Neonatal and Early Infancy Burns in the only Referral Burn Center in Northeast of Iran: Report of a Decade

ABSTRACT

Background: Burn in the neonatal and early infancy period (<6 months of age) is a relatively rare accident, but it can cause severe problems. This study is designed to evaluate the epidemiology and etiology of burn injury in neonatal and early infancy period.

Methods: In a cross-sectional study, we collected information about neonatal and early infancy burn injuries from the hospital information system in a 10-year period starting from January 1, 2007, in Imam Reza Hospital in the northeast of Iran. Data were analyzed by SPSS version 16.

Results: There were 3 neonatal and 47 early infancy burn injuries (0.7% of all burn injury admissions). All injuries occurred at home. The mean age was 122.3 ± 51.7 days and 31 (62%) were males. The mean percentage of burn total body surface area (TBSA) was 19.21 ± 11.44 (range = 3–55%). Mean of hospital stay was 11.9 ± 7.5 days. The fatality rate was 2%. The most common mechanisms of burn injury were scald (41, 82%) and flame (5, 10%). The most common hot liquid containers were kettle (21, 42%) and samovar (8, 16%). Explosion (28.50 ± 2.12) had caused the longest hospital stay. Patients burnt by hot liquid splashed from samovar had a more burnt TBSA (30.13 ± 10.71) than those burnt by other mechanisms (P = 0.04).

Conclusions: Hot beverages and food preparation simultaneous with child care are dangerous conditions which can cause burn injury in infants and neonates. The results of this study set a valuable background for running some prevention programs to prevent neonates and infants from burn injury.

Keywords: Burns, epidemiology, infants, neonate

INTRODUCTION

Burns are a major cause of mortality and morbidity in individuals of all age groups, especially in developing countries[1] and especially in the Middle East.[2] Iran with a young population pyramid is highly prone to these injuries.[3]

Globally, infants sustain a relatively small population of burn victims as indicated by research from developed and less developed countries.[4] Children younger than 5 years show a higher rate of fatality from burns compared with other age groups in both developing and developed countries.[5] Neonates and infants are more vulnerable to the consequences of any type of trauma.[6] Their defense mechanisms are not completely developed, and they hardly can resist against extensive changes in fluid and electrolyte encountered during major burn injuries. Given their tiny dermal coverage, any thermal injury can lead to a deep burn in these patients. Burning is the 11th cause of death in children between the ages of 1–9. Furthermore, in nonfatal childhood injuries, burning stands at the fifth place.[6] Fire burn is the fifth leading cause of unintentional injury death in the age group < 1 year.[7]
Ethics Committee of Mashhad University of Medical Sciences. Statistics in the US show that pediatric burn injuries are the third leading cause of unintentional death in children, which are only less than the number of children deaths in motor vehicle accidents and drownings. On the other hand, the few available kinds of literature are case reports of neonatal burn. We found three epidemiological studies in Pakistan (with 11 neonates), Nigeria (21 neonates), and South Africa. In the latter one, only 86 patients under the age of 4 months were admitted during a 37-year period. In our country, the situation is somehow different: burn injury in early infancy and neonatal period represents one of the notable forms of trauma. Although geriatric burn has been studied in Iran, to the best of our knowledge, no published study has focused on infants and neonates in Iran.

Even in survivors, the results of burns are devastating, and they may develop disfigurement or disability and also experience long hospitalization period, ostracism, and stigma. Burns may also cause cardiac insufficiency, muscle weakness, delay in growth, and loss of bone mass. These conditions are worsened by physical inactivity and prolonged bed rest. Children are also susceptible to Vitamin D deficiency as a result of less exposure to the sunshine. Due to the knowledge gap in this regard, the present study was performed to have a better and more detailed understanding of epidemiology, etiology, and morbidity of burns in this high-risk group in a 10-year period.

METHODS

In this cross-sectional study, we collected information of neonatal and early infancy (0–6 months old) burn injuries in a period of 10 years starting from January 1, 2007, in burn center of Imam Reza Hospital in Mashhad. This is the only referral burn center in Mashhad, as the second most populous city in Iran. Imam Reza Burn Center is a 100-bed department located in the largest referral teaching hospital in northeast of Iran. It admits burn patients from all age groups. Approximately 30% of admitted patients are children under 15 years. Annually ≥1000 burn patients from all provinces in the east of this country and some patients from neighborhood countries are admitted to this burn center.

The information of patients was extracted from the hospital information system. Any missed data were gathered from the medical records. Furthermore, the mechanism and agent of burn injury were collected from physicians’ and nurses’ notes and records of the burn ward. No exclusion criterion was considered. The study protocol was approved by the Ethics Committee of Mashhad University of Medical Sciences.

We used the SPSS (SPSS Inc.) for data analysis. Descriptive analysis was performed by reporting the frequency and percentage of burns for each mechanism, agent, and container. The continuous variables (i.e., the length of hospital stay [LOH], burnt total body surface area [TBSA], and age) were described by mean ± standard deviation (range). The inferential analysis was performed using one-way ANOVA test. The level of significance was considered at \( P < 0.05 \).

RESULTS

During the study period, there were 3 neonatal and 47 early infancy burn injuries (0.7% of all burn injuries admissions) including 31 male infants and neonates (62%). Mean age of the infants was 121.70 ± 50.77 (range = 7–180) days. Ninety-four percent (47) were discharged while 2 (4%) individuals discharged against medical advice and one of the cases (2%) died who was a 5-month-old infant with 31% burned TBSA. There was also a right foot amputation in a 6-month-old infant because of unsalvageable fourth-degree burn resulting from immersion of the foot in a pot full of very hot food. The hospitalization period was 11.94 ± 7.53 (range = 1–30) days, and the mean percentage of burn TBSA was 19.21 ± 11.44 (range = 3–55). Nearly half of the patients, i.e., 24 (48%) underwent surgery [Table 1].

Eighty-two percent (41) of burns were caused by scalds, followed by flame (5, 10%). Overall, the most common burning agent was hot water (35, 70%). In 21 cases (42%), kettle was the hot liquid container, while samovar accounted for 8 cases (16%) [Table 2].

Among different burn-causing objects in this study, the natural gas explosion had the longest LOH (28.5 ± 2.12) \( (P = 0.01) \). Moreover, flame (20.50 ± 9.39) caused the most lasting hospital stay among other burn agents [Table 2]. Furthermore, burn percentage was significantly related to burn-causing object: samovar caused the most burnt TBSA (30.13 ± 10.71) \( (P = 0.04) \). However, no statistical association was observed between mechanism and burnt TBSA. LOH was correlated to burnt TBSA \( (r = 0.31, P = 0.02) \), but no such correlation was found for age and burnt TBSA \( (r = 0.22, P = 0.12) \). The frequency of burn injury increased from 3 in patients less than 31 days to 18 in infants 151–180 days.

The information of location of burn accident was available for 90% (45) of admitted patients including kitchen (40, 88%), living room (4, 9%) and bathing room (1, 3%). The activity before burn incidence was as follow: 64% (32) of burn injuries occurred when parents were preparing or drinking tea,
followed by food preparation (8, 16%), room warming (4, 8%), and bathing (1, 2%).

**DISCUSSION**

In a 10-year period, 50 neonates and infants were hospitalized. Hot water was the most common burning agent, and the kettle was the most common container which caused burn injury. Furthermore, considering mechanisms, scald injuries were at the top of the list. Only one of the infants died during the study period. There was a significant relationship between the mechanism of burn and LOH. Furthermore, burned surface area was significantly associated with the object that caused burning.

We intended to assess the epidemiologic and etiologic features of neonatal and early infancy burns between 0 and 6 months of age in Mashhad. All severe cases of burn injuries in northeast of Iran (including children and adults) are referred to Imam Reza Burn Center in Mashhad. Neonates and infants are admitted to the pediatric burn ward and the most severe ones are transmitted to burn intensive care unit. We do not resuscitate infants with burns <10% TBSA by crystalloids routinely, but breastfeeding is encouraged unless there be another contraindication. In burns ≥10% TBSA, we start resuscitation by Ringer’s lactate solution according to Parkland formula. If the burn injury is severe enough to need to withdraw oral feeding, then a balanced glucose containing solution such as half saline dextrose 5% is considered as maintenance fluid, to prevent hypoglycemia.

We prefer conservative management in all scald injuries except the most severe ones with an obviously full-thickness damage. While management of burn patients is completely covered by insurance companies in this country, biologic and modern dressings are not covered by basic insurance and are not accessible for most patients. All superficial partial-thickness burns are covered by paraffin gauze as interface dressing after a thorough cleansing of the wound by tap water and debridement of sloughed blisters. In superficial burns with minimal exudative discharges, this interface dressing is left in place until the wound is completely re-epithelialized. An antibiotic or antiseptic cream or solution (nitrofurazone cream, 0.5% acetic acid solution, or mupirocin cream) is used intermittently on this interface dressing and is covered with a secondary fluffy dressing, and this secondary dressing is changed periodically. In wounds with moderate to profound exudative discharges, the dressing is changed as indicated. In patients who are referred with delay and infected deep burn wounds, mafenide acetate cream is preferred for limited

**Table 1: Epidemiologic findings of burnt neonates and infants during a 10-year period in Mashhad**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>LOH (days)</th>
<th>Burnt TBSA (%)</th>
<th>Age (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>19 (38)*</td>
<td>12.89±7.76**</td>
<td>20.66±11.10</td>
<td>122.26±43.79</td>
</tr>
<tr>
<td>Male</td>
<td>31 (62)</td>
<td>11.35±7.45</td>
<td>18.32±11.74</td>
<td>121.35±55.32</td>
</tr>
<tr>
<td>P</td>
<td>0.48</td>
<td>0.48</td>
<td>0.95</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Surgery</th>
<th>Frequency</th>
<th>LOH (days)</th>
<th>Burnt TBSA (%)</th>
<th>Age (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>24 (48)</td>
<td>15.88±7.46</td>
<td>18.56±12.62</td>
<td>117.75±52.54</td>
</tr>
<tr>
<td>No</td>
<td>26 (52)</td>
<td>8.31±5.61</td>
<td>19.81±10.45</td>
<td>125.35±49.84</td>
</tr>
<tr>
<td>P</td>
<td>&lt;0.001</td>
<td>0.70</td>
<td>0.60</td>
<td></td>
</tr>
</tbody>
</table>

*Data represented as n (%). **Data represented as mean±SD

**Table 2: Age, burnt total body surface area (TBSA) and length of hospitalization (LOH) in various burn mechanisms, agents and containers**

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Hot liquid/Burning agent</th>
<th>Container</th>
<th>Age (days)</th>
<th>Burn TBSA (%)</th>
<th>LOH (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scald burns</td>
<td>Water (35, 85%)</td>
<td>Kettle (21, 60%)</td>
<td>108.7±54.8*</td>
<td>17.5±9.6</td>
<td>11.9±6.5</td>
</tr>
<tr>
<td></td>
<td>Samovar (8, 23%)</td>
<td>Glass (1, 3%)</td>
<td>146.7±32.7</td>
<td>30.1±10.7</td>
<td>12.0±7.4</td>
</tr>
<tr>
<td></td>
<td>Baby bathtub (1, 3%)</td>
<td>Baby bathtub (1, 3%)</td>
<td>63</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Tea (3, 7%)</td>
<td>Tea pot (2, 67%)</td>
<td>155.5±23.3</td>
<td>30.0±17.3</td>
<td>10.7±10.8</td>
</tr>
<tr>
<td></td>
<td>Oil (1, 2%)</td>
<td>Unknown (1, 33%)</td>
<td>54.0±31.1</td>
<td>8.5±2.1</td>
<td>12.0±11.3</td>
</tr>
<tr>
<td></td>
<td>Food (2, 5%)</td>
<td>Unknown (1, 33%)</td>
<td>180</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pot (1, 100%)</td>
<td>140</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>Flame/fire</td>
<td>Primus cook stove (2, 40%)</td>
<td>Pot (2, 100%)</td>
<td>175.0±7.0</td>
<td>11.5±4.9</td>
<td>6.5±2.1</td>
</tr>
<tr>
<td></td>
<td>Fire accelerator (1, 20%)</td>
<td>-</td>
<td>74.5±68.5</td>
<td>14.8±8.4</td>
<td>15±15.5</td>
</tr>
<tr>
<td></td>
<td>Safety matches (1, 20%)</td>
<td>-</td>
<td>150</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Household fire (1, 20%)</td>
<td>-</td>
<td>171</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td>Explosion</td>
<td>Natural gas (2, 100%)</td>
<td>Liquefied petroleum gas cylinder (1, 50%)</td>
<td>62</td>
<td>30</td>
<td>14</td>
</tr>
<tr>
<td>Contact</td>
<td>Stove (1, 50%)</td>
<td>Natural gas network (1, 50%)</td>
<td>109</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Fire pan (1, 50%)</td>
<td>-</td>
<td>80</td>
<td>25</td>
<td>27</td>
</tr>
</tbody>
</table>

*Data represented as mean±SD in variables with at least two cases. The percentages are in cascading order: they can be summed to form a 100% of the left cluster for each row.
infected areas and 0.5% acetic acid plus 5% betadine solution is used for more extensive infected wounds. These patients are scheduled for debridement or excision as soon as possible after resuscitation is completed.

Obviously, full-thickness or deep partial-thickness wounds and burns which do not recover by conservative management are considered for surgical management. Tangential excision is the routine surgical practice for these patients and fascial excision is used rarely, if ever for very deep or heavily infected wounds. As the dermal layer is so thin in neonates and infants, harvesting a thick partial-thickness autograft can lead to a full-thickness unrepaired wound in donor site. Hence, we prefer to use a thin split-thickness graft as thin as 0.008 inches for most burn wounds except cosmetically important areas.

Considering the rarity of burns in neonatal and early infancy period, especially in developed countries, information is limited to some case reports, case series, and iatrogenic burns in premature or sick neonates in neonatal intensive care units. In a previous study performed by Ray in 1995 in children younger than 5 years, similar to our result, it was found that scalds were the most common cause of burning in children. However, in a case series of neonates, direct contact burn was the most common cause.

Age is considered as a risk factor in burn patient, and many indices of burn severity including Baux score and Abbreviated Burn Severity Index represent that mortality is directly correlated to age. However, it seems this correlation may be inverse in children. There was some inconsistency about the effect of age on mortality in children. While in some studies, mortality of children younger than 1 year was about two-fold more than older children, others did not consider young age as a risk factor of mortality in burnt children. The fatality rate in a case series including 11 neonates was 27.2%. The fatality rate in our study was 2%, which is lower than the fatality rate reported for infants in another research from this country. In that study in Tehran, 65 out of 282 patients <1-year age were deceased (23%). The mean of TBSA in those patients was 23.8, which is a little more than our patients. The overall fatality rate in all patients in this burn center at that period of time was about 21%, which is far more than neonates’ and infants’ fatality rate. In another study on preschool children in this center, the mortality rate of this group was 3.85%, which is near to mortality in smaller children in this study and far less than adults. The most common mechanism of burn injury in deceased children in that study was a natural gas explosion. It seems that the effect of young age on mortality needs more investigations and indices of severity in burnt children are different from adults.

We found that the most burn-causing object was kettle; however, in a similar research, the cup was the most frequent burn-causing object. Interestingly, in that study, 82% of burns, related to preparation or consumption of food, were scalds which have occurred during preparation or consumption of hot beverages, especially coffee. While in some other studies, bathtub scald is a common mechanism of injury in this study, scald injury during bathing was observed in only one patient. Burns in male infants were 1.6 times more common than females in this study. In another study on neonates, male-to-female ratio was 2.6. Some other studies also came to this conclusion that male burn victims are more prevalent, but those studies were performed on all children not exclusively on neonates and infants. It seems that male infants may be more active and can harm themselves by grabbing hot liquid containers while their parents or caregivers are preparing food or hot beverage, especially tea. Surprisingly, even when we analyzed data according to the age of patients, burn injury was more common in 1-, 2-, or 3-month-old males while grabbing skill is not yet developed in this age. Different features and tendencies between male and female infants may also be an explanation. Although Torabian and Saba found a significant association between mechanism and age, our study was performed in infants younger than 6 months and there was no relationship between age and mechanism of injury. As like Nguyen et al., the frequency of burn injury increased with age in our study.

While in most studies, explosions are categorized in fire/flame mechanism of burn injury, as regards the extensive and continuously developing natural gas network in this country and to an emphasis on the importance of explosions related to liquefied gas cylinders and domestic natural gas network, we considered this burns as a separate category. Burns related to natural gas explosions have unique features. They commonly have ≥1 victim, a large surface of the body, especially exposed areas including face and hands are injured, and inhalation injury is common in victims of explosions. In this study, victims of scalds in cases occurred due to samovar overturn, and flame/fire occurred in the household fire accident had the most burnt TBSA and victims of natural gas explosions stayed in the third position, but they had the longest LOH among all patients. Jay et al. and Lari et al. have previously declared that the flammable liquid was responsible for the severe injury. The mean burn percentage in an article by Tse et al. was far lower (4%) than our study (19.2%). Many practitioners may have been impressed by the tiny body of neonates and infants and prefer to hospitalize them. In this burn center, the mean of burnt TBSA in all hospitalized patients was about 30%, and it may show that neonates and infants are hospitalized with
smaller burns in comparison to adults in this center. A study accomplished by Koç and Sağlam[33] showed that the mean of LOH in the pediatric group (27.5 days) was longer than the average of our study (11.94 days), while the burnt TBSA in our study was larger (19.2% vs. 15.8%). The highest LOH was in respect to an explosion in ours, while in Western Australia study, it belonged to flame. Along with many expert professionals, a pediatrician expert in burns has been working as a member of the multidisciplinary burn team for many years in this center. While the overall mortality is reported to be 21% in this center[35] at that period of time, the low mortality in this age group may reflect appropriate management of neonatal and early infancy burn injuries in this center.

Family size is continuously decreasing in this country, and many young couples prefer to live independent and far from grandparents. In this condition, many young mothers have to do daily household chores while taking care of their children, and inadvertent burn injury in this situation may not be avoidable. Encouraging young couples to ask help of grandparents for child care during the 1st month of parenthood may be a way to reduce the risk of burn injury in this tiny and vulnerable population group. While another person is not available to help young parents, they must be aware of the risk of burn injury in newly capable to grabbing infants and put hot cups far from the reach of infants and drink hot beverages, while those are enough cold to prevent burn injury in their kids while they are toting them. Furthermore, putting hot liquid containers such as kettles and pots far from edges of tables and on the rear burners of stove may be a solution to prevent of burn injury in infants.

One of the limitations of our study was that depth of burns and probably inhalation injury in patients injured by fire/flame or explosion was not recorded in patient’s files, but as much as about one half of the patients underwent surgical excision and skin grafting, so it could be concluded that at least some burned areas in one half of the patients were deep enough to need to surgery. Another potential limitation is that the mild cases were not brought to a burn center and these results may have an underestimation. Burn injuries which were not severe enough to require in hospital care or severe ones who died before hospital admission are not present in this study. However, this is the first study in this country and one of a few published studies all around the world to focus on this vulnerable age group.

CONCLUSIONS

Hot beverages and food preparation simultaneous with child care are dangerous conditions which can cause burn injury in infants and neonates. Mothers’ education about dangers of child toting during tea preparation and drinking and encouraging young couples to ask help of grandparents for child care during the 1st month of parenthood can reduce burn injury in this group of patients. The results of this study set a valuable background for running some prevention programs to prevent neonates and infants from burn injury.

Acknowledgment

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Informed consent

The data were retrospectively driven from patients records and all names or personal identifiers were removed before data analysis

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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