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Paediatric ICU burns in Finland 1994–2004

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ABSTRACT

Introduction: The paediatric burn population requiring intensive care in Finland has never been examined before. The aim of this study was firstly to determine the aetiology, incidence and prognosis of paediatric burns requiring intensive care in Finland and secondly to compare the possible differences between the two national burn centres.
Methods: All burn patients' charts were retrospectively reviewed in two national burn centres from an 11-year-period. Patients whose ICU stay was more than 48 h, were included.
Results: Forty-five children who were hospitalized in the two burn centres during the study period met the inclusion criteria. They represent 2.4% (45/1898) of all burns victims hospitalized in these burn centres during that time giving an incidence of 0.1/100,000 per year in Finland. The median age was 5 years, every third patient was 0–2 years old and 75.6% were male. Most burns were scalds (42.2%), which caused all burns (100%) in age group 0–2 years. Flame burns were most frequent (83%) in the age group 6–10 years. In the 11–16 years old patients, high voltage/electric burns caused 50% of all burns and flame the other 50%.

The overall median TBSA in all burns was 26%. The median (range) hospital stay was 12 days (2–193) (0.88 days/% burned) and the median (range) ICU days was 7 (2–64) (0.29 days/%). Intubation and respirator therapy was needed in 31 (46%) patients. There were no patients who needed haemofiltration or haemodialysis and no mortality.

Only six patients (13%) were treated conservatively and 39 (87%) surgically. Dressing changes under general anaesthesia were preferred in Helsinki (37 times) and especially in the paediatric hospital (32 times) compared to Kuopio (7 times). Allografts were used only in Helsinki in 4 patients whereas artificial skin was used only in Kuopio in 15 patients. The overall cost of care was very similar in both centres being 1292–1425 euros per hospital day.
Conclusions: There were some small differences between the two burn centres in treatment policies. Most patients were male and most common aetiology was scald. The prognosis of these patients was excellent with no mortality.

1. Introduction

Children are at great risk for burn injuries because of their natural curiosity, impulsiveness and less acute perception of dangerous situations. Various epidemiologic studies have been performed concerning paediatric burns all over the world [1–15]. Also, there are only a few articles on aetiology or incidence of paediatric burns requiring intensive care [16].

Although success in treating these patients is highly rewarding, paediatric ICU burns are challenging to both

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caregivers and the patients. The prognosis of massive burns in children is excellent when treated aggressively in specialized burn units [13,17]. However, the prognosis of small children, less than 3–4 years old, is worse than in older children [7,13]. The reported mortality in paediatric burns varies from 0.2% [8] to 10.2% [10].

The aim of this study was firstly to determine the aetiology, incidence and prognosis of paediatric burns requiring intensive care in Finland and secondly to compare the possible differences between the two national burn centres.

2. Materials and methods

The study protocol was approved by the ethical committees of both University Hospitals. All children aged 0–16 years that were hospitalized in the Burn Units of University Hospital of Kuopio and the University Hospital of Helsinki 1994–2004 and required intensive care due to their burns for more than 2 days were included in this retrospective study. The indicators for intensive care were either burn extent itself, facial or laryngeal oedema with the possibility of needing intubation or the need for close monitoring of adequate fluid resuscitation. Patients with a less than 48 h stay in the ICU were excluded, because of the nature of their injury. These children had sustained II° burns but needed short monitoring to ensure adequate fluid therapy and to monitor the development of possible laryngeal oedema. We did not consider them as ''true'' ICU patients. The 0–7-year-old patients in Helsinki were treated in a paediatric hospital by the same plastic surgeons that treat the other burn patients in Helsinki Burn Centre.

The reviewed data included age, gender, burn size (TBSA %), presence or absence of inhalation injury, burn aetiology, the length of hospitalisation and stay in the ICU. Also the data relating to patient transfer, operative and conservative treatment, day of first operation (excision), the use of autografts, allografts and artificial skin, respirator days and the presence of sepsis, need for haemofiltration, mortality, cost of care and the discharge pattern were recorded.

The patients were divided into four age groups based on the behaviour of children (i.e., newborn to 2 years, 3–5 years, 6–10 years and 11–16 years). The data was retrospectively collected from patient charts and the cost analysis was based on the data obtained from the hospitals' billing departments including all costs of care during hospitalization (regular hospital days, ICU days, operations, wound care products, etc.).

Tertiary hospital care in Finland is divided into five areas of responsibility lead by five university hospitals. The area of responsibility of Helsinki University Hospital consists of 1.73 million people and that of Kuopio University Hospital of 870,000 people. The burn patients coming to these two burn centres from their own areas of responsibility were used separately to calculate the nationwide incidence of paediatric ICU burns.

Table 1 – Demographic comparison of excluded and included study patients

	Excluded	Included
N	22	45
Gender		
Female	8	11
Male	14	34
TBSA (median)	15%	26%
Age (median)	1	5
Aetiology		
Scald	86%	38%
Flame	9%	36%
High voltage	5%	21%
Steam	0%	5%
Intubation (N)	2	18
Length of hospital stay (median) (days)	10	18

3. Results

Sixty-seven children who were hospitalized in the two burn centres during the study period were treated in the intensive care unit due to their burns. Of those, 22 patients were admitted to the ICU for less than 48 h resulting in 45 patients who met the definite inclusion criteria (Table 1). They represent 2.4% (45/1898) of all burns victims hospitalized in these burn centres during the same time. The demographics of these patients are presented in Table 2. The median age was 5 years, every third patient was 0–2 years old and 75.6% were male.

The aetiology of the burns is presented in Fig. 1. Most burns were scalds (42.2%), which caused all burns (100%) in age group 0–2 years. Flame burns were most frequent (83%) in the age group 6–10 years. In the 11–16 years old patients, high voltage/electric burns caused 50% of all burns and flame the other 50%. There were two suicide attempts with high voltage in this group, 14 and 16-year-old boys, and all of the electric burns occurred around train power lines.

The median total body surface area burned was 17% in group 0–2 years, 37.5% in group 3–5 years, 27% in group 6–10 years and 35% in group 11–16 years. The overall median TBSA in all burns was 26%. The boys in the age groups 6–10 and 11–16 had larger burns than girls. The median TBSA in all patients treated in Kuopio and Helsinki Burn Units was 27% and 24%, respectively. The distribution of burn extent is presented is Fig. 2.

Table 2 – Age and sex distribution of the patients, N (%)

	0–2 years	3–5 years	6–10 years	11–16 years	Total
Male	13 (28.9%)	7 (15.6%)	4 (8.9%)	10 (22.2%)	34 (75.6%)
Female	2 (4.4%)	1 (2.2%)	2 (4.4%)	6 (13.3%)	11 (24.4%)
Total	15 (33.3%)	8 (17.8%)	6 (13.3%)	16 (35.6%)	45 (100.0%)

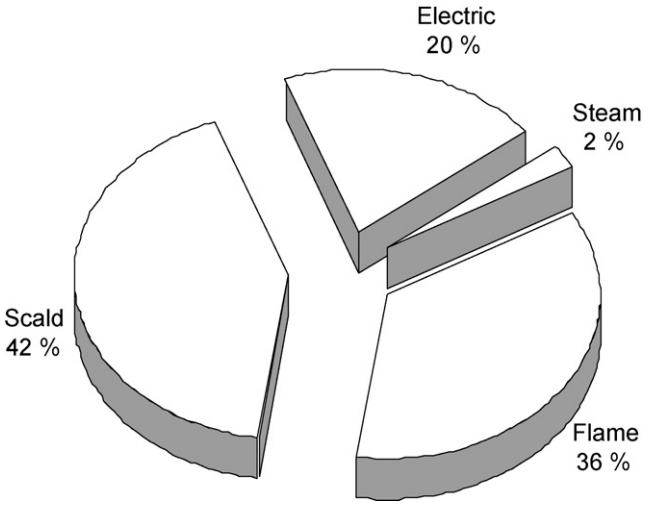

Fig. 1 – Aetiology of burns.

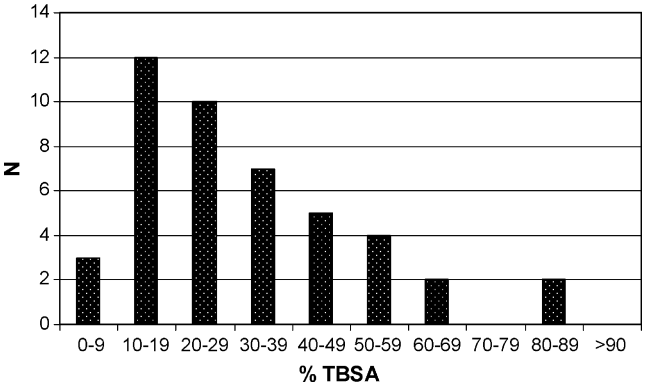

Fig. 2 – Distribution of burn extent.

Most burns involved the upper extremities (87%) and the trunk (82%). The anatomical locations of the burns of different aetiology are presented in Table 3.

The patients were referred to the burn unit from another university hospital (18%), central hospital (38%), local hospital (7%), health centre (7%) or directly from the site of the accident (31%). All patients excluding one were transferred to the burn centre within 24 h of the accident. Intubation prior to transfer was performed to 18 (40%) patients. The primary estimation of burned area in the referring unit was underestimated more than 10% in 11% (five patients) of cases and overestimated more than 10% in 9% (four patients) of cases compared to the final estimation performed in the burn unit. The ranges of under- and overestimation were 2–36% and 1–45%, respectively.

The median (range) hospital stay in the whole study group was 18 days (2–193) (0.88 days/% burned) and the median (range) ICU days were 7 (2–64) (0.29 days/%), with 0.35 days/TBSA% in Helsinki and 0.25 days/TBSA% in Kuopio (Table 4). Intubation and respirator therapy was needed in 31 (69%) patients. The median respirator time in these patients was 6 days. Four patients (6%) developed sepsis during their stay in the ICU. There were no patients who needed haemofiltration or haemodialysis and there was no mortality.

Six patients (13%) were treated conservatively and 39 (87%) surgically. A total of 68 operations were performed in Kuopio Burn Unit and 45 in Helsinki Burn Unit. The first operation was performed at mean 2.6 and 5.2 days post burning in Kuopio and Helsinki, respectively. Steam burns, flame burns, high voltage injuries and scalds were treated operatively in 100%, 100%, 90% and 58% of cases, respectively. Dressing changes under general anaesthesia were preferred in Helsinki (37 times) and especially in the paediatric hospital (32 times) compared to Kuopio (7 times). Allografts were used only in Helsinki in 4 patients whereas artificial skin was used only in Kuopio in 15 patients (10 patients with TransCyte® and 5 patients with Integra®). No free flaps were needed during the primary stay in hospital. The discharge pattern is described in Table 5. Almost half of the patients (42%) were discharged directly to home from the burn unit. The medium cost of care, TBSA% burned and length of stay in hospital presented in Table 6. The median cost of care per patient was similar in both burn units when the two hospitals in Helsinki were evaluated as one. The high cost of care in Helsinki Burn Unit was balanced by the low cost of care in the Paediatric Hospital.

4. Discussion

Treating major burns in centralized national burn centres has been shown to be cost effective and save lives [18]. Paediatric burns needing intensive care are a subgroup of burns within this category. Data relating to paediatric ICU burns in Finland has not been gathered before this conjoined study between the two national burns centres in Finland. Altogether demographic data on paediatric ICU burns is scarce.

This study showed, as most previous studies on paediatric burns [3–5,8,10–12,14], that scalds were the major cause of

Table 3 – Anatomical location of burns

Area/aetiology	Scald (%)	Flame (%)	Steam (%)	Electric (%)	Total (%)
Head	68.4	62.5	0	44.4	60.0
Neck	68.4	25.0	0	55.6	48.9
Chest	73.7	93.8	0	88.9	82.2
Back	31.6	56.3	100 (1 case)	55.6	46.7
Upper extremity	84.2	87.5	100 (1 case)	88.9	86.7
Lower extremity	47.4	62.5	100 (1 case)	77.8	60.0
Genitalia	15.8	18.8	0	33.3	20.0

Numbers represent percentage of cases involved.

Table 4 – Length of stay in hospital and ICU in two national burn centers (the data of two hospitals in Helsinki are presented individually)

	LOS	LOS/TBSA	ICU days	ICU days/TBSA
Kuopio	20 (3–193)	0.85	6 (2–64)	0.25
Helsinki	18 (5–48)	0.89	12 (2–29)	0.35
Helsinki Burn Centre	29	0.58	14	0.35
Paediatric Hospital	17	0.94	4	0.30
Total	18	0.88	7	0.29

LOS: length of stay; LOS/TBSA: hospital days per total body surface area burned (%); ICU days: days treated in intensive care unit; ICU days/TBSA: days treated in ICU per TBSA burned (%). All values are presented as median (range).

burns, especially in small children, causing 42% of all burns in this special burn group requiring intensive care. Scalds are by far the most leading cause of small burns, but obviously scalds may cause major burns, too, leading to respirator therapy, multiple operations and intensive care. Also, the fact that the majority of paediatric burns occur in children less than 4–5 years old [4,6,12,14] and especially boys [8,14,19], was supported by this study. Boys outnumbered girls in each age group, being up to 7.1 times more in number in the 3–5-year-old children. Boys' tendency of being wild, active and curious by nature may contribute to this finding.

Scalds became less common in older age groups where flame and high voltage became the most important aetiological factors. In a Finnish study it was found earlier that flame was the leading aetiological factor in burns needing intensive care and causing mortality in all patients combined [20]. As a child gets older, the burn aetiology in major burns changes from accidental spills of hot liquid to playing with matches and climbing on dangerous electric poles. In this study, all ICU burns in the 11–16-year-olds were caused by flame (50%) or high voltage (50%). The incidence of high voltage injuries is the same as in a Turkish epidemiological study in the age group of 7–15 years [10]. Fortunately, the high standard of electric safety limits the number of high voltage injuries in Finland.

The chest and upper extremities were the most often affected areas in this study. The chest is a common target for accidental hot liquid spills and upper extremities, on the other hand, are a common site for flame burns. The head was affected in 60% of patients and the neck in almost half of the patients. This is more than in a burn population not requiring intensive care. Again, this speaks both for the serious nature of this burn subgroup and for the fact that head and neck burns often require careful monitoring due to the increased risk for laryngeal oedema and need for respiratory support.

Every third patient (31%) came to the burn centre directly from the site of the accident. In Helsinki it is common to bring very small children directly to the paediatric hospital whereas in Kuopio it is more common to be first seen by a doctor in a central hospital from where the patient is referred to the burn centre. Luckily, all but one patient was referred to a burn centre within 24 h after injury. This indicates that the need for rapid transfer of these patients is well recognized.

Table 5 – The discharge pattern

	Kuopio (*N*)	%	Helsinki (*N*)	%	Total (*N*)	%
University Hospital	3	13	12	54	15	33
Central Hospital	5	22	2	9	7	16
Local Hospital	0	4	3	14	3	7
Psychiatric Hospital	1	4	0	0	1	2
Home	14	61	5	23	19	42
Total	23	100	22	100	45	100

Table 6 – Cost of care per patient, total body surface area burned (TBSA %) and hospital days (HD)

	Kuopio Burn Unit	Helsinki Burn Unit		
		Two hospitals together	Burn Centre	Paediatric Hospital
€	25842	25656	57404	11651
TBSA (%)	27	24	40	18
Hospital days (HD)	20	18	29	17
HD/TBSA	0.74	0.75	0.73	0.94
€/TBSA	957	1069	1435	647
€/HD	1292	1425	1979	685

Values are presented as median of all values per unit.

In a very small child the correct estimation of burn extent is crucial in terms of fluid resuscitation and survival. It was surprising to see such great variance in the initial burn extent estimation done in the referring units. As much as a 45% overestimation and 36% underestimation was noted. Children may easily develop pulmonary oedema in case of excess fluid resuscitation and, on the other hand, may suffer greatly from dehydration due to under resuscitation, also. Therefore, as a small burned child arrives in the burn unit, it is vital to carry out a careful estimation of burn extent and assess the need for fluid replacement accordingly [21].

A rather large portion (87%) of patients was treated operatively. However, these children were seriously hurt and aggressive surgical intervention was justified. Also, the use of both allografts ($N = 4$) and artificial skin ($N = 10$) in treating partial thickness burns increased the number of operations. Dressing changes performed under general anaesthesia was preferred in Helsinki. This is likely to be only a matter of custom rather than having a scientific or medical background to it. Patients can be sedated in the wards for dressing changes as well as long as an anaesthetist is available.

This study included only patients who were admitted to the two national burn units. Previously, the mortality of paediatric burns has been reported to be 0.2–10.2% [8,10,12,19]. The results in this study were good in regards of having no need for renal replacement therapy and no mortality. However, the number of serious paediatric burns not reaching the burn unit is unknown. The only previous data on mortality in Finnish paediatric burns is from a retrospective burn study where a single case of mortality (0.28%) was observed [6]. Finnish health care is very structured and all very severe burn cases were referred to these two units. However, there may have been some patients outside the catchment area who were treated in a central or a university hospital, but the number is not known.

There were some small differences between the two burn units (Table 6) when the Helsinki Burn Centre and Paediatric Hospital in Helsinki were evaluated as one and Kuopio Burn Centre as the other. The median cost of care in Kuopio was 1292 euros per hospital day and 1425 euros per hospital days in Helsinki. The higher cost of care in Helsinki Burn Centre was balanced with the low cost of care in the Paediatric Hospital. The costs due to bigger use of expensive artificial skin in Kuopio might have been balanced by the numerous OR dressing changes in Helsinki. The first operation was performed 2.6 days earlier in Kuopio Burn Unit. This is explained by the fact that in Helsinki it is customary to wait longer for the final decision whether or not to operate scalds.

Tertiary health care in Finland is divided into five university hospital districts. The district of Helsinki University Hospital covers a population of 1.73 million people and that of Kuopio University Hospital about 870,000 people. Hence, together they cover about 50% of the population of Finland (5.2 million people). The number of patients referred to the two burn units from within these two districts was 31 during the 11-year study period resulting in 2.82 patients per year from these districts giving an incidence of 0.1/100,000/year in Finland. During an 11-year-period this would add up to (0.1/100,000/year) $\times$ 5.2 million $\times$ 11 years = 57 patients in Finland. There were 45 patients in our study group. Hence, during the study period, an estimate of 12 paediatric burn patients requiring care in the ICU (21%) were treated somewhere else than in a national burn centre. This indicates that the centralization of these uncommon and potentially life threatening burns is still unsuccessful in Finland.

Altogether, the prognosis of paediatric burns requiring intensive care is excellent when treated in a specialized burn unit. The treatment of these patients is challenging and rewarding to both patients and caregivers and requires up-to-date knowledge of the latest technologies and principles of modern burn and wound care.

REFERENCES

[1] Lyngdorf P. Epidemiology of scalds in small children. Burns Incl Therm Inj 1986;12:250–3.

[2] Elisdottir R, Ludvigsson P, Einarsson O, Thorgrimsson S, Haradsson A. Pediatric burns in Iceland. Hospital admissions. A population based study. Burns 1999;25:149–51.

[3] Akita S, Nakagawa H, Tanaka K, Hirano A. Analysis of pediatric burns in Nagasaki University from 1983 to 2002. Burns 2005;31:1041–4.

[4] Parish R, Novack A, Heimbach D, Engrav L. Pediatric patients in a regional burn center. Pediatr Emerg Care 1986;2(3):165–7.

[5] Ryan C, Shankowsky H, Tredget E. Profile of the paediatric burn patient in a Canadian burn centre. Burns 1992;18(4):267–72.

[6] Zeitlin R, Somppi E, Jarnberg J. Paediatric burns in central Finland between the 1960's and the 1980's. Burns 1993;19(5):418–22.

[7] Morrow S, Smith D, Cairns B, Howell P, Nakayama D, Peterson. Etiology and outcome of pediatric burns. J Pediatr Surg 1996;31(3):329–33.

[8] Ying S, Ho W. An analysis of 550 hospitalized pediatric burn patients in Hong Kong. J Burn Care Rehabil 2001;22(3):228–31.

[9] Al-Shehri M. The patterns of paediatric burn injuries in Southwestern Saudi Arabia. West Afr J Med 2004;23(4):294–9.

[10] Tarim A, Nursal T, Yildirin S, Noyan T, Moray G, Haberal M. Epidemiology of pediatric burn injuries in southern Turkey. J Burn Care Rehabil 2005;26(4):327–30.

[11] Zamencnikova I, Stetinsky J, Tymonova J, Kadlik M. Burn injury in children. Acta Chir Plast 2005;47(1):13–5.

[12] Maghsoudi H, Samnia N. Etiology and outcome of pediatric burns in Tabriz, Iran. Burns 2005;31:721–5.

[13] Thombs B, Singh V, Milner S. Children under 4 years are at greater risk of mortality following acute burn injury: evidence from a national sample of 12902 pediatric admissions. Shock 2006;26(4):348–52.

[14] Xin W, Yin Z, Qin Z, Jian L, Tanuseputro P, Gomez M, et al. Characteristics of 1494 pediatric burn patients in Shanghai. Burns 2006;32:613–8.

[15] Sharma P, Bang R, Al-Fadhli A, Sharmma P, Bang S, Ghoneim I. Paediatric burns in Kuwait: Incidence, causes and mortality. Burns 2006;32:104–11.

[16] Zamencnikova I, Tymonova J, Stetinsky J, Bakhtary A, Jourova I, Hladik M, et al. Critical and severe burn injury in children. Acta Chir Plast 2005;47(1):16–8.

[17] Spies M, Herndon D, Rosenblatt J, Sanford A, Wolf S. Prediction of mortality from catastrophic burns in children. Lancet 2003;361:989–94.
[18] Sörensen B. The value of centralization. Burns Incl Therm Inj 1982;9(2):77–83.
[19] Ngim RC. Epidemiology of burns in Singapore children—an 11-year study of 2288 patients. Ann Acad Med Singapore 1992;21(5):667–71.
[20] Papp A, Härmä M, Ruokonen E, Alhava E. Burns treated in Kuopio University Hospital Burn Unit 1994–2000, Finnish. Duodecim 2001;16:1637–40.
[21] Freiburg C, Igneri P, Sartorelli K, Rogers F. Effects of differences in percent total body surface area estimation on fluid resuscitation of transferred burn patients. J Burn Care Rehabil 2007;28(1):42–8.