

The influence of age on the frequency, manner of origin and outcome of burns in children

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ABSTRACT

Background: The aim of this study was to determine the impact of early treatment on the outcome of burns in children. An additional goal of the work is to determine the number of burns with regard to the age and sex of the patient, the number of burns with regard to the percentage and degree of the burned surface, the type of etiological factor that caused the burn and ways of treating burns in children.

Methods: This study included patients hospitalized for burns between the ages of 0 and 18 years. We analyzed the connection between the age of the child and the frequency of burns, the type of burns that may result from contact with hot liquids, open flames and pyrotechnics, and the outcome of treatment which may or may not result in scarring. An assessment of the total burnt body surface was measured according to Berkow's rule.

Results: This study proved that the highest frequency of burns occurs in children under five years of age, and that the way in which burns are caused in 97.4% of cases is contact with hot liquid. In 71.8% of burns cases in children up to five years of age, these are medium-severe, second-degree burns. The outcome of the treatment of children up to five years of age was no scarring in 92.3% of cases.

Conclusion: The results of this study showed that the highest incidence of burns is in children younger than five years, that the most common cause of burns in children is hot fluid, that conservative treatment is the most common, and that the outcome is no scarring. In most cases, the burns are moderate, second-degree burns, whereby the total burnt area of the body is mostly 0-20%.

Key words: Burns, children, body tissue, treatment outcome

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INTRODUCTION

Burns or thermal injuries are injuries that occur when a heat source or chemical destroys part or all of the layers of cells that make up human skin (1). The clinical picture of burns mostly depends on the classification of burns, so in younger children, burns with hot liquids most often occur as an accident in the kitchen or bathroom, while in older children, burns are more often caused by ultraviolet radiation and accidents using chemicals (2). In most cases, the skin is often the burnt part of the body, but the tissues under the skin, as well as the internal organs, can be burned even when the skin is not damaged (1). According to the degree of burn, we divide it into: first-degree burns (superficial burns because they affect the surface layer of the skin, epidermis), second-degree burns (affecting the epidermis entirely), third-degree burns (subdermal burns, affecting the epidermis, the entire dermis and a smaller or larger subdermis), fourth-degree burns (in addition to the skin, deep structures are also severely affected: subcutaneous tissue, muscles and bones) (3). With regard to children, in addition to assessing the depth, it is also important to assess the burned area of the body. Different rules, modified for children, are used to estimate the size of the burnt area, because in addition to body parts, age is also taken into account (4). A quick estimate of the burnt area is calculated by the Palm Rule, which represents 1% of the total body area. The Berkow or Lund-Browder rule is more precise because it takes into account body parts and age. According to this rule, for a child under one year of age, the neck and head represent 18%, the torso both front and back, 18%, each arm, 9% and each leg 14% of the total body surface area. For each subsequent year of life, the head loses 1% and each leg gains 1% (5). Evaluating these parameters, burns were categorized into mild, moderate and severe (6). Mild burns are generally treated conservatively, while moderate and severe burns, depending on the degree of burns, are treated with surgical excision (debridement) and early covering of

the damage by skin grafting. In most cases, burns in children are mild or moderate and mostly heal without scarring (7). Heating the tissue beyond physiologically viable limits results in the destruction of biological tissue; for this reason, many complications relating to burns arise. Any contact with objects, liquids, gases and vapors with a temperature higher than 70 °C leads to a burn disease in the contact tissue. When heating tissue to several hundreds or thousands °C, excessive excess heat leads to direct carbonization of the tissue. As a result of a burn injury, there can be total destruction of the cells of the exposed tissue, and in the surrounding tissues, there is partial disruption of the structure and function of the tissue. Regarding milder burn forms, there is a smaller or larger delamination of the epithelium and an accumulation of exuded liquid, which creates blisters called bullae. A large amount of thermal energy turns the tissue substance into a strong inflammatory factor, which leads to the initiation of a strong inflammatory reaction and considerable pain, and in severe cases, a systemic inflammatory response occurs in the form of systemic inflammatory response syndrome. Such a strong inflammatory reaction leads to a catabolic reaction; in order to provide substances for the healing process, the metabolism is accelerated and the synthesis of proteins in the acute phase of inflammation is enhanced. As a result of damage to blood vessels, bleeding occurs; there is increased permeability as a result of which macromolecules are exudated from the plasma. Damage to the skin or mucous membranes makes it easier for infections to enter, and the risk of developing sepsis and septic circulatory collapse increases (8).

The aim of this study was to determine the impact of early treatment on the outcome of burns in children. An additional goal of the work is to determine the number of burns with regard to the age and sex of the patient, the number of burns in relation to the percentage and degree of the burned surface, the type of etiological factor that caused the burn and methods of treating burns in children.

PARTICIPANTS AND METHODS

Subjects

This study includes all hospitalized patients for burns treated at the Department of Pediatric Surgery, Clinic of Surgery, University Clinical Hospital Mostar in the period from January 1, 2010 to December 31, 2019. The study group consists of all children aged 0 to 18, divided into three groups; preschool children (0–5), school-age children (6–13) and adolescents (14–18). We include patient arrival times at the hospital in the research, which we divide into three groups, namely, patients who arrived within 24 hours, after 24 hours and after 48 hours from the time the burn occurred. Based on the protocol, medical history and discharge letters of treated patients, we determine the nature of the burns, estimate the total burnt body surface according to Berkow's rule, which divides the burns into mild, moderate and severe, and determine the degree of the burns. We include in the research the impact of early treatment on the outcome of burns in children.

Methods

For this cross-sectional research, we collected data by considering the medical documentation, medical histories and discharge letters of patients aged 0 to 18 years and hospitalized for burns at the Pediatric Surgery Department of the Surgery Clinic at the University Clinical Hospital Mostar in the period from 01.01.2010 to 31.12.2019.

Data on patients were collected from the Hospital Information System (BIS) based on medical documentation in the form of medical history.

The connection between the child's age and the frequency of burns was analyzed, as well as the way in which the burns occurred, which can be the result of contact with hot liquid, an open fire or pyrotechnics, and the outcome of treatment, which may or may not result in scarring.

The parameters that will be considered in hospitalized patients due to burns are: age, sex,

time of arrival at the hospital, method of burn injury, assessment of the total burned body surface according to Berkow's rule (5), involvement of the body surface, degree of burn, method of burn treatment and outcome of burn treatment.

Statistical analysis

The chi-square test was used to compare nominal variables. When the expected frequency was missing in the comparison of categorical variables, Fisher's exact test was used. The possibility of error is accepted at $\alpha < 0.05$, and differences between groups were accepted as statistically significant for $p < 0.05$. The software system SPSS for Windows (version 23.0, SPSS Inc., Chicago, Illinois, USA) and Microsoft Excel (version 10, Microsoft Corporation, Redmond, WA, USA) were used for statistical analysis.

RESULTS

In most cases, the way burns occur across both sexes is contact with a hot liquid. In boys, the cause of burns is usually an open fire, whereas this outcome is statistically less likely among girls. Arrival times in hospital within 24 hours in both sexes were statistically equal. In most cases, the male sex has an arrival time after 48 hours. According to the variable of the total burnt body surface, the first group of 0-10% is the most common among males, and the second group of 11-20% is the most common among females. The second-degree burn variable is the same for both sexes. In females, we see a significant statistical deviation from third-degree burns. The burn category parameter is equal as regards the moderate category in both sexes. A significant statistic is that the light category of burns is more prevalent in males, and the severe category of burns is more prevalent among females. Across both sexes, the method of treatment is, in most cases, conservative treatment. In most cases, the treatment outcome of burns in both sexes is no scarring (table 1).

Table 1. Comparison of research results by sex

	Sex				χ^2	p
	M		F			
	n	%	n	%		
Time of arrival					1.375	0.733*
Up to 24 h	32	84.2	19	82.6		
24-48 h	1	2.6	2	8.7		
>48 h	5	13.2	2	8.7		
Cause of burns					4.091	0.160*
Hot liquid	28	73.7	20	87.0		
Open fire	9	23.7	2	8.7		
Pyrotechnics	0	0.0	1	4.3		
Acid	1	2.6	0	0.0		
Total burnt body surface					2.610	0.447*
0-10%	20	52.6	9	39.1		
11-20%	13	34.2	12	52.2		
21-30%	4	10.5	1	4.3		
31-50%	1	2.6	1	4.3		
Degree of burn					2.728	0.310*
1	3	7.9	1	4.3		
2	30	78.9	15	65.2		
3	5	13.2	7	30.4		
Category of burns					4.026	0.135*
Easy	8	21.1	3	13.0		
Medium	29	76.3	16	69.6		
Heavy	1	2.6	4	17.4		
Method of treatment					2.364	0.326*
Conservative	34	89.5	18	78.3		
Dressing with “Suprasorb A+Ag”	4	10.5	4	17.4		
Skin transplantation	0	0.0	1	4.3		
Treatment outcome					0.067	0.749*
No scar	29	76.3	19	82.6		
Scarring	9	23.7	4	17.4		

*Fisher's exact test

The cause of burns for patients up to five years of age is, in most cases, a hot liquid. In a very small number of cases involving children up to five years of age, the cause of burns is an open fire. In the age group older than five years, the cause of burns is an open fire and hot liquid. In

very rare cases, burns occur as a result of pyrotechnics or acid. In most cases, for both age groups, the arrival time in hospital was within 24 hours. We divided the parameter of the total burnt body surface into four groups: 1. 0-10%, 2. 11-20%, 3. 21-30%, 4. 31-50% (table 2).

Table 2. Comparison of research results by age groups of patients

	Age groups				χ^2	P
	<5		>5			
	N	%	n	%		
Time of arrival					0.298	<1*
Up to 24 h	32	82.1	17	85.0		
24-48 h	2	5.1	1	5.0		
>48 h	5	12.8	2	10.0		
Cause of burns					24.402	<0.001*
Hot liquid	38	97.4	8	40.0		
Open fire	1	2.6	10	50.0		
Pyrotechnics	0	0.0	1	5.0		
Acid	0	0.0	1	5.0		
Total burnt body surface					1.338	0.826*
0-10%	18	46.2	11	55.0		
11-20%	18	46.2	7	35.0		
21-30%	2	5.1	1	5.0		
31-50%	1	2.6	1	5.0		
Degree of burn					2.746	0.255*
1	2	5.1	2	10.0		
2	31	79.5	12	60.0		
3	6	15.4	6	30.0		
Category of burns					0.453	0.907*
Easy	8	20.5	3	15.0		
Medium	28	71.8	15	75.0		
Heavy	3	7.7	2	10.0		
Method of treatment					3.153	0.218*
Conservative	35	89.7	15	75.0		
Dressing with “Calcium-alginate fibers with 1.5% ionic silver”	4	10.3	4	20.0		
Skin transplantation	0	0.0	1	5.0		
Treatment outcome					11.422	<0.001*
No scar	36	92.3	10	50.0		
Scarring	3	7.7	10	50.0		

*Fisher's exact test

For the age group up to five years, I found that the first two groups of burnt body surfaces were equal. For the age group consisting of patients older than five years, the largest percentage of burnt body surface area was found in the first group. According to statistics relating to children making up the age group under five years, I have proven that in most cases, these children are suffering from second-degree

burns. Regarding the age group of patients older than five years, second-degree burns are most common. Analyzing the parameter of the category of burns, I found that in both age groups, the most common category of burns is moderate. The most common treatment for patients in both age groups is conservative treatment. By researching the treatment outcomes of patients in both age groups, I

noticed significant statistical differences. In the age group up to five years, the outcome of treatment is no scarring, while in the age group older than five years, the number of patients with and without scarring are comparable. Using a statistical test, significant differences were observed in the variables that result in burns occurring and the outcome of burn treatment (table 2).

The results of the research proved that the most common cause of burns among hospitalized patients is hot liquid. In some cases, the cause of burns is an open fire, while in a very small number of cases, burns are caused by pyrotechnics or acid (figure 1).

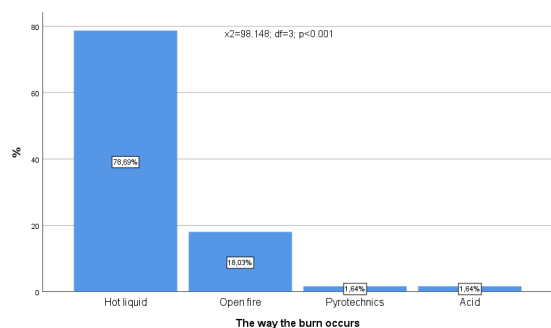


Figure 1. Percentage of respondents according to the cause of burns (n = 59).

The outcome of the treatment of burns was no scarring among a large number of hospitalized patients. In a smaller number of patients, the outcome of the treatment was scarring (figure 2).

In the case of patients who attended hospital within 24 hours, the cause of the burn was in most cases hot liquid and the total burned body surface was the same in the first two groups of 0-10% and 11-20%.

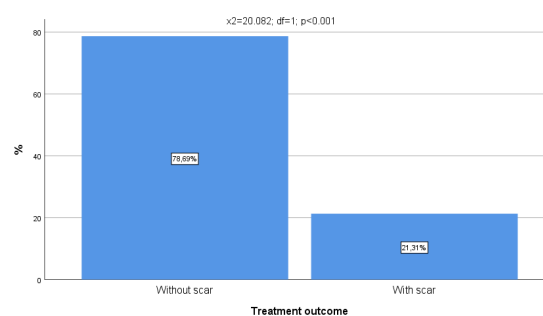


Figure 2. Percentage of subjects according to treatment outcome (n = 59).

Patients hospitalized within 24 hours of the onset of the burn were suffering from second-degree burns in most cases, and the burn category was moderate. The method of treatment for patients hospitalized within 24 hours is conservative treatment. The outcome of the treatment of patients hospitalized within 24 hours is no scarring. In the case of patients who are hospitalized 24-48 hours after the burn, the cause of the burn is generally hot liquid. The total burned body surface of patients hospitalized within 24-48 hours is 0-10%. Patients hospitalized within 24-48 hours are generally suffering from second-degree burns and the categories of burns are statistically equal, either mild, moderate or severe. The method of treatment for patients hospitalized 24-48 hours after suffering a burn is in most cases conservative, and the outcome of the treatment is no scarring. Patients hospitalized after 48 hours of being burned were, in most cases, burned by hot liquid, the total burned body surface was 0-10%, the burn degree was second-degree and the burn category was light. For patients hospitalized more than 48 hours after a burn, the treatment method is conservative in most cases. The outcome of the treatment of patients hospitalized 48 hours after being burned is, in most cases, no scarring (table 3).

Table 3. Comparison of survey results by time of arrival in hospital

	Time of arrival						χ^2	p
	Up to 24 h		24-48 h		>48 h			
	n	%	n	%	n	%		
Cause of burns							4.612	<1*
Hot liquid	39	76.5	3	100.0	6	85.7		
Open fire	10	19.6	0	0.0	1	14.3		
Pyrotechnics	1	2.0	0	0.0	0	0.0		
Acid	1	2.0	0	0.0	0	0.0		
Total burnt body surface							3.222	0.806*
0-10%	22	43.1	2	66.7	5	71.4		
11-20%	22	43.1	1	33.3	2	28.6		
21-30%	5	9.8	0	0.0	0	0.0		
31-50%	2	3.9	0	0.0	0	0.0		
Degree of burn							3.828	0.345*
1	4	7.8	0	0.0	0	0.0		
2	39	76.5	2	66.7	4	57.1		
3	8	15.7	1	33.3	3	42.9		
Category of burns							13.489	0.003*
Easy	7	13.7	1	33.3	3	42.9		
Medium	42	82.4	1	33.3	2	28.6		
Heavy	2	3.9	1	33.3	2	28.6		
Method of treatment							12.422	0.008*
Conservative	46	90.2	2	66.7	4	57.1		
Dressing with “Suprasorb A+Ag”	5	9.8	0	0.0	3	42.9		
Skin transplantation	0	0.0	1	33.3	0	0.0		
Treatment outcome							1.228	0.558*
No scar	41	80.4	2	66.7	5	71.4		
Scarring	10	19.6	1	33.3	2	28.6		

*Fisher's exact test

DISCUSSION

This study proved that the highest frequency of burns occurs in children under five years of age, and that most burns are caused by contact with a hot liquid. The burns are mostly moderate and second-degree, with a total burned surface of the body of 0-20%. Such burns are most often treated using a conservative method of treatment and the outcome of the treatment in most cases is no scarring. Such research results can be explained by the curiosity of children at

that age and the burn being caused accidentally, often due to parental inattention. Burns in children up to five years old are caused by contact with a hot liquid in 97.4% of cases. In 71.8% of burns among children under five years of age, these are moderate, second-degree burns. A total burned body surface involving 0-20% of the body surface was proven in 92.4% of cases. In 82.1% of cases, such children were hospitalized within 24 hours of the onset of the burn. Hospitalized children were treated conservatively in 87.9% of cases. The outcome

of the treatment of children under five years of age was no scarring in 92.3% of cases. Observing the results of all the aforementioned parameters, I proved that the highest frequency of burns occurs among children up to five years old. In 97.4% of cases, burns are caused by contact with hot liquids in patients under the age of five. Therefore, I proved that the highest frequency of burns in children up to five years old occurs due to contact with hot liquid. For both sexes, the method of treatment in most cases is conservative treatment, in 89.5% of men and 78.3% of women. This proves that the most common form of burn treatment is conservative treatment. The outcome of burn treatment is no scarring in 78.69% of hospitalized patients, which confirms that the most common outcome of burn treatment is no scarring. The majority of previous studies primarily dealt with the etiological causes of burns in children under five years of age, comparing the most affected parts of the body (9, 10). All studies agree that the largest number of burns among children under the age of five are caused by hot liquids, most often hot water. Kemp A.M. et al. claim that the highest frequency of burns, in 72% of cases, occurs in children under five years of age and that in 55% of cases, these are caused by hot liquid as a result of an accident in the kitchen. In this study, in 50% of cases, the wounds healed with a scar (10). One possible reason for the different outcome of burn wound healing is a greater degree of burn, a greater percentage of burned body surface and a more severe form of burn. Begum F. et al. proved that in 51.3% of children under five years of age, burns were caused by hot liquid, and that in 50% of cases, the lower limbs were burned (9). Research conducted by Tarim A. et al. was based on burns caused by hot liquid, either hot water or hot milk. In 67.9% of patients living in urban areas, the burn was caused by hot water, and in 33.6% of patients living in rural areas, it was caused by hot milk. This research proved that antibiotics are used in 78% of burns caused by hot milk (7). With regard to treatment in this research, in 87.9% of cases, treatment was conservative, while in the research conducted

by Lee K.C. et al. most of the treatment was based on dressing the burn with calcium-alginate fibers, with 1.5% ionic silver (11). Such deviation can be explained by the more frequent infections of burn wounds, a higher degree of burn and a higher percentage of the burned body surface. In this cross-sectional study, there were limitations in the form of a small number of hospitalized patients, due to the burns and a time-limited study. Despite the aforementioned limitations resulting from the high frequency of burns in children under five years of age, it is important to conduct research of this kind, in order to draw parents' attention to this important health problem. Burns in children are not harmless, they not only cause severe pain, they also cause psychological trauma, as wound dressing is carried out under total anesthesia in the operating theater and is a very painful and traumatic event. Burns also cause physical trauma in the form of scars, which can reduce future working capacity and limit the future life of a child. With this research, I would like to highlight the relatively large number of children with burns, who are most often burned up to the age of five in the family home, and wish to stress the importance of preventing burns.

CONCLUSION

Based on the results of this study, it can be concluded that the highest incidence of burns occurs in children under five years of age, that the most common cause of burns in children is hot fluid, that conservative treatment is used most frequently and that the outcome is scarring. In most cases, burns are moderate, second-degree burns and the total burnt area of the body is usually 0-20%.

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CONFLICT OF INTEREST

The author(s) declare no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

AUTHORS' CONTRIBUTIONS

ŽM: contribution to study conception and design, literature review, acquisition of data, writing of the paper, interpretation of data, critical revision of the paper; VŠČ: contribution to study conception and design, supervision, critical revision of the paper, assistance in writing the paper.

ETHICAL BACKGROUND

Statement of the institutional review board: The experimental protocol was approved by the Ethics Committee of the Faculty of Medicine at the University of Mostar. The study was conducted in accordance with the guidelines of the Declaration of Helsinki and approved by the Ethics Committee at the University Clinical Hospital Mostar, no. 648/20 from 28.07.2020.

Informed consent statement: Informed consent was obtained from all subjects involved in the study.

Data availability statement: We deny any restrictions on the availability of data, materials and associated protocols. Derived data supporting the findings of this study are available from the corresponding author on request.

REFERENCES

1. Kvesić A. and associates. Surgery. Zagreb: Medicinska naklada 2016; 856–65.
2. Palao R, Monge I, Ruiz M. Chemical burns: pathophysiology and treatment. *Burns*. 2010;36:295-304.
3. Chan QE, Barzi F, Cheney L, Harvey JG, Holland AJ. Burn size estimation in children: still a problem. *Emerg Med Australasia*. 2012;24:181-6.
4. Hettiaratchy S, Papini R. Initial management of a major burn: II – assessment and resuscitation. *BMJ*. 2004;329:101-3.
5. Rispoli D. Rule of Nines; c2014 [cited 2014 Dec 16] Available from: [http://www.wheelessonline.com/userfiles/fig%204\(4\).jpg](http://www.wheelessonline.com/userfiles/fig%204(4).jpg)
6. Hettiaratchy S, Dziewulski P. Pathophysiology and types of burns. *BMJ*. 2004;328: 1427-9.
7. Tarim A, Nursal TZ, Basaran O, Yildirim S, Türk E, Moray G, et al. Scalding in Turkish Children: Comparison of Burns Caused by Hot Water and Hot Milk. 2006;32:473-6.
8. Demling RH. The burn edema process: current concepts. *J Burn Care Rehabil*. 2005;26:207-27.
9. Begum F, Khajuria A, Abdi H, Williams A, Jones I, Villapalos JL et al. In Hot Water: The Impact of Burn Injuries From Hot Water Bottles - Experience of a UK Burns Unit and Review of the Literature. 2019;45:974-982.
10. Kemp AM, Jones S, Lawson Z, Maguire SA. Patterns of Burns and Scalds in Children. *Arch Dis Child*. 2014;99:316-21.
11. Lee KC, Joory K, Moiemmen NS. History of burns: The past, present and the future. *Burns Trauma*. 2015;2:169.