

Paediatric burns: A brief global review

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Abstract

Burn injuries are a major cause for hospitalisation and are associated with significant morbidity and mortality, particularly in children under the age of four years. Childhood burns place enormous socio-economic burden on individuals, their families and health services. This article briefly discusses the extent of childhood burns, contributing factors and general measures to help prevent these burns.

Introduction

Burn injuries are a major cause for hospitalisation and are associated with significant morbidity and mortality, particularly in children under the age of four years¹⁻³. Globally, the precise number of children suffering from burn injuries annually is unknown⁴. Published data indicates that Africa has the highest incidence of hospitalised paediatric burns while the Americas the lowest⁴. Annually, in excess of 1300 children are reported to die from burns in South Africa, while over a 20-year period at a major American paediatric burns centre 145 children died⁵⁻⁶. More than half of the world's paediatric burn population reported reside in Asia owing to Asia's larger population⁴.

Childhood burns place enormous socio-economic burden on individuals, their families and health services². Significant physical and psychological sequelae are associated with non-fatal burns, with survivors requiring ongoing treatment, rehabilitation and regular surgical intervention⁷. Throughout the treatment phase paediatric burns are susceptible to increased severity, deterioration and total burn index⁸. The cost of paediatric burns to both society and affected individuals

is significant, with Australian hospital expenditure for the year 2001–2002 from burns and scalds estimated to be \$38.7 million⁹. Furthermore, the mean daily cost of wound dressings for burn patients in an Australian intensive care in 2007 was calculated at \$700.74¹⁰.

To better understand burns in paediatric patients, WoundsWest undertook a general review of the literature.



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An additional aim of the review was to identify appropriate educational measures that could be adopted to help reduce the incidence of childhood burns in Western Australia. Articles published in PubMed, Cinahl and Google Scholar between 2000 and 2010 were reviewed. While a systemic review of the literature was not undertaken, it was sufficiently comprehensive to provide a realistic overview of the scope of the problem.

Paediatric burns

Globally, scalds are the most commonly treated burn that generally result in less severe injuries and rarely require a lengthy hospital stay^{2,8,11-25}. Scalds may be superficial, deep or a combination of both. Unintentional scalds generally occurred from hot liquid spills to the upper body with the wound displaying irregular margins and depth²⁶. Conversely, intentional scalds generally presented as immersion injuries from hot tap water to the extremities, buttocks, perineum or both²⁶. Intentional scalds appear more symmetrical, with delineated upper margins and the child having old fractures and unrelated injuries²⁶. Up to 22% of child maltreatment cases involve intentional burns or scalds²⁷.

While there are enormous variations in the age of patients with burn injuries, global studies demonstrate that the 0–4 age group had the highest incidence^{2,8,11,15-17,24,28-33}. The high incidence of burn injuries in this age group is attributable to children's impulsiveness, lack of awareness, higher activity levels, natural curiosity and total dependency on their caregiver^{3,28,34}. In toddlers, the upper part of the body, including the anterior trunk was the most frequently burned area¹⁻³. Burns of the upper body were associated with the natural curiosity of the 0–4 age group exploring their surroundings through pulling, touching and grabbing objects¹.

Globally, over half of the disability-adjusted life years lost from fire-related burns occurred between the ages of 0 and 14 years³⁵. Children under the age of two years had the highest risk for burns, with the majority occurring between the age of 7–12 months^{12,36}. Presumably care givers were responsible for scalds in this age group since infants generally did not walk². Older children were more likely to receive burns from flame injuries^{2,17-18}. This is supported by an Australian study, which identified that 95% of flammable liquid burns occurred in young adolescent males³⁷.

The majority of paediatric scalds occurred within the home from food preparation, food consumption (hot water, tea, coffee, soup, oil and milk) or bathing activities, and were deemed largely preventable^{1-2,8,12,16,28,30,33,38}. Owing to the structural thinness of their skin, children were more susceptible to the effects of scald burns and to deeper burns at

a lower temperature than adults³⁹. Short-term complications arising from childhood burns included infection and septicaemia, while long-term problems encompassed hypertrophic and keloids scarring, contractures, amputation and disfigurement²⁸. Burns generally affect a greater proportion of the child's body due to the larger body surface area³⁹.

Geographical implications for paediatric burns

Developing nations

Paediatric burns were more prevalent in developing countries and were associated with a high mortality rate^{7,22}. Annually, 3.2% of the South African population received burns with 50% occurring below the age of 20 years^{1,32}. Throughout Africa the incidence of burns has increased due to poverty; illiteracy; urban migration; overcrowding; and the establishment of slum areas and shanty towns that have minimal safety measures and are generally unfit for human habitation^{1,40}. The majority of buildings were constructed from wooden frames and plastic materials that were susceptible to the rapid spread of fire³². The incidence of burn commonly occurred when parents, in an attempt to find work, left children unattended, unsupervised or in the care of other children¹. Other factors implicated with burn injuries included the usage and storage of traditional cooking appliances and lighting, and using the same area for both cooking and sleeping¹.

In Egypt and Pakistan, where there were seasonal weather variations, females experienced a high ratio of burns²⁸. While in settings with all-year-round warm temperatures, such as Angola and Cote d'Ivoire, males were reported to have a slight preponderance²⁸. Paediatric burns were identified as a major cause of mortality, morbidity and disability in Bangladesh³⁰.

The risk of burn injuries in developing nations was primarily associated with the type of cooking substance and variety of cooking implement used^{33,40}. Unstable pots and stoves were associated with a significant number of injuries^{33,40}. The incidence of childhood burn tended to be higher in rural children than urban children^{22,30}. These burn injuries commonly occurred through the traditional habit of: preparing tea with two pots (one placed on top of the other); cooking over low stoves; cooking in large pots (cheese making); consuming foods while sitting on the floor; transporting hot liquids in buckets and pots; or falling into a hot container^{2,41}. Sterilisation of milk by boiling rather than pasteurising resulted in burns in many rural areas².

Developed nations

In developed countries the literature identified enormous variations in paediatric burns³. In Australia, Indigenous children had higher hospitalisation rates for burns and scalds than non-Indigenous children⁴²⁻⁴⁵. Scalds account for about 60% of all paediatric burns in Australia⁴⁶. An epidemiology study found that children younger than five years were more likely to sustain head and neck scalds from hot tap water⁴⁷. In 2005–2006 Aboriginal children aged 1–4 years accounted for 9% of all burn presentations at a major paediatric hospital emergency department in Western Australia⁴⁸. Burn injuries were overrepresented in Aboriginal children compared to other causes⁴⁸. Two Australian studies found that, despite parental supervision, young children, with a median age of 12 and 17 months respectively, sustained burn injuries in the home when using a wood stove or hot iron⁴⁹⁻⁵⁰. A study of 24 children, with a median age of eight years, reported that motorbike exhaust burns produced right lower leg burns, particularly in boys⁵¹. Another study of scald burns, from contact with containers of hot water or from room humidification (for the purpose of treating upper respiratory tract infections), reported that children aged between seven months to 14 years experienced the highest incidence⁵². The majority of burns from campfires occurred from inadequate extinguishment of hot ashes and coals⁵³. Treadmills produced friction injuries, particularly for children about three years of age, with 90% of cases receiving full-thickness or deep partial friction burns⁵⁴.

Within the United Kingdom, tea was the commonest cause of burns, while hot water and coffee was the principle cause of burns in Denmark. In Mexico, common cooking ingredients (soups, grease, coffee, beans and menudo) were associated

with a high incidence of burns³³. While in the United States of America, noodle soups and the ease with which instant soup containers could be tipped over was associated with unintentional scalds in children below the age of five years^{40,55}. Hot foods, curling irons and clothing irons were additional causes of burns^{40,56}. The widespread use of microwave ovens increased the risk of scald burns in children³⁹. Ready access to these ovens posed a significant risk for scalds in children as young as 18 months, who could open the door and remove the hot contents²⁹.

In Ireland, children of asylum seekers were more likely to sustain scalds at a younger age and in a domestic setting than Irish children, due to poverty and overcrowding⁵⁷. Non-immersion hot water scald burns accounted for the majority of childhood burns in Turkey⁵⁸. An Icelandic study reported a significant increase in the incidence of hot fluid burn injuries in children³⁸. A study undertaken in India found that girls were more likely to be burnt than boys¹⁵. In Israel, a high incidence of burns was reported amongst Jewish children during the Passover (holy day) festivities⁵⁹. These burns may be associated with cooking and the use of candles. A retrospective study of the epidemiology of barbecue burns at a Welsh burns centre reported that males were commonly injured⁶⁰. Paediatric barbecue burns resulted through the direct contact with either the barbecue or hot sand. Nearly two-thirds of paediatric patients received burns from low-lying, disposable barbecues that generally affected the legs⁶⁰.

In the Czech Republic, the majority of burns occurred in the kitchen, while outdoor burns resulted from handling highly flammable and explosive liquids including petrol, spirits or solvents¹². These results were similar to research from

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Turkey². Outdoor burns generally involved older children cooking over campfires or using charcoal; adding starter fluids to fires; electrical installations (mainly high-voltage); and explosives (detonators, gunpowder and fireworks)¹². Household burns frequently results from the use of saucepans, in lieu of vaporisers for the management of respiratory infections, and unsupervised contact with electrical heaters and hot irons¹². Modification to household practices and the recent introduction of electric water heaters in Taiwan led to an increase in scalds in the 1–2 age group⁶¹.

Ingestion of corrosive agents, which cause oropharyngeal and gastro-oesophageal injuries, resulted in burns that ranged from minor burns to severe necrosis⁶². The extent of damage depended on the agent, amount, concentration and duration of exposure. Causative agents included household bleaches and oven cleaners. The ingestion of caustic alkali substances was associated with more severe injuries⁶². A study of socio-demographic characteristics of children who sustained corrosive burns reported an association with lower parental education and socio-economic status, and families who had three or more children⁶³. Corrosive agents were generally purchased unlabelled and stored in Coke bottles.

The most common mechanism for scald burns in western society involve children: pulling on tablecloths; reaching up and pulling over containers near the edge of an elevated surface or stove (which accounted for under half of all injuries); pulling electric cords attached to kitchen and ironing appliances; and carrying containers of hot liquids^{3,14,33}. Children also sustained burns when adults tripped over them or from being carried by an adult while holding hot liquids⁶⁴. Hot milk scalds tended to be more extensive and had higher mortality than those occurring from hot water⁴¹. Scalds typically occurred in rooms that were not childproof³⁹.

The time taken for children to receive a serious scald depended on the temperature of the liquid, with hot fluid

achieving temperatures between 22 and 28°C and boiling fluid reaching 37°C (Table 1)^{39,65}. Recent research into cooling curves showed a marked variation in heat retention, with semisolid or high-density liquids having the highest risk for causing burns³³.

Risk factors for paediatric burns

Globally, the majority of children burned were boys with a ratio of around 2:1 to girls^{1,3,12,14,18,21,31,38,66-67}. From birth until four years, male children had a higher incidence of burns and thereafter females. The change in burn incidence is believed to be associated with the growing responsibilities

Table 2. Risk factors associated with paediatric burns^{7; 28; 66; 68}.

• Overcrowding
• Child other than first-born
• Mother pregnant
• Mother recently dismissed from job
• Recent family relocation
• Lack of parental supervision
• Lack of fire and flame enclosure
• Fire and stove located at floor-level
• Use of man-made fabrics
• Residing in a slum or congested area
• Presence of physical impairment or disability
• History of sibling death from a burn
• Prior history of a sibling burn
• Presence of a pre-existing impairment (blindness, epilepsy or lameness)
• Lack of water supply
• Unstable candles
• Use of small kerosene stoves and lanterns
• Use of volatile and highly flammable materials
• Home storage of flammable substances
• Inadequate exits
• Children residing primarily indoors
• Child unwell
• Parental illiteracy
• Low income
• Low socio-economic status

Table 1. Time taken for serious scalds to occur in children⁶⁵.

Type of liquid	Temperature	Time
Boiling water from a kettle	100°C	Under 1 second
Cut of hot tea/coffee	70–95°C	Under 1 second
Hot water from a tap	60°C	1 second
Hot water from a kettle 5–10 minutes after boiling	55°C	10 seconds
Hot water from a tap with a temperature regulator	50°C	5 minutes

and respective activities of both genders²⁸. The exploratory behaviour of boys and the higher incidence of misbehaviour-related injuries is associated in the higher incidence in the earlier years³. Girls generally experienced more scald burns in the kitchen through their exposure with fire, hot liquids and other substances while helping their mothers with household chores^{1,28}.

There is growing evidence that paediatric burns are associated with being socio-economically disadvantaged. Research identified such parental factors as: education; income; knowledge of burn prevention and care; supervision; and features of the home as being significantly related to burns⁷. The characteristic of the neighbourhood, the type of housing, child dependency and socio-economic factors were implicated in children hospitalised for burns in South Africa⁷. Table 2 provides a list of risk factors associated with paediatric burns.

Some of these factors can be modified including suitable storage of a flammable substance and improving literacy levels and education²⁸. Other factors cannot be modified, for example, presence of a pre-existing impairment and child other than the first-born.

Death rates from exposure to smoke, fire and flames was significantly higher in children of parents classified as never having worked or being long-term unemployed, compared to children of parents from higher managerial and professional occupations⁷. Socio-economic differences for injury morbidity identified children from the lower socio-economic groups had more than three times the risk for hospitalisation than children from higher socio-economic groups⁷. An Australian study reported that children with burns from lower socio-economic quintiles had nearly twice the rate of hospitalisation than children from the least disadvantaged quintile⁶⁹. Parental neglect was thought to be a role in childhood burn injuries². Abused or neglected burn children required more skin grafting and treatment in intensive care units, receive extremity burns, and were likely to come from single-parent families⁷⁰.

Underlying health problems increase the risk for burns and influence health outcomes. In areas of Africa, epilepsy non-compliance with anticonvulsant therapies, and other health conditions such as: pneumonia; meningitis; gastroenteritis; and tuberculosis (which are associated with febrile seizures) increased the risk of falling into open fires¹. The incidence of burn injuries for disabled children, even after controlling for



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demographic factors, was significantly higher than those with no disability³⁶. Attention deficit hyperactivity disorder was coupled with a higher incidence of childhood burns⁷¹.

Protective factors associated with burns in boys includes a history of a previous injury for those residing in a good environment²⁸. Additional protective factors included improved maternal education and the presence of a living room²⁸.

Seasonal, day and time-related factors for burns

Paediatric burns were associated with seasonal variations. In Sub-Saharan Africa, Egypt, Turkey and Taiwan there was an increased incidence of burns during the colder dry winters from the usage of traditional cooking (kerosene stoves and fires) and heating methods (boiling water)^{1-2,16,18,40}. In Malawi, boys were reported to be occasionally caught in bushfires while preparing for the planting season¹. Paediatric burns predominate in colder seasons in Taiwan and were believed to be associated with making hot tea and eating food from

chafing-dish (a portable cooking device)¹⁶, while in Turkey, burns commonly occurred in summer⁴¹.

In the Czech Republic, burn injuries occurred most frequently in the summer holidays, winter months and the weekend¹². During the day, burns peaked in the home from dinner activities around 11am and 7pm^{12,16,66}. Outdoor burns increased during the afternoon, with the peak around 4pm¹².

Burn prevention measures and education

In recent decades, industrialised countries have seen a decline in the mortality and hospitalisations of burn injuries through the establishment of specialised centres, implementation of preventive strategies and broader societal changes such as a decline in cigarette smoking³⁵. However, the benefits have not been achieved by children across all socio-economic groups³⁵.

A recent study relating to the first aid management of burns found that while the majority of patients received first aid, 8.7% did not, and in 5.2% of cases the treatment was

Table 3. Intervention measures to raise awareness of burn injuries^{2; 28; 64; 66; 68}.

Intervention measures	Prevention strategies
Improve socio-economic status	<ul style="list-style-type: none"> Improved parental education Improved housing Provision of basic amenities e.g. water, smoke alarms Regulate and design industrial products e.g. kerosene stoves, storage of flammable substances Child supervision – particularly those with impairments
Community programmes	<ul style="list-style-type: none"> Appropriate child supervision – particularly for the impaired Parental education – specific to burns General public – store flammable material away from the home
Improve design standards	<ul style="list-style-type: none"> Improve sleepwear flammability standards Introduction of new and less flammable fabrics Design of more close-fitting dresses Redesigning cooking packages e.g. upright soup packages
Education and awareness	<ul style="list-style-type: none"> Use of hot water Leaving children unattended Electric apparatus Chemical substances Workplace Kitchen appliance – to be kept out of reach of child Heating devices First aid knowledge Vigilance when child unwell Install microwave ovens at height accessible only to adults or older children Microwave oven not to be operated by a child younger than seven years Microwave food to be stirred and temperature-tested before serving or eating Adults not to carry child while drinking, eating or carrying hot beverages Place children in a safe area e.g. high chair or playpen during food or beverage preparation Hot beverages and foods to be kept out of children's reach

unknown⁷². The recommended application of cold water for 20 minutes or longer, which is associated with a considerable reduction in re-epithelialisation time in children, was only applied to 12.1% of cases⁷². Superficial depth burns were more likely to receive recommended first aid measures while suboptimal treatment was common in children younger than 3½ years and for those with friction burns⁷².

While the kitchen has been shown to be unsafe for young children, parents appear not to appreciate the risk for burns and scalds, which may explain why behavioural interventions such as the placement of pots on the stove's back burners has been ineffective¹⁴. Research shows that the most effective way to reduce the incidence of paediatric burns is through public education that targets high-risk areas in relation to specific preventive measures².

The variety of causes for burns necessitates a combination of health education, environmental modifications, parental education, product design interventions (with specific attention to the kitchen), to prevent burn injuries^{28,56}. Table 3 provides a list of intervention measures and prevention strategies.

Summary

Regardless of the enormous global variation in the epidemiology of paediatric burns, they remain a major cause of hospitalisation and are associated with significant morbidity and mortality. Burn injury prevention necessitates enormous commitment and policy changes and intervention, encompassing health education, environmental modifications, parental education and product design at international, national and local levels.

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