.5)	1494 (100.0)

\*  $p < 0.01$  compared to other age groups.

Table 9  
Mechanisms of burns by time periods

Time period	Domestic no. (%)	While playing no. (%)	At school or hospital no. (%)	Public total no. (%)	Total no. (%)
1980–1987	343 (26.5)	70 (39.8)	13 (48.8)	83 (40.9)	426 (28.5)
1988–1995	522 (40.4)	62 (35.2)	7 (25.9)	69 (34.0)	589 (39.4)
1996–2002	428 (33.1)	44 (25.0)	7 (25.9)	51 (25.1)	479 (32.1)
All periods	1293 (86.5)	176 (11.8)	27 (1.8)	203 (13.6)	1494 (100.0)

Table 10  
Level of supervision during burns

	Frequency	Percentage
Alone	951	63.7
With parents	367	24.6
With family	102	6.8
With baby sitter	6	0.4
Other	68	4.5
Total	1494	100.0

with 231 (15.5%) requiring two or more operations. However, surgery was still the primary mode of treatment for full-thickness burns. There were no significant differences between local and migrant patients in the number of operations.

### 3.7. Length of hospitalization

The average hospital stay was  $16.1 \pm 12.2$  days and has been decreasing in recent years, related to the decreasing

severity of burns. Patients in the 7–14 year age group required more operations and stayed longer in hospital than the other age groups. More severe patients needed more operations and longer stay in the hospital.

## 4. Discussion

The burn center of the Ruijin Hospital, the oldest burn center in China, is responsible for the admission of the majority of burn patients in Shanghai, the largest city in China populated by 13 million local people and about 5 million migrants. With the industrialization of the country, the epidemiology of pediatric burns has corresponded to the time characteristics. The total annual number of pediatric burn admissions has been stable for the last 23 years, with 63.3% of patients in the 0–3 year age group, similar to the results of other countries [4]. At the same time, and while the population of Shanghai residents has risen 2 million people since 1980, the number of residents' children admitted with

Table 11  
Patients with TBSA greater than 30% by time period

Period	n/TBSA	Local	Migrant	Total
1980–1987	n (%)	14 (53.8)	12 (46.2)	26 (6.1)
	TBSA	$43.5 \pm 19.5$	$40.6 \pm 9.2$	$42.1 \pm 14.4$
1988–1995	n (%)	23 (63.9)*	13 (36.1)	36 (6.1)
	TBSA	$47.7 \pm 15.4$	$37.5 \pm 4.6$	$42.6 \pm 10.0$
1996–2002	n (%)	4 (28.6)	10 (71.4)*	14 (2.9)
	TBSA	$32.8 \pm 5.5$	$46.2 \pm 7.3^*$	$39.5 \pm 6.4$

TBSA: total body surface area.

\*  $p < 0.02$  when populations compared in each period.

burns has dropped from 271 (63.6%) in the first period of the study to 171 (35.7%) in the most recent period. While many more Shanghai residents' homes have hot water running from the taps than they had in 1980, many still rely on large communal boilers (open flame apparatus) to heat water for cooking, washing, and bathing. Young children are usually curious about their surroundings, but have no ability to notice potential dangers [5]. Engineering solutions to a safe source of domestic hot water may have an important role to play in reducing scald burns among children. Our study found that most burns happened while the children were alone (951 cases, 63.7%) or under improper supervision. Further work to elucidate the injury narratives of these children will be necessary to identify the exact mechanism of their injuries.

Burns occurred most commonly in the domestic setting (86.5%). It was common that when these burns occurred, both parents were working and the children were taken care by grandparents or baby sitters. On the other hand, the number of patients from migrant families increased dramatically with the quick industrialization of the city resulting in many migrants from villages at the same time. In the migrant population, the children might even have no constant supervision [5]. In addition, the migrant population often works and lives in significantly poorer conditions than the local population, including a higher proportion living in or near potentially dangerous worksites [6,7]. The average annual income of migrant workers is US\$ 1000 compared to US\$ 4000 for residents. One-third of migrants are unemployed at any given time. This study shows that the number of migrant burn children was disproportionately higher than the proportion of the total burn cases in all age groups during the last period (64.3% versus 35.7%,  $p < 0.01$ ). Assuming an equal proportion of children among the migrant and local populations, the risk of burn is almost five times higher among migrant's children (61.6 per million versus 13.2 per million). Under the circumstances where many of these pediatric burns are workplace related, they may be susceptible to legislative change forbidding children from accompanying parents to live in construction sites. Most injury prevention campaigns have this legislative component as well as an educational component. As domestic hot-water heaters become more common in Shanghai households, it would be helpful to introduce legislation limiting the temperature of the water to 49 °C in order to avert scald burns [8]. It is thus important to educate the relatives and the baby sitters, especially in migrant population, to be aware of the necessity of childcare and the potential hazards of the home environment and how to prevent common burn injuries [9].

Furthermore, the pediatric burns involved predominantly the head and neck, the anterior trunk, and the right lower limb, similar reports appeared in other studies [10–13]. Scalding was the most common cause for the pediatric burns examined, similar to the findings of other studies [10]. The

occurrence of chemical and contact pediatric burns was elevated during 1980–1987, because during that period, in the construction areas there were often chemical incidents as a result of rural materials used, due to the lack of development of the industry in China [11]. We also found the tendency of scalds occurring less often in the older pediatric age groups, along with a higher incidence of industrial burns (flames, chemical, or electrical) [12]. After 1988, there were less industrial burns among children, which may indicate the effectiveness of occupational safety education carried out by the government and might relate to the improvement of living standards of migrant people [13,14].

Of the 1494 cases examined, most children (53.9%) suffered from moderate burns. The median TBSA in the extensively burned group was lower than 30%. In this group the most common burn sites were the head and neck and the anterior trunk. Skin grafts were not always indicated; thereby the average number of operation was less than two. Most children received conservative treatment, leading to a relatively short mean hospital stay of  $16.1 \pm 12.2$  days.

Burn treatment is a combination of wound management, surgery, rehabilitation, and psychological counseling. Work in this study suggests that the majority of pediatric burn patients require more of the latter two aspects of treatment and must start as earlier as possible. But it is very unfortunate not to find any special funds or institutes to establish pediatric burn rehabilitation. We encourage the government at all levels and the medical workers to focus on this aspect of burn management.

In summary, the epidemiological features of pediatric burns changed with the socio-economic development and population shift in the last 23 years. Migrant children have become the majority of the pediatric burns. Domestic scalding causing mild to moderate burns constituted the vast majority of our admissions. There were more severe burns among the elder pediatric age group, but scalding was more common in the younger ages. All pediatric burns, especially flame, chemical, electrical, and contact burns, were potentially preventable through effective constant parental supervision. Burn prevention education should be the focus of pediatric burn prevention efforts especially in the migrant groups, and more funds are needed for physiological and psychological rehabilitation.

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