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Paediatric Burns: a Thirteen-year Single-centre Retrospective Study in Croatia

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Abstract

Objective – Burn injuries (BI) are a great threat to children and are a significant therapeutic challenge. They demand prompt attention to avoid infection and scarring. The main goal of this paper is to analyse the demographic and clinical characteristics of BI in children treated in the Paediatric Intensive Care Unit (PICU), University Hospital of Split (UHS). **Patients and Methods –** The data of patients with BI admitted to the PICU from 2010 through 2022 were collected retrospectively from medical documentation. The subjects were analysed and stratified into groups according to age, sex, cause of burn, percentage of affected total body surface area (TBSA) and length of stay (LOS) in the PICU. **Results –** A total of 20 children were treated. Of these, 14 were boys and 6 were girls. The most common cause of burns in children was skin contact with hot liquids (60%). Burns affecting 10 to <20% of TBSA were found in 60% children. Children with TBSA <15% were significantly older than those with TBSA ≥15% (6.9±6.3 years *vs*. 1.9±1.9 years; P=0.022). The mean LOS in the PICU was 3.7 days. Most children had burns on their chest, legs and arms. **Conclusion –** There were no deaths or serious associated injuries, but burns caused significant morbidity, and disrupted the children's physical and emotional stability. As BI are preventable, awareness should be raised and burn prevention programmes should be encouraged, especially those intended for toddlers.

Key Words: Child ▪ Burns ▪ Intensive Care Units ▪ Paediatric.

Introduction

A burn implies an injury to the skin or other tissue caused by heat, radiation, electricity, friction, or contact with chemicals, as well as damage to the respiratory system that occurs due to smoke inhalation (1). The global burden of burn injury (BI) in children remains significant considering that nearly a third of all BIs occur in children under the age of 16 years, of whom the majority are under the age of five years. Furthermore, in countries with a prevailing low socioeconomic status, 50% of all BIs appear among infants and children under the age of 4 years (1-3). According to the World Health Organization (WHO), these injuries account for ~180,000 deaths annually around the world, and are the fifth most common cause of non-fatal childhood injuries (2). The mortality rate is highest in newborns and then decreases from the fourth year of life until adolescence, when it starts to increase again, probably due to greater exposure at work, or the tendency to risky behaviour (4).

Regarding the aetiology of BIs, studies report scald burns (involving contact with hot liquid, steam, or gas) as the most common cause of all paediatric burns (accounting for 62% of all cases), followed by flame burns (2, 3). However, the prevailing cause of BIs depends on the age of the child. Therefore,

scalds tend to be the most common type of thermal injury in children under the age of 5 years, accounting for over 65% of cases, while children older than 5 years more frequently sustain flame burns (52% of all cases) (1, 2, 5). Although electrical or chemical burns account for only a smaller proportion of events, they should not be neglected because of the specificity of their treatment and the possible mechanisms of prevention (6, 7).

There are several types of classification of BIs. Those involving both the depth of the burn and the percentage of total body surface area (TBSA) are the most frequently used (4, 8). The main criterion for determining the depth of the burn is the loss of epithelium, that is, the degree of loss of skin thickness. However, the traditional classification of burns (first, second, third or fourth degree) has been replaced by a classification system that implies the need for surgical treatment (8). Burns are currently classified as superficial, superficial partial-thickness, deep partial-thickness and full thickness (8). The term "fourth-degree burn" still serves for the deepest subgroup, with involvement of the fascia, muscle, and bones. While deep partial-thickness burns are usually treated with surgical procedures, full thickness and fourth-degree burns are treated with surgical excision and grafting (8, 9).

The assessment of the size of the burned skin surface is based on the proportion of the burned surface in relation to the total surface of the child's body. A modified Lund and Browder chart method compensates for the variations in body areas which occur with growth, and therefore can give a precise assessment of the size of the burned skin surface in children. It is the most used and most accurate method in children (10).

Burns can also be classified according to the overall severity of the BI into mild, moderate and severe (2). This classification depends on the depth of the burn, the percentage of the burned surface, the localization of the burn, the presence of inhalation injury, and the previous health status (8). Knowing that severe burns can induce a response that affects almost every organ system, identification of the injury mechanism can be helpful in detecting accompanying systemic manifestations. Every BI causes a hormonal and metabolic response, which can result in both local and systemic manifestations of different extents due to the severity of the initial injury (4). Inflammation, development of the systemic inflammatory response syndrome (SIRS), hypermetabolism, muscle wasting, hypoproteinaemia, potential development of the acute respiratory distress syndrome (ARDS), gastrointestinal, hepatic and renal dysfunction are all pillars of BI that need to be taken into consideration while dealing with severely burned paediatric patients (11-13).

Therefore, acute management of paediatric BIs varies from simple outpatient treatment to more complex emergency treatment, intensive care admission, and surgical interventions (14-16). According to the WHO's current Global Burn Registry (GBR) data, over half of paediatric patients who sustain major burns require treatment in a burn centre with a paediatric critical care unit (2). The goals of initial patient management include maintenance of overall homeostasis, while treating all the possible complications that appear as a consequence of the BI. Initial efforts are directed towards resuscitation, airway management and fluid substitution. Intermediate efforts are focused on managing multi-organ failure, and finally, efforts focus on chronic wound healing, pain management, recovery of functional capabilities, and rehabilitation (16). Many countries in the world have fully developed national programmes to prevent burns in children (17-19). The emphasis is on raising awareness about the threats of hot objects and liquids, and encouraging responsible behaviour to prevent burns in children.

The main purpose of this paper is to present the characteristics of burned children treated in the Paediatric Intensive Care Unit (PICU), University Hospital of Split (UHS) in Croatia. There is a scarcity of epidemiological data regarding burns in children in Croatia. The results of our study might help reveal needs in the community, to guide planning, local policy development or decision-making related to the education of parents and guardians of children, as well as childcare settings.

Patients and Methods

This was a cross-sectional study. Our study included all burned children under the age of 18 years admitted to the PICU, UHS, in the period from 1st January 2010 to 31st December 2022. Children lacking medical documentation regarding the aetiology and characteristics of their burns were excluded from the study. All data were obtained by analysing medical documentation from the medical history archives. The patients were categorized into two age groups: <2 years and 2-18 years. A previous Croatian study by Škarić et al. found a higher number of burned children in those up to two years of age (30). Therefore, to be comparable we used the same cut-off.

The data collected from each subject were: age, sex, body height and weight, as well as the TBSA affected by burns, the cause of injury, and length of stay (LOS) in the PICU. The patients were stratified into groups according to demographic data (age and sex), percentage of TBSA affected by burns, the cause of injury, and LOS.

Ethic Statement

The study protocol was approved by the Ethics Committee of the University Hospital of Split (2181-147-01/06/M.S.-20-02) and was conducted according to Declaration of Helsinki from 1975 and its amendments from 1983.

Statistical Analysis

Statistical analysis was performed using IBM SPSS software version 23 (IBM Corp., Armonk, NY, USA). Continuous variables were reported as means±standard deviations, and comparisons were conducted using an independent samples T-test. Categorical data, depicted in absolute figures along with the corresponding percentages, were subjected to Chi-square analysis for intergroup comparisons. When >20% of cells had an expected count less than 5, Fisher's exact test was used instead of the Chi-square test. Conclusions were drawn at a significance level of 0.05.

Results

During the thirteen-year period observed, a total of 24 children with BIs received treatment in the PICU. Among these, four were excluded from the study due to inadequate medical documentation concerning both the origin and the specifics of their burns. Subsequently, we examined the medical records of 20 children with burn injuries, with an average age of 4.9±5.5 years. Among them, 10 (50.0%) were under two years of age. Of the treated children, 14 (70%) were boys. The comparison revealed that no disparity was observed regarding gender distribution or TBSA, which averaged 13.9%±5.2% (Table 1). The mean duration of PICU stay was 3.7±1.7 days, ranging from two to a maximum of eight days. All the patients were discharged home, except one who was transferred to another hospital after five days of treatment. Of all the cases, 60% of children sustained burns from contact with hot liquids within their home environment. This comprised 20% with water, 15% with tea, 10% each with soup and coffee, and 5% with whey. Additionally, burns due to ignition involving petrol, gunpowder, gas from a gas bottle, or an unknown flammable liquid were experienced by two children each (10%). A statistically significant difference in burn aetiology was observed among the studied groups (Table 1), and when comparing hot liquid burns specifically with all other causes combined, a considerably higher proportion of children under two years of age (90%) suffered hot liquid burns compared to only 30% among those aged two years or older (P=0.020).

Out of all the children, 19 patients exhibited burns affecting multiple body regions. As indicated in Table 2, the predominant locations of burns were the arms (70%), chest (65%), and head (60%). Half of the patients had burns on their legs. The abdominal region was the least frequently affected area in children, followed by the back and neck, and lastly the genital and gluteal areas. When comparing affected regions by age, no statistical difference was found (Table 2).

Table 3 shows the distribution of burned body areas on the basis of the aetiology of the burns.

Table 1. Characteristics of Paediatric Burn Patients across Age Groups*

Characteristics	All patients (N=20)	<2 years (N=10)	2-18 years (N=10)	P-value
Age (years)	4.9±5.5	0.9±0.4	9.0±5.3	<0.001†
Gender				
Boys	14 (70.0)	6 (60.0)	8 (80.0)	0.628‡
Girls	6 (30.0)	4 (40.0)	2 (20.0)	
Weight (kg)	25.9±23.5	9.6±2.2	40.5±24.5	0.003†
Height (cm, N=10 available data)	120.6±46.8	75.4±7.3	150.7±34.5	0.002†
TBSA§ (%)	13.9±5.2	15.0±3.8	12.8±6.3	0.371†
Length of stay in PICU‖	3.7±1.7	3.4±1.5	3.9±2.0	0.532†
Aetiology				
Hot liquid	12 (60.0)	9 (90.0)	3 (30.0)	0.020‡
Petrol	2 (10.0)	0 (0.0)	2 (20.0)	
Gunpowder	2 (10.0)	1 (10.0)	1 (10.0)	
Gas bottle explosion	2 (10.0)	0 (0.0)	2 (20.0)	
Unknown flammable liquid	2 (10.0)	0 (0.0)	2 (20.0)	

*Continuous and categorical variables presented as mean±SD and frequency (percentage), respectively; †Independent samples T test; ‡Fisher's exact test; §Total Body Surface Area; ‖Paediatric Intensive Care Unit.

Table 2. Regional Distribution of Burned Body Areas in Paediatric Burn Patients across Age Groups*

Body area	All patients (n=20)	<2 years (n=10)	2-18 years (n=10)	P-value
Head	12 (60.0)	5 (50.0)	7 (70.0)	0.650†
Neck	3 (15.0)	3 (30.0)	0 (0.0)	0.211†
Chest	13 (65.0)	7 (70.0)	6 (60.0)	1.000†
Abdomen	4 (20.0)	4 (40.0)	0 (0.0)	0.087†
Back	3 (15.0)	2 (20.0)	1 (10.0)	1.000†
Arms	14 (70.0)	7 (70.0)	7 (70.0)	1.000†
Legs	10 (50.0)	6 (60.0)	4 (40.0)	0.371‡
Genitalia	1 (5.0)	0 (0.0)	1 (10.0)	1.000†
Gluteal region	1 (5.0)	0 (0.0)	1 (10.0)	1.000†

*Data presented as N (%); †Fisher's exact test; ‡Chi-square test.

Table 3. Regional Distribution of Burned Body Areas in Paediatric Burn Patients by Aetiology*

Distribution	Aetiology				
	Hot liquid (N=12)	Petrol (N=2)	Gunpowder (N=2)	GBE† (N=2)	UFL‡ (N=2)
Head	4 (33.3)	2 (100.0)	2 (100.0)	2 (100.0)	2 (100.0)
Neck	2 (16.7)	0 (0.0)	1 (50.0)	0 (0.0)	0 (0.0)
Chest	10 (83.3)	1 (50.0)	1 (50.0)	0 (0.0)	1 (50.0)
Abdomen	4 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Back	3 (25.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Arms	7 (58.3)	2 (100.0)	2 (100.0)	2 (100.0)	1 (50.0)
Legs	8 (66.7)	1 (50.0)	0 (0.0)	1 (50.0)	0 (0.0)
Genitalia	1 (8.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Gluteal region	1 (8.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

*Data presented as N (%); †Gas bottle explosion; ‡Unknown flammable liquid.

Burns caused by hot liquids affected multiple body regions, with as many as 83% of individuals burned by hot liquids experiencing burns on their chest, two-thirds having leg burns, and over half with burns on their arms. Nearly all individuals burned by other causes, including petrol, gunpowder, gas bottle explosions, and unknown flammable liquids, exhibited burns on their heads and arms. In some cases, among the patients burned by these causes, burns were also observed on the neck, chest, and legs, while other regions remained unaffected.

Regarding the TBSA, 12 children (60%) presented with burns covering an area between 10 to <20%, while four children (20%) had burns of 0-<10% and 20-<30% TBSA, with a maximum of 26.0%. Patients were categorized into two groups on the basis of TBSA: those with less than 15% and those with 15% or more. Children with a smaller burned TBSA, aged 6.9±6.3 years, were significantly older than those with a larger TBSA, aged 1.9±1.9 years; P=0.022. Considering burns caused by hot liquids compared to all other causes combined, 87.5% of burns ≥15% were caused by liquids, while liquids caused 41.7% burns in those with TBSA <15% (P=0.070). Furthermore, when comparing affected body areas, a difference was observed only for the head. Among those with <15% TBSA, the head was affected in 10 children (83.3%), whereas in those with ≥15% TBSA, it was affected in two children (25.0%), P=0.019.

Discussion

This study encompasses and analyses a total of 20 patients who were admitted and treated in our Unit within the observed thirteen-year period. Burn injuries affected more boys than girls overall, which is in accordance with the literature data (1, 20-23). One of the proposed explanations for this gender distribution is the riskier behaviour of boys compared to girls, caused by their greater impulsiveness and curiosity. This is particularly evident in older age groups, when external causes of burns come into play regarding the aetiology (1). As observed in other epidemiological studies, contact with hot liquid in a household with adults, but with a lack of supervision, emerges as the most common cause of burns (1-3, 20-23). Considering the aetiology of burns, a considerably higher proportion of children under two years of age (90%) suffered hot liquid burns compared to only 30% among those aged two years or older, which corresponds to literature data reporting scalds as the most common type of BI in children under the age of five (2). Accordingly, a Portuguese study showed that as many as 89% of children up to the age of five acquired burns from pouring hot liquid, most often in households (22). However, in countries with low socioeconomic status, such as Brazil, India or Bangladesh, where open flames are normally used for everyday activities such as cooking, flame injuries prevail (24).

The importance of awareness of the aetiology of BIs in certain age groups is the basis for designing preventive programs in order to minimize the prevalence of burns and, consequently, morbidity and mortality. It is concerning that a significant number of young children experience burns within their own homes. Prevention measures, such as childproofing and educating parents about potential hazards, are crucial to reduce these incidents. Parents should be advised not to leave their children unattended, especially those under two years, near hot drinks in the kitchen, and to keep a safe distance from hot liquids, such as coffee or soup, when sitting at the table, as was the case in our research. Children should not be allowed to play or wear loose clothing near a fire. It would also be useful to install safety guards around stoves and ovens (18, 25). If an injury does occur, it is important to know how to take care of it properly.

Since educators and teachers spend a large amount of the day with children, they may find themselves in a situation when providing first aid is required. Implementing simple education programmes for employees working in educational institutions would therefore provide a more secure environment, with staff capable of reacting properly and providing first aid in a timely manner (26-28). However, as a child grows up, the injury mechanism changes, resulting in ignition, explosion and

contact with open flames becoming the most prevailing source of injury. Therefore, specific preventive measures regarding adolescents should also be directed towards distribution policies for fireworks and other explosives (27).

Most of our patients suffered burns affecting 10-20% of their TBSA, with an overall mean treatment duration of 3.7 days. Although there is a clear association between the severity of the BI determined by the TBSA affected by burns, and the duration of treatment, our research did not show any statistically significant association, which can be attributed to our relatively small sample. However, it is generally known that the LOS in the PICU is determined by the surface and degree of the burn, mostly by complications that occur during treatment, such as infections (1, 29).

Hot liquids were found to be the most frequent cause of burns among our patients, especially among those who had ≥15% TBSA affected by burns. Therefore, a higher percentage of TBSA affected can be expected when hot liquids are the cause of burns. This underlines the importance of the causal factor when predicting the overall severity of a BI (3, 5).

As for the parts of the body affected by burns, the arms (70%), along with the chest (65%) and head (60%) were the most frequently burned regions, followed by the legs (50%). In a similar study conducted in Zagreb, the legs were the most affected region (61% of the cases) (30). Taking age into account, no significant difference was observed regarding the part of the body affected by burns. Considering that head burns can cause potentially fatal airway obstruction, all patients with such injuries require intensive care and treatment. Among our patients, these injuries were most commonly caused by contact with hot liquids. Likewise, hot liquids were mostly responsible for burns affecting the chest, arms and legs, as was reported by some other researchers as well (30–32).

There were no deaths, which is in line with the results of other studies showing low mortality (3, 29). Although this paper provides comprehensive data regarding the epidemiology, aetiology, severity and treatment duration of children with burns, it also has its limitations. The retrospective design of the study resulted in the need to analyse medical archives, which were often incomplete. Also, a limitation of our study was the short follow-up period. Furthermore, our sample was rather small, which can be ascribed to the fact that most children admitted to the UHS for burns are treated in the Department of Plastic and Reconstructive Surgery. Consequently, it can be presumed that the total number of children with burns that require hospital treatment in our hospital is greater than reported here.

Conclusion

The main goal of this paper was to elucidate the most important risk factors regarding the epidemiology and aetiology of BI, as well as to establish the major clinical characteristics of children with burns in the observed thirteen-year period. BIs are more common in younger children, with a significantly higher prevalence among boys. Scalds, that are mostly a consequence of contact with a hot liquid in the family home, tend to be the most common type of burns. Burns caused by hot liquids most frequently affect the arms, chest and head, which are therefore the most consistently burned body regions overall. Considering the preventable nature of burns, the emotional and physical burden that a BI represents to the child, the economic burden it imposes on the healthcare system, and given the possibility of chronic complications, the importance of establishing simple but practical preventive programmes is very evident. These programmes should operate at all levels, focusing on the child, and include parental, educational, and legal aspects. We believe that the data obtained from this study might be able to contribute to the development of preventive community programmes in the future.

Conflict of Interest: The authors declare that they have no conflict of interest.

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