Characteristics of Thermal Burns in Children Admitted to an Israeli Pediatric Surgical Ward

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Abstract

Background: Reports of burn injuries in children are usually made by highly specialized burn units. Our facility admits children with burns covering < 20% total body surface area, while those with major burns are transferred to burn units at tertiary care facilities.

Objectives: To review our experience with thermal burns.

Methods: We conducted a retrospective review of all thermal burns admitted to our hospital during a 5 year period.

Results: Among 266 patients (69.2% boys) aged 3.5 ± 3.6 years, children < 3 years old were the most frequently injured (64.7%). Scalds (71.4%) were the most common type of burn. Partial thickness burns were sustained by 96.6% of children and TBSA burned was 4.2 ± 3.6%. The mean hospital stay was 3.8 ± 4.5 days, and was significantly prolonged in girls (4.6 ± 4.8 vs. 3.5 ± 4.3 days, P = 0.01). Percent TBSA burned was correlated with patient age (r = 0.12, P = 0.04) and length of hospital stay (r = 0.6, P < 0.0001). Six patients (2.3%) (mean age 3.4 ± 2.3 years) were hospitalized in the Pediatric Intensive Care Unit due to toxin-mediated illness.

Conclusions: Children under the age of 3 years are at increased risk for burn injury, but older children sustain more extensive injuries. Prevention and awareness are needed for child safety.

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According to the Office of Statistics and Programming, National Center for Injury Prevention and Control, U.S. Centers for Disease Control, fire/burn-associated injuries rank among the top ten causes of unintentional injury deaths among children under the age of 14 years [1]. Non-fatal fire and burn-related injuries, which often result from simple preventable domestic accidents, are among the ten most frequently observed reasons for unintentional injury admissions to hospital emergency rooms among children younger than 5 years old [2-11]. Burns may result in severe critical trauma and may also have long-term physical and psychological consequences [3].

In most countries, including Israel, moderate to severe pediatric burn injuries are reported by highly specialized burn units [9,10,12-15]. The Wolfson Medical Center is a secondary level government hospital serving a population of approximately 550,000 individuals in the towns of Holon, Bat Yam and Jaffa, which are south of Tel Aviv. Children with thermal burns are admitted to the hospital's Department of Pediatric Surgery where they are treated jointly by the pediatric and plastic surgery teams. Patient management is supervised by the pediatric surgery team, in consultation with the plastic surgeon as required. Patients with major burns (> 20% of total body surface area) are transferred to the burn unit of a nearby tertiary care facility. Patients presenting with second-degree (partial thickness) burn of 8% TBSA or more or with third-degree (full thickness) burn are routinely hospitalized in our department. In addition, burns of < 8% TBSA in "critical areas" such as the face, neck, perineum or circular burns of the extremities are also routinely admitted by our department.

The present report describes pediatric thermal burn cases treated at our facility. The aim of this study was to describe the characteristics and circumstances of thermal burns not referred to burn units in the Israeli pediatric population. Specifically, this survey was intended to identify patterns of injury including distributions by age, gender and socioeconomic/ethnic groups so that appropriate preventive interventions may be proposed.

Patients and Methods

The study was approved by the Institutional Ethics Committee. The medical charts of all children under the age of 17 treated in the hospital's pediatric emergency department for burns and subsequently admitted to the Department of Pediatric Surgery from January 2000 to December 2004 were reviewed. The pediatric surgery department admits children with thermal burns covering less than 20% TBSA. Records of patients with all types of thermal burns (including scalds and contact burns) were included. Cases of chemical or electrical burn (n=8) and cases of burn associated with trauma (n=6) were excluded.

All thermal burns are treated in a similar fashion in the emergency room: after cooling the burned area for 10–15 minutes by cool normal saline without excision of blisters, a dressing with silver sulfadiazine is applied. A prednisolone 0.5% + chloramphenicol 3% ointment is applied on burns of the face and genitalia. Analgesics are given, as well as intravenous rehydration as necessary, according to the adapted Parkland's formula.

Data collection

Demographic characteristics and socioeconomic parameters (ethnicity, number of siblings, parents' occupation) were extracted from the patients' medical records. Information concerning the injury such as place (home or elsewhere) of the accident, time and date were noted. Thermal injury-related data included mechanism and causes of burns (scalds, flame,

TBSA = total body surface area

contact burn or other causes), involved body area, depth of burn (partial or full thickness), and percentage of involved body surface area. Core temperature during the hospitalization, clinical and laboratory data, and length of hospital stay were also recorded.

Additionally, patients with a potential to develop burn-related sepsis were identified from among those children who required care at the Pediatric Intensive Care Unit, according to prior reported criteria [16]. Considered factors were systemic signs of infection appearing in the first 48 hours following the infliction of the burn and associated with one of the following: a) clinical signs of toxin-mediated illness defined as the appearance of widespread generalized erythrogenic rash, fever (> 38.5°C), systemic signs of toxicity that respond to appropriate antibiotic therapy; or b) positive blood culture of either *Sterptococcus aureus* or group A Streptococcus.

Data analysis

Analysis of data was carried out using SPSS 9.0 statistical analysis software (SPSS Inc., Chicago, IL, USA, 1999). Descriptive statistics for continuous variables such as age and days of hospitalization were calculated and are reported as mean ± standard deviation as well as median (range). Distributions of continuous variables were tested for normalcy using the Kolmogorov-Smirnov test (cutoff $P < 0.01$). Categorical variables were described using frequency distributions. Associations between categorical variables were examined using the chi-square test, exact as appropriate. Associations between continuous variables with approximately normal distributions and categorical variables were assessed using the *t*-test for independent samples, while associations between categorical variables and continuous variables with distributions significantly deviating from normal were tested using the Mann-Whitney U test. Between continuous variables, Pearson's correlation coefficients or Spearman's rho were calculated to describe associations as appropriate. All tests were two sided and considered significant at $P < 0.05$.

Results

Gender and age

During the 5 year study period 266 children were hospitalized for thermal burn injury: 184 (69.2%) were boys and 82 (30.8%) were girls (male to female ratio 2.2:1). Patients were 3.5 ± 3.6 years old (range 1 month to 17 years). No significant difference in age was observed between boys and girls. Children under 3 years old were the most frequently injured (n=172, 64.7%), including 30 infants younger than 1 year (11.3 % of the study population).

Time of injury

Nearly one-third (31.2%) of admissions occurred during the springtime (April to June) and 35.7% of children were admitted on a Thursday or Saturday [Figure 1]; however, these differences were not significant. Most emergency room admissions occurred between 6 p.m. and midnight [Figure 2].

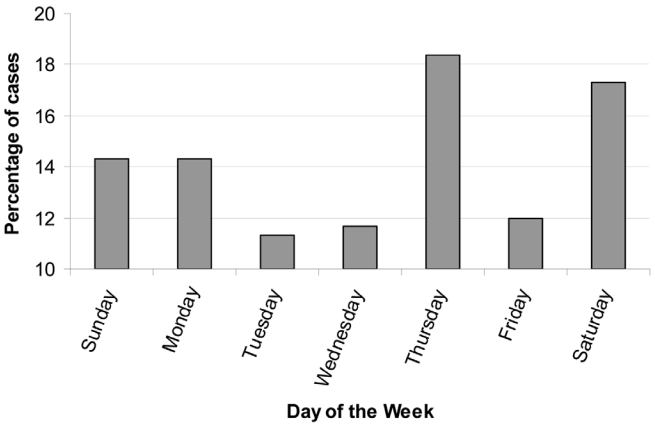

Figure 1. Percentage of burn cases by day of week

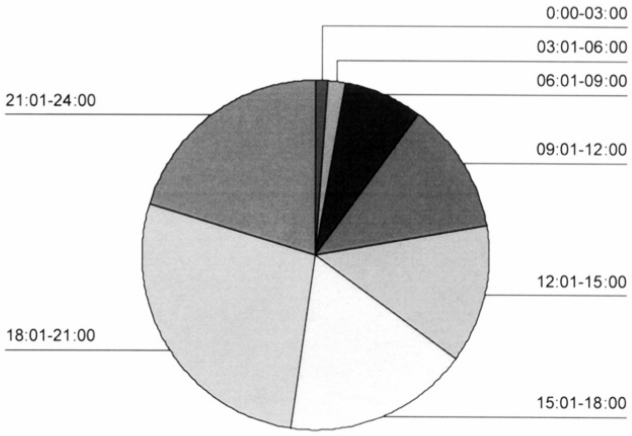

Figure 2. Occurrence of burns by time of day

Causes and mechanisms of burns

Most injuries occurred at home (228 cases, 85.7%), particularly in the kitchen and bathroom. Thirty-four cases (12%) occurred outside the home. Data on location of accident were not available for four cases. No association was found between age and home/not home burn ($P = 0.8$).

Despite the involvement of a forensic social worker in the investigation of 51 cases (19.2%), no events of intentional burn or child abuse were proven. However, 11 children (4.1%) were considered victims of negligence due to a history of previous admission for one or more episodes of burn (5 cases) and/or various traumas (6 cases).

Type of burns

Scalds were the most common type of burn (198 cases, 74.4%), followed by contact burns (45 cases, 16.9%) and burns from open flames (17 cases, 6.4%). No burn type was listed for six cases (2.2%). Among the 190 cases of scalds, the most frequent cause of injury was hot water (142 cases), followed by coffee/tea (n=37) and other beverages (n=11). Scald burns caused by coffee were observed more than twice as frequently on Saturday compared to

other days of the week, accounting for 23.9% vs. 11.0% of all thermal burns ($P = 0.02$).

Contact burns were due to an electric hot plate or stovetop (n=22), barbecue/coals (n=15), food (n=8), gas explosion (n=5), and firecrackers (n=3). Males accounted for 73.6% (n=39) of these cases, and 38 cases (72%) were under 5 years of age. There were no cases of inhalation injury.

Characteristics of burns

Overall, injuries were described as a partial thickness burn in 257 children (96.6%) and full thickness in nine (3.4%).

The % TBSA injured was 4.2 ± 3.6% (range 0.5–20%). The mean % TBSA burned was 3.8 ± 3.3% in males vs. 4.8 ± 4.1% in females ($P = 0.1$). A significant, positive association between age and % TBSA burned was detected ($r = 0.12$, $P = 0.04$). There were 240 children (90.2%) with burns < 10% TBSA (mean 3.2 ± 2 %). Among them, 158 (65.8%) had injury of at least one area including head-neck, hands, feet or genitalia-perineum.

Children sustaining scalds suffered burns to 4.5 ± 3.6% TBSA compared to children with other types of burn injuries (3.0 ± 3.3% TBSA, $P < 0.0001$). Among children with scalds, those injured by soup had more extensive burns than those scalded by other liquids (7.6 ± 5.4 vs. 4.4 ± 3.5% TBSA, $P = 0.04$), followed by children scalded by water compared to other liquids (4.7 ± 3.6 vs. 3.5 ± 3.4% TBSA, $P = 0.006$). Conversely, contact burns were less extensive than other types of burn injuries (range 0.5–4.0% TBSA, 2.6 ± 2.5 vs. 4.5 ± 3.7% TBSA, $P < 0.0001$) and those injured by stove tops had the least extensive injuries compared to children with other types of contact burns (1.7 ± 1.7 vs. 3.3 ± 2.8% TBSA, $P = 0.02$). Contact burns were characterized as partial thickness in 50 children (94.3%), full thickness in 1 child (1.9%), and a combination of partial and full thickness burns in 2 children (3.8%). Forty-three (81.1%) children had an injury of the upper or lower limbs.

Sites of burn injuries

Figure 3 displays burn frequencies by anatomic location. As can be seen, the most common burn sites were head/neck, anterior torso, arms and legs. The majority of patients (59.8%) had more than one site of burn, such that the mean number of sites per child was 1.9 ± 0.9. Significantly more boys than girls sustained burns to the abdomen (15.8% vs. 4.9%, $P = 0.01$), while significantly more girls than boys sustained burns to the feet (17.1% vs. 8.2%, $P = 0.03$). No other burn sites differed by gender.

Table 1 shows that children with burns to the anterior torso or hands were significantly younger than children with burns on other parts of the body, while children with burns on the posterior torso, abdomen or legs were significantly older than children with burns in other anatomic locations.

Demographic and socioeconomic characteristics

The majority of patients belonged to two-parent families (85%), while 8.8% lived in single-parent homes (divorced, never married).

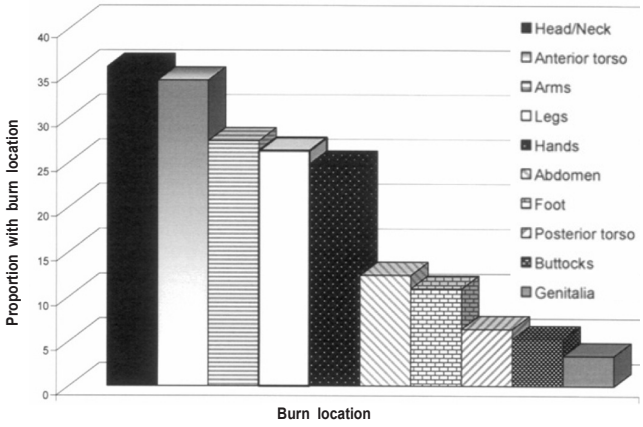

Figure 3. Proportion of subjects with burn by anatomic location

An additional 1.2% lived in some type of foster care setting, while family status of the remaining 5.6% of subjects was not recorded. Subjects had 1.8 ± 1.7 siblings.

There were 227 (85.3%) Jews, 32 (12.2%) non-Jews (mainly Moslems) and 7 (2.6%) cases of unknown ethnicity. Ethnic distribution of the study population reflects the ethnic distribution of this area. Differences in burn location, severity and extent were not detected by ethnic origin, though significantly more non-Jews than Jews were burned on Saturday (40.6% vs. 14.5%, $P = 0.004$).

Parents' level of education was available for less than 15% of the study population. Among those for whom education level was available, the majority (66.6% of fathers and 77.1% of mothers) reported completing at least 12 years of formal education. Educational achievement of parents did not affect the location, severity or type of burn suffered by the child.

Length of hospital stay

The mean hospital stay was 3.8 ± 4.5 days (range 1–28 days). Though % TBSA burned did not significantly differ by gender (4.8 ± 4.1% in girls vs. 3.8 ± 3.3% in boys, $P = 0.1$), duration of hospitalization was significantly longer in girls compared to boys (4.6 ± 4.8 vs. 3.5 ± 4.3 days, $P = 0.01$). A significant association was detected between percent TBSA burned and length of hospital stay ($r = 0.6$, $P < 0.0001$), but an association between

Table 1. Site of burn injury by age in 266 children

Burn area	No. of patients	%	Age (yrs) with vs. without location of interest	*P*
Head/neck	95	35.7	2.8 ± 2.8 vs. 4.0 ± 3.9	0.1
Trunk – anterior	91	34.2	2.5 ± 2.5 vs. 4.1 ± 4.0	< 0.025
Trunk – posterior	17	6.4	5.0 ± 3.8 vs. 3.5 ± 3.6	0.005
Abdomen	33	12.4	4.4 ± 3.6 vs. 3.7 ± 3.6	0.03
Buttocks	14	5.3	4.3 ± 2.8 vs. 3.5 ± 3.7	0.09
Genitalia/perineum	9	3.4	5.6 ± 3.6 vs. 3.5 ± 3.6	0.1
Arms	73	27.4	3.2 ± 3.3 vs. 3.7 ± 3.7	0.6
Hands	66	24.8	2.6 ± 2.8 vs. 3.9 ± 3.8	0.002
Legs	70	26.3	5.7 ± 4.5 vs. 2.8 ± 2.9	< 0.0001
Feet	29	10.9	2.9 ± 3.9 vs. 3.7 ± 3.6	0.1

patient age and duration of hospitalization was not detected. Core temperature did not differ by gender (37.9 ± 1.0 vs. 37.4 ± 3.1 degrees in girls and boys, respectively, $P = 0.2$); however, core temperature was significantly associated with both percent of TBSA ($r = 0.5$, $P < 0.0001$) and number of days hospitalized ($r = 0.8$, $P < 0.0001$).

Six patients (2.3%, 4 males and 2 females), aged 16 months to 6 years (mean 3.4 ± 2.3), were hospitalized in the PICU for toxin-mediated illness. All children presented high fever (mean 39.3 ± 0.5°C, range 38.5–40°C) that appeared within 1.5 ± 0.8 days (range 1–3 days) of sustaining the injury. These burn injuries all occurred at home. There were five scalds due to hot water and one contact burn. Four of the injuries involved burns to the head/neck (4.2% of all head/neck burns), and two of the injuries involved no head/neck injury (1.2% of non-head/neck injuries). Among children hospitalized in the PICU, % TBSA injured was 9.8 ± 6.9% (range 2–18%) compared to 4.0 ± 3.3% in patients without PICU hospitalization ($P = 0.07$). Blood cultures were sterile in all six cases while burn site cultures grew *Sterptococcus aureus* in one case, Staphylococcus coagulase negative and Enterococcus in one other case, and were sterile in four children. Skin rash and exfoliation were detected in three patients and hypotension in one patient. All patients were successfully treated with antibiotics. The length of stay in PICU-hospitalized patients was 13.8 ± 3.2 days compared to 3.6 ± 4.3 days for patients not requiring the PICU ($P = 0.002$). There was no mortality in this series.

Discussion

The purpose of this study was to characterize burned children hospitalized in our facility during a 5 year period. Demographically, our patient population appears to reflect the demographic distribution of the general population served by the hospital. Because data were extracted from medical records, it is subject to information bias; however, it is unlikely that such bias would be systematic. We choose to focus on thermal burns including scalds, flame and contact burns, because electrical and chemical burns are relatively rare in children [11]. Non-bath related scalds have been shown to be the most frequent source of burn injury worldwide and in Israel [10,15,17-19], and our findings are consistent with these reports.

The age and gender distribution in our series is similar to those from other reports from Israel [15,17,20] and from studies from all around the world [3-5,7,21], but differed from the report of Lin et al. [10] where both genders were almost similarly injured. Also differing from some studies [2,11], our series detected no significant difference in age between boys and girls. However, children under the age of 3 years were more frequently burned [5,13,14,21,22]. It has been reported that males under age 2 are most likely to be scalded by hot beverages [7,21], which is attributable to their limited cognitive and motor development at this age, necessitating greater parental awareness. In the present survey, children with burns to the anterior torso or hands were significantly younger than children with burns to other parts of the body. In addition, children with burns to the posterior torso, abdomen or legs were significantly older than children with burns in other anatomic locations. These findings suggest that preventive interventions should be age appropriate, considering different injury risks by age group.

In our series, burn injuries were more frequent in spring, consistent with other studies [4,23]. In contrast, several reports [5,10,11], including from Israel [20], found an increase in injuries during winter, which was related to seasonal culinary habits. Comparing burn injuries among Jewish and non-Jewish Israeli populations, Goldman and co-authors [15] found that burns were more common during spring and winter among these populations, respectively. This was attributed to unsafe heating methods in the homes and in Bedouin tents. We found no differences between these two populations, perhaps because our patients all live in an urban area. In a recent study of burns in Israel, Haik and collaborators [17] reported that 36.8% of incident burn injuries occurred among non-Jewish patients of all ages, and concluded that non-Jewish ethnicity is a risk factor for burns in Israel. The distribution of ethnicity in our series (12.2% non-Jewish) does not suggest increased risk among non-Jews in our area.

More than one-third of our patients were admitted on weekends (Thursday and Saturday), consistent with other Israeli reports [15,20] relating this fact to the preparations for the Sabbath meal. In this series, non-Jews were more frequently burned on Saturday, but no other differences in day of the week were significant. Our patients were most commonly admitted in the evening, consistent with the timing of the typical Israeli dinner hour [20], which seems to occur later than in other countries [4,7,10].

The majority of our patients (85.7%) sustained burn injuries at home. It is well established that the majority of burn injuries in children occur at home and particularly in the kitchen and the bathroom [3-6,9,12,13,17,18]. Preventive measures to increase child safety such as health and public education [11,12], and changes in the home (including kitchen and bathroom) [2,6,7,11,21] are also necessary in our region.

As in other studies [2,4,11,15,17,21], scalds were the most frequent type of burns encountered in our patients. Hot water was the primary cause of scalding (75%) followed by coffee and tea (19.7%). Hot beverages were found to be responsible for more than twice the injuries on Saturdays compared to other days. In contrast to reports citing fire as the next most common cause of burn [2,4,11,15,21] our survey found contact burns (especially by a hot iron) to be the second most frequent cause of burns. Contact burns are due to heated objects such as domestic devices (hot plate or stovetop) which induce a localized distinct injury [24]. It has been reported that this type of injury was most frequently observed in males under the age of 5 who sustained a partial thickness burn in an extremity [25]. In our series, there was no age or gender difference in contact burns.

The mean length of stay of our patients was comparable with others reports on scalding and contact burns [7,25]. Duration of hospitalization was significantly associated with % TBSA burned 15]. There was no mortality in our report, but six patients

PICU = Pediatric Intensive Care Unit

were hospitalized in the PICU for toxin-mediated illness. The percentage of TBSA burned and overall hospitalization among these patients was longer compared to those not requiring PICU treatment.

In conclusion, children aged less than 3 years old are at increased risk for burn injury, but older children sustain more extensive injuries. Burn injury prevention must be an essential element of parental education. To this end, our department currently offers an educational program on accident prevention for children hospitalized for trauma and for their parents.

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