EPIDEMIOLOGY OF PAEDIATRIC BURNS IN IRAN

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SUMMARY. We surveyed the epidemiology of the patients in a tertiary burn care centre (the Motahari Burn Hospital) in Tehran in the 4-yr period 2005-2009. Scalding was the major cause of burn injury for patients under the age of 6, while there were many more flame and electrical burns in late childhood. Males were mainly affected (male to female ratio, 1.7:1). Most burns occurred in the summer, probably due to older children’s increased outdoor activities during school vacations. Most of the injuries took place in the kitchen. Age was directly related to the higher total body surface area and mortality rate. Explosion of propane gas at home had a high incidence. Length of hospital stay increased in relation to the burn surface area. Infants were found to be at greatest risk for burn injuries, while older children were at higher risk for severe burns. Before arriving at the hospital, 22 patients had received traditional therapy in the home which was not effective and caused some problems. Pre-hospital care by emergency medicine service personnel was complete and effective. 374 patients had positive results for wound culture (42.9%). The most frequent bacteria found in burn wound cultures was coagulase-negative Staphylococcus (66.8%). Blood culture was positive in 12% of the patients with positive burn wound culture and the most frequent bacteria in blood culture was Pseudomonas aeruginosa. The overall mortality rate was 10.6%. Treatment and prevention programmes should target high risk groups. Important criteria include older age, flame burn, presence of inhalation injury, total body surface area (TBSA) burned above 40%, and sepsis.

Keywords: paediatric burns, prevention, epidemiology, trauma

Introduction

The National Burden of Disease Study in 2003 in Iran showed that burn injury is the 13th most frequent cause of the burden of disease in the general population, and the 7th in children aged 5-14 yr. Burn injury is considered an important preventable cause of injuries in children, and it still produces significant morbidity and mortality in our country. The stages of treatment of burns are sophisticated, expensive, and time consuming since patients need special care and equipment, as well as well-trained staff. Therefore prevention is much more rewarding than treatment and it first requires exploration of the epidemiological characteristics of this injury. Thus, we conducted the current study to survey the epidemiology and outcome of burn injuries in children treated at a referral burn center in Tehran, Iran.

As estimated by World Health Organizations (WHO) Global Burden of Diseases for 2004, over 300,000 patients of all ages died due to fire-related burns; 30% of them were under the age of 20. The outcome of patients was related to age, part of body affected, TBSA, time interval from injury to hospital admission, type of care given and post-burn complications.1

Children with severe burns often suffer from impaired mental and physical development and from prolonged enduring of pain, resulting in large medical expenses both to the family and to the health care system.2-3 Paediatric burns constitute a substantial proportion of total burn admissions. In comparison to the other types of physical trauma in children, a higher proportion of burn patients require hospital care, and many endure longer hospital stays and undergo more critical treatments.4-9 The objective of this study was to consider epidemiological features of paediatric burn injuries, treatment in pre-hospital care, burn-related complications, clinical outcomes and determination of risk factors for paediatric burn injury in Iran.

Materials and methods

This is a retrospective descriptive study on the 870 paediatric burn patients who were admitted to our burn centre between 2005 and 2009. Relevant data were col-
lected in a pre-coded format from patients medical records. The patients were children aged 14 and younger, admitted to Motahari Burn Hospital. No patient was excluded from the study. The following data were obtained: age, gender, place of burn, site of injury in the body, seasonal variation, cause of injury, accompanying trauma, extent of burns, ignition of clothing, the length of time from injury to initial care, presence of inhalation injury, history of previous medical condition, any treatment for burns received at home, pre-hospital care provided by medical staff, admission to an intensive care unit (ICU), and ICU-related mortality, length of hospital stay (LOS), wound infection, results of burn wound culture, treatment outcome, mortality rate, and cause of death. Patients were admitted on the basis of ABA criteria for treatment at a burn centre. Inhalation injury was defined on the basis of exposure to smoke, burns in a closed space, presence of carbonaceous sputum, signs of airway obstruction, deterioration of PO$_2$ in serial arterial blood gas tests and/or positive findings in bronchoscopy. Sepsis was defined as an systemic inflammatory response to infection and a positive blood culture. The systemic inflammatory response syndrome (SIRS) was defined as a condition with body temperature $>$38 °C or $<$36 °C, heart rate $>$90 beats/minute, respiratory rate $>$20/minute and white blood cell (WBC) count $>$12000/µl or $<$4000 µl. Swab cultures were taken from all patients during hospitalization, and tissue culturing was performed for those patients who had local signs of wound infection. Cultures were considered positive if the colony forming unit (CFU) was $>$100,000 in one gram of tissue. Patients who needed special intensive care, including those with respiratory failure needing ventilator support, or with sepsis and/or multiple organ failure, were admitted to the ICU.

After admission, intravenous fluid therapy was provided for burn-related shock in the first 24-48 hours postburn according to the Parkland formula and the Galveston formula (for children). Wound dressings impregnated with silver sulphadiazine, nitrofurazone or mafenid ointment, and sometimes Acticoat were changed every day. Dead tissue debridement was carried out in the operating room for the next 10-14 days. Split thickness skin grafts were also performed over the wounds. If indicated, early excision (in the first 2-5 days) and grafting of burn wounds were performed. Surgery (usually with flaps) was performed by expert plastic surgeons to prevent desiccation.

Data were analysed using Statistical Package for Social Sciences (SPSS, version 16. Chicago, Inc) and values are presented as number (%) for categorical variables, and as mean ± standard deviation (SD) for quantitative parameters.

### Results

During the 4-yr period 2005-09, over 6000 patients were admitted to our hospital, of whom 870 were under 15 years of age; 16.7% of the patients required plastic and reconstructive surgery while 9.5% had complications requiring ICU admission.

#### Age and sex

The male to female ratio was 1.7:1 (63% male vs. 37% female). The mean age was 4.19 yr (range, 1 month to 14 yr). Most patients (37.9%) were in the 2-6 yr age range (Table I).

#### Type of burn

Scalding was the most prevalent type of burn (68.2%) in the first four age groups. In the 5th age group, flame was the major cause of burn injury. Flame burns accounted for the highest incidence in non-scald burns, mostly in the 5th age group. Other causes were electricity (4.8%), contact burns (2.2%), and chemical burns (0.3%). Unlike other reports, as age increased, the percentage of scald-related burns decreased, while fire-related burns increased (Table II).

### Table I - Sex-based comparison between burns in different age groups

<table>
<thead>
<tr>
<th>Age group</th>
<th>Years</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0-1 years</td>
<td>78</td>
<td>42</td>
<td>120 (13.8%)</td>
</tr>
<tr>
<td>2</td>
<td>1-2 years</td>
<td>148</td>
<td>82</td>
<td>230 (26.4%)</td>
</tr>
<tr>
<td>3</td>
<td>2-6 years</td>
<td>199</td>
<td>131</td>
<td>330 (37.9%)</td>
</tr>
<tr>
<td>4</td>
<td>6-10 years</td>
<td>70</td>
<td>43</td>
<td>113 (13.0%)</td>
</tr>
<tr>
<td>5</td>
<td>10-14 years</td>
<td>55</td>
<td>22</td>
<td>77 (8.9%)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>550 (63.3%)</td>
<td>320 (36.7%)</td>
<td>870 (100%)</td>
</tr>
</tbody>
</table>

### Table II - Comparison of causes of burns in different age groups

<table>
<thead>
<tr>
<th>Age group</th>
<th>Scalds</th>
<th>Flame</th>
<th>Hot material</th>
<th>Electricity</th>
<th>Acid</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>0-1 yr</td>
<td>104</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>2.00</td>
<td>1-2 yr</td>
<td>204</td>
<td>20</td>
<td>3</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>3.00</td>
<td>2-6 yr</td>
<td>223</td>
<td>80</td>
<td>6</td>
<td>18</td>
<td>3</td>
</tr>
<tr>
<td>4.00</td>
<td>6-10 yr</td>
<td>59</td>
<td>45</td>
<td>0</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>5.00</td>
<td>10-14 yr</td>
<td>3</td>
<td>64</td>
<td>4</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>593 (68.2%)</td>
<td>213 (24.5%)</td>
<td>19 (2.2%)</td>
<td>42 (4.8%)</td>
<td>3 (0.3%)</td>
</tr>
</tbody>
</table>
### Place of injury
Most burn injuries occurred at home (89.7%): 58.2% in the kitchen, 17.5% in the living room, and 3.7% in the bathroom. Only 10.3% of the paediatric burns occurred outside the home.

### Burn extent
The overall mean TBSA in all patients was 21.59% (range, 1 to 100%). The mean TBSA was 20.5%, 21.3%, and 23.8% respectively in the 0-2, 2-6, and 6-10 yr age groups. In the 10-14 yr age group, girls had a similar mean TBSA (about 20%) but in boys aged 10 to 14 yr, it was above 40% (range, 26-100%), which revealed a significant difference ($p<0.01$).

### Length of hospital stay
The median LOS was 9 days (mean ± SD = 9.2 ± 11.4 days). The mean ± SD LOS increased from 6.8 ± 4.8 days in patients with a burn area of 1-9% to 13.7 ± 1.8 days in patients with a burn area of 40% or more (Table III). Hence, LOS related significantly with TBSA ($p<0.02$).

Patients with burns caused by scalding had shorter LOS (57.2% with less than 10 days) compared to patients with burns caused by flames (17.6% with LOS between 11 and 20 days, and 31.4% with LOS over 20 days). 60.5% of patients hospitalized for longer than 20 days were also found to have flame burns.

### Seasonal distribution
Paediatric burns were more common during the summer (32.4%).

### Inhalation injury
Sixty patients (6.9%) had inhalation injury. Forty-nine patients were burned in a closed space and 11 (18.3%) in an open space. Thirty-one cases of inhalation injury occurred due to gas explosion. Fifteen patients (25%) with inhalation injury developed severe respiratory failure and were admitted to the ICU for special respiratory care. Among the patients with inhalation injury, 18 patients (30%) expired; however, of patients without inhalation injury (810 patients), 71 patients (8.7%) expired. The difference was significant ($p<0.0001$) (Table IV).

### Amputation
There were 31 cases of amputation (3.5%), 6 of which were due to electrical burns.

### Treatment at home
Twenty-two patients had received traditional home therapy before arriving at the hospital - all of them within 4 h. Of these, 15 patients had received non-effective treatment at home.

### Pre-hospital care
Most patients who were within 4 hours’ distance from a burn care centre received adequate fluid therapy and did not develop pre-renal azotaemia. 594 patients had received fluid therapy, 346 had had cold compresses placed over the burn site, and 36 had had escharotomies performed by medical staff before admission to the hospital.

### Ignition of clothing
In 109 cases (12.5%), the patients’ clothing caught fire; 41 patients (37.6%) had 4th degree burns. In cases with no ignition of clothing (761 patients), 146 patients had sustained 4th degree burns (19.1%). The difference was statistically significant ($p<0.0001$).

### Treatment outcomes
Out of the 870 patients in this study, 10.6% expired, 286 patients (32.9%) had partial recovery and continued their treatment as outpatients, and 56.9% enjoyed complete recovery. Patients with a history of medical conditions such as diabetes, hypothyroidism, heart diseases, valvular disorders, seizure, renal disease etc, constituted 97 cases (11.1%), leading to 7 fatalities (7.2%). In patients with no previous history (773 patients), 82 patients expired (10.6%), indicating a statistically significant difference ($p<0.0001$).

<table>
<thead>
<tr>
<th>Age group</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1 yr</td>
<td>120</td>
<td>13.9%</td>
</tr>
<tr>
<td>1-2 yr</td>
<td>230</td>
<td>9.5%</td>
</tr>
<tr>
<td>2-6 yr</td>
<td>330</td>
<td>9.7%</td>
</tr>
<tr>
<td>6-10 yr</td>
<td>113</td>
<td>7.5%</td>
</tr>
<tr>
<td>10-14 yr</td>
<td>77</td>
<td>14.9%</td>
</tr>
<tr>
<td>Total</td>
<td>870</td>
<td>10.6%</td>
</tr>
</tbody>
</table>

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**Table III** - Mean age, mean hospital stay, and mean number of debridements in each TBSA group

<table>
<thead>
<tr>
<th>TBSA group</th>
<th>Mean age (yr)</th>
<th>Mean hospital stay (days)</th>
<th>Mean number of debridements</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>4.7</td>
<td>6.8</td>
<td>0.5</td>
</tr>
<tr>
<td>10-20</td>
<td>3.7</td>
<td>9.9</td>
<td>0.8</td>
</tr>
<tr>
<td>20-40</td>
<td>3.8</td>
<td>12.01</td>
<td>1.3</td>
</tr>
<tr>
<td>40+</td>
<td>5.7</td>
<td>13.7</td>
<td>1.8</td>
</tr>
</tbody>
</table>

**Table IV** - Treatment outcomes in ICU patients

<table>
<thead>
<tr>
<th></th>
<th>Complete recovery</th>
<th>Partial recovery</th>
<th>Death (percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>With inhalation injury</td>
<td>0</td>
<td>0</td>
<td>15 (100%)</td>
</tr>
<tr>
<td>Without inhalation injury</td>
<td>3</td>
<td>15</td>
<td>50 (73.5%)</td>
</tr>
</tbody>
</table>

**Table V** - Mortality in different age groups

<table>
<thead>
<tr>
<th>Age group</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>Total</td>
<td>870</td>
<td>10.6%</td>
</tr>
</tbody>
</table>
Plastic and reconstructive surgery

Plastic surgery was performed in 144 patients (16.5%) - more frequently in those with explosion and fire-related burns (21.3% and 17.9%, respectively) compared to other types of burn. Most reconstructive surgery included distant flaps for coverage of defects in hand, wrist, and forearm.

Infection

Six hundred and fourteen patients developed signs of burn wound infection and underwent wound biopsy and culture. Of these, 374 patients had positive culture results (42.9%). The bacteria most frequently found in the cultures were coagulase-negative *Staphylococcus* in 250 cultures (66.8%), *Pseudomonas aeruginosa* in 165 cultures (44.1%), coagulase-positive *S. aureus* in 126 patients (33.6%), *Acinetobacter* in 56 patients (14.9%), and *E. coli* in 54 cultures (14.4%). *Candida* was found in only 3 cases (0.8%). Blood culture was positive in 12% of the patients with positive wound culture, the most frequent being *Pseudomonas aeruginosa*. Patients with sepsis had an 11% mortality rate compared to 9.4% mortality in patients without sepsis ($p < 0.05$). The most frequently administered antibiotics were Amikacin (91.9%), Cefazidim (60.5%), Meropenem (37.7%) and Cephazoline (17.6%).

In-patient mortality

During the 4-yr study period, there were 10.6% inhospital burn-related deaths. Seventy-two per cent of the burn-related deaths related to children with a burn area of 40% and more. The highest mortality rate was 53.8% in the 13 to 14 years age group, which included only 1.5% of all the patients, probably because of the high risk behaviour in this age group; 8.8% of the patients between 10-14 yrs had a 14.6% mortality rate, the highest mortality rate among the 5 age groups. Fire-related burn injuries accounted for 47% of the deaths compared to 53% of deaths related to scalds (Table VI).

**Comparison of annual admissions**

Over the 4-yr period, paediatric burn admissions increased from 187 to 241 patients per year (Table VII).

Discussion

The epidemiology of burns helps us to understand burn patients better, to take measures for successful prevention and treatment, and to evaluate the quality of burn care in our centres. In the US, it is estimated that between 1 and 2 million burn injuries occur each year, about 6-8% leading to hospitalization, and 5-6.5% of them to death.

In the Western World, due to safety measures and preventive programs, the incidence of burn injuries is decreasing; however, in developing countries, burns continue to be an important cause of morbidity and mortality.

In this study, the most common cause of burn injuries in children was scalds, and the place where most of the burn injuries occurred was the kitchen.

Analysis of the cause of burns by age group shows that scalding was the main cause of injuries in infants, toddlers, and early children, while in other studies, scalds were the most common cause of burn injuries in older children.

Most of the burn injuries in our study occurred at home (89.7%), 58.2% of them in the kitchen. This is probably due to the usual way of cooking in Iran, i.e. preparing rice and hot tea with boiling water. Parents - especially mothers - are therefore advised not to leave children alone and unsupervised in the kitchen. Peleg et al. found that burn prevention programmes addressing parents were more effective than those solely considering children.

Flame was the second most common cause of burn injury and occurred primarily in older children. In other reports flame was the commonest cause of burn-related death.

Our study showed that as children grow older, scald
burns are replaced by flames. Patients with scald-related burns usually had shorter LOS (57.2% with LOS less than 10 days). Patients with burns caused by flames had longer LOS (17.6% with LOS lasting 11-20 days, and 31.4% with LOS longer than 20 days).

In our study, 32.2% of burns occurred in summer, while Goldman et al. found December, January, and March to be the months with the highest prevalence of burn injuries (9%, 10%, and 9%, respectively) while June and November had the lowest (7%).

Most burn victims in our study were children aged 2-6 yrs: children aged 6 yr or younger constituted up to 78.1% of our study population. Special attention should be paid to these children. The average TBSA in our study was 21.59%. Additionally, 40.8% of children had TBSA greater than 20%. There were 60 patients with inhalation injury, 18.3% of which accidents occurred in an open space. This rate is higher than others one reported in the literature. Electricity was the cause of 28.5% of burn-related amputations, significantly higher than that of scalds; it was the cause of 14% of amputations. Our results showed that emergency staff provided effective pre-hospital care. This shows the capability of emergency Medi-caid in providing proper burn care.

The hospital stay was directly related to TBSA. In a study from Hong Kong, the mean hospital stay was 7.4 days, while the overall LOS in our study was 10 days. Further investigation is needed to reveal the causes of longer LOS in our study.

Our study has paved the way for the development of preventive programmes for burns among children in Iran. Policymakers should be aware of the annual increase in the number of children hospitalized for burn injury. Increasingly efficient household safety measures, especially in the kitchen, training families and parents on risk prevention, providing safe activities for younger children during the summer vacations and other free time, and designing educational programmes and regulations are some possible recommendations. Further studies to evaluate the efficacy of these recommendations should be carried out.

Conclusion

The incidence of paediatric burns is increasing in Iran, with most of the injuries occurring in boys under the age of 6, in the kitchen, and during summer vacations. Scalding is the commonest cause of burns in the Iranian paediatric population, followed by flame. The larger the TBSA, the longer the length of hospital stay, with a subsequent increase in morbidity.

RÉSUMÉ. Nous avons effectué une étude dans un Centre des Brûlés de niveau tertiaire (le Motahari Burn Hospital) à Téhéran pendant dans la période de 4 ans 2005-2009 et nous avons constaté que la principale cause des brûlures pour ce qui concerne les patients âgés de moins de 6 ans a été l’ébouillantement. Les enfants plus grands ont été atteints principalement par des brûlures causées par les flammes et par l’électricité. Les mâles ont été principalement affectés (ratio homme-femme, 1.7:1). La plupart des brûlures se sont produites durant l’été, probablement en raison du fait que les enfants plus grands augmentent leurs activités de plein air pendant les vacances scolaires. Les accidents de ce type ont lieu dans la cuisine. L’âge était directement lié au taux de la mortalité plus élevé comme aussi au taux de la surface corporelle totale plus élevée. Les explosions de gaz propane à la maison avaient une incidence élevée. La durée du séjour hospitalier augmentait par rapport à la surface de brûlure. Les nourrissons ont été jugés la catégorie la plus exposée au risque de la brûlure en général, tandis que les enfants plus grands étaient plus à risque pour des brûlures graves. Avant d’arriver à l’hôpital, 22 patients avaient reçu un traitement traditionnel à la maison, qui n’a pas été efficace et a causé quelques problèmes. Les soins d’urgence préhospitaliers fournis par le personnel du service de médecine étaient complets et efficaces. 374 patients ont eu des résultats positifs pour la culture des plaies (42,9%). Les bactéries les plus communs trouvés dans les cultures de plaies de brûlures ont été les *Staphylococcus* à coagulase négative (66,8%). L’hémoculture était positive dans 12% des patients avec culture des lésions positive, et les bactéries les plus fréquentes observées dans les cultures du sang étaient *Pseudomonas aeruginosa*. Le taux global de mortalité était de 10,6%. Il faut que les programmes de traitement et de prévention soient orientés vers les groupes à risque élevé. Les critères les plus importants sont l’âge plus avancé, les brûlures par flamme, la présence de lésions par inhalation, la surface corporelle brûlée au-dessus de 40%, et la septicémie.

Mots-clés: brûlures pédiatriques, prévention, épidémiologie, traumatismes

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