BURNS

VUSI'S STORY

Five years ago, when he was 13 years old, Vusi suffered serious burns. He woke up one night to find his blanket and bedroom ablaze from a candle that had fallen over. The flames injured his face, hands and feet.

After many months in hospital, he left wearing a brown elasticized pressure garment around his face and hands so that his scars would not become thick and raised, as often happens.

From the start, Vusi was very sensitive about his appearance. People on the streets and at school used to tease him about the mask-like pressure garment, comparing him to a masked television entertainer. The long hospital stay and the psychological stress led to problems at school and his education was delayed. Despite all he went through, though, Vusi has become a charming, friendly person with an engaging smile. He loves music and voluntarily spends time with blind children and others with disabilities, encouraging them to exercise more.

Africa's first burns charity, "Children of Fire", has, for the past twelve years, been helping severely burned children to obtain complex surgery, therapy and education. They now also work on community safety, teaching those at risk how to prevent fire burns, as well as imparting first aid and fire-fighting skills. The organization also helps inventors of safer paraffin or biofuel stoves to publicize their inventions more widely, and in a similar way promotes the use of safer candlesticks.

In June 2007, 15 teenaged burns survivors, along with other young volunteers, climbed Mount Kilimanjaro in a campaign to raise awareness of burn injuries and how to prevent them, and to increase tolerance of disability and disfigurement. Vusi was one of those who climbed to above 5000 metres and 12 others reached the summit.

Adapted from the Children of Fire web site (http://www.firechildren.org, accessed 9 June 2008).

Chapter 4
Burns

Introduction

Children are naturally curious. As soon as they are mobile, they begin to explore their surroundings and play with new objects. In this way, they acquire the skills they need to survive in the world. At the same time, though, they come into contact with objects that can cause severe injuries. Playing with fire or touching hot objects can result in burns. This is a debilitating condition accompanied by intense pain and often by longer-term illness that creates suffering not only for the child but for the wider family and community. Fortunately, the prevention, acute care and rehabilitation of burns have improved greatly over the past few decades. There is now ample evidence that a number of measures are effective in preventing burns. These include the introduction and enforcement of items such as smoke alarms, residential sprinklers and fire-safe lighters, and laws regulating the temperature of hot-water taps. Nonetheless, considerable disparities exist between countries in the extent of their prevention, care and rehabilitation of burns.

This chapter describes what is currently known about childhood burns and how to prevent and manage them. In doing so, it summarizes the epidemiology of burns in children and the risk factors and discusses in detail both proven and promising interventions. The chapter concludes with a set of recommended interventions and a description of areas where further research is required.

For the purpose of this chapter, a burn is defined as an injury to the skin or other organic tissue caused by thermal trauma. It occurs when some or all of the cells in the skin or other tissues are destroyed by hot liquids (scalds), hot solids (contact burns), or flames (flame burns). Injuries to the skin or other organic tissues due to radiation, radioactivity, electricity, friction or contact with chemicals are also considered as burns (*1*).

Burns may be distinguished and classified by their mechanism or cause, the degree or depth of the burn, the area of body surface that is burned, the region or part of the body affected, as well as the extent. Box 4.1 summarizes three of the most commonly used classifications.

BOX 4.1

Classification of burns

There are several ways of classifying burns. The following are three commonly used typologies, based respectively on the cause, extent and severity of the burn.

Classification by mechanism or cause

Causally, burns may be classified as thermal or inhalational.

- *Thermal burns* involve the skin and may present as:
  - scalds – caused by hot liquid or steam;
  - contact burns – caused by hot solids or items such as hot pressing irons and cooking utensils, as well as lighted cigarettes;
  - flame burns – caused by flames or incandescent fires, such as those started by lighted cigarettes, candles, lamps or stoves;
  - chemical burns – caused by exposure to reactive chemical substances such as strong acids or alkalis;
  - electrical burns – caused by an electrical current passing from an electrical outlet, cord or appliance through the body.
- *Inhalational burns* are the result of breathing in superheated gases, steam, hot liquids or noxious products of incomplete combustion. They cause thermal or chemical injury to the airways and lungs *(2)* and accompany a skin burn in approximately 20% to 35% of cases. Inhalational burns are the most common cause of death among people suffering fire-related burn *(3)*.

Classification by the degree and depth of a burn

Burns may also be classified by depth or thickness:

- *First-degree or superficial burns* are defined as burns to the epidermis that result in a simple inflammatory response. They are typically caused by exposure of the unprotected skin to solar radiation (sunburn) or to brief contact with hot substances, liquids or flash flames (scalds). First-degree burns heal within a week with no permanent changes in skin colour, texture, or thickness.
- *Second-degree or partial-thickness burns* result when damage to the skin extends beneath the epidermis into the dermis. The damage does not, however, lead to the destruction of all elements of the skin.
  - Superficial second-degree burns are those that take less than three weeks to heal.
  - Deep second-degree burns take more than three weeks to close and are likely to form hypertrophic scars.
- *Third-degree or full-thickness burns* are those where there is damage to all epidermal elements – including epidermis, dermis, subcutaneous tissue layer and deep hair follicles. As a result of the extensive destruction of the skin layers, third-degree burn wounds cannot regenerate themselves without grafting.

In adults, a full-thickness burn will occur within 60 seconds if the skin is exposed to hot water at a temperature of 53° C *(4)*. If, though, the temperature is increased to 61° C, then only 5 seconds are needed for such a burn. In children, burns occur in around a quarter to a half of the time needed for an adult to burn.

Classification by extent of burn

The extent of burn, clinically referred to as the total body surface area burned, is defined as the proportion of the body burned *(5)*. Several methods are used to determine this measurement, the most common being the so-called "rule of nines". This method assigns 9% to the head and neck region, 9% to each arm (including the hand), 18% to each leg (including the foot) and 18% to each side of the trunk (back, chest and abdomen). The "rule of nines" is used for adults and children older than 10 years, while the Lund and Browder Chart is used for children younger than 10 years *(6)*. The calculation assumes that the size of a child's palm is roughly 1% of the total body surface area *(7)*.

Epidemiology of burns

According to the WHO Global Burden of Disease estimates for 2004, just over 310 000 people died as a result of fire-related burns, of whom 30% were under the age of 20 years (see Statistical Annex, Table A.1). Fire-related burns are the 11th leading cause of death for children between the ages of 1 and 9 years. Overall, children are at high risk for death from burns, with a global rate of 3.9 deaths per 100 000 population. Among all people globally, infants have the highest death rates from burns. The rate then slowly declines with age, but increases again in elderly adults.

The long-term consequences and the disability that can result from burns place a considerable strain on individuals and their families, as well as on health-care facilities. According to WHO data, approximately 10% of all unintentional injury deaths are due to fire-related burns (see Statistical Annex Table A.1). In addition, fire-related burns are among the leading causes of disability-adjusted life years (DALYs) lost in low-income and middle-income countries (see Statistical Annex A.2).

Mortality

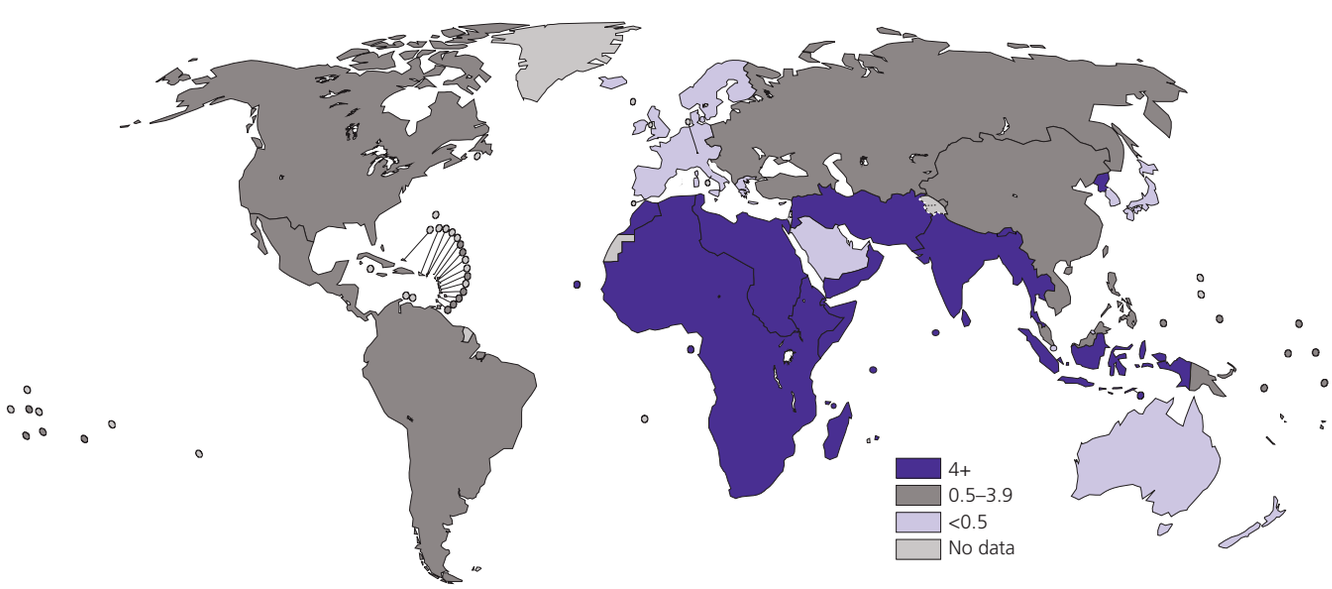
Globally, nearly 96 000 children under the age of 20 years were estimated to have been fatally injured as a result of a fire-related burn in 2004. The death rate in low-income and middle-income countries was eleven times higher than that in high-income countries, 4.3 per 100 000 as against 0.4 per 100 000 (see Statistical Annex, Table A.1). However, as can be seen in Figure 4.1, burn-related deaths show great regional variability. Most of the deaths occur in poorer regions of the world – among the WHO regions of Africa and South-East Asia, and the low-income and middle-income countries of the Eastern Mediterranean Region. The death rates in the Americas and the high-income countries of the Europe and the Western Pacific regions are among the lowest in the world.

Every year 70 Member States – mainly middle-income and high-income countries –submit to WHO mortality data that include the fourth digit of the International Classification of Disease codes, which allows disaggregation into subtypes of burns. Analysis of these data show that, in 2002, fire-related burns made up 93.0% of all burn deaths, scalds contributed 5.4% and the rest, 1.6%, were as a result of contact, chemical or electrical burns (*8*).

Studies from high-income countries suggest that smoke inhalation is the strongest determinant of mortality from burns, mostly from house fires or other conflagrations. For children over three years of age, smoke inhalation is strongly associated with mortality, despite improvements in the care of burns (*9*).

FIGURE 4.1

Mortality rates due to fire-related burns per 100 000 children[a] by WHO region and country income level, 2004



Africa	Americas		South-East Asia	Europe		Eastern Mediterranean		Western Pacific	
LMIC	HIC	LMIC	LMIC	HIC	LMIC	HIC	LMIC	HIC	LMIC
8.7	0.7	0.6	6.1	0.2	1.1	0.4	4.7	0.3	0.6

[a] These data refer to those under 20 years of age.

HIC = High-income countries; LMIC = low-income and middle-income countries.

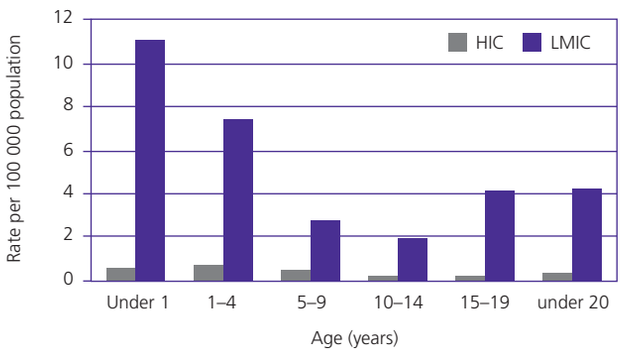
Source: WHO (2008), Global Burden of Disease: 2004 update.

Age

Figure 4.2 shows child death rates from burns by age group. Infants have the highest rates, while those aged between 10 and 14 years have the lowest rates. The death rate climbs again in the 15–19-year age range, possibly as a result of greater exposure, experimentation and risk-taking, as well as the fact that many in that group are beginning employment.

FIGURE 4.2

Fatal fire-related burn rates per 100 000 children by age and country income level, World, 2004



HIC = High-income countries; LMIC = low-income and middle-income countries.

Source: WHO (2008), Global Burden of Disease: 2004 update.

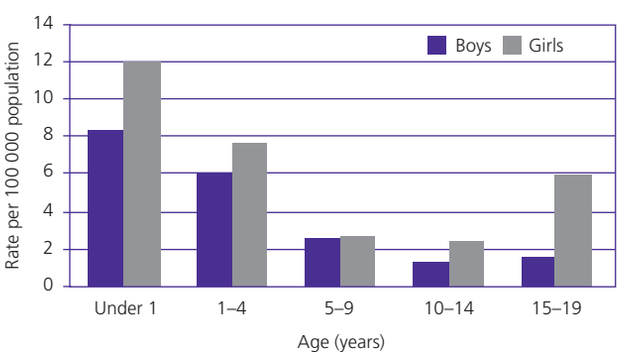
Gender

Burns are the only type of unintentional injury where females have a higher rate of injury than males. The fire-related death rate for girls is 4.9 per 100 000 population, as against 3.0 per 100 000 for boys. The difference is particularly pronounced in infants and also in adolescents between the ages of 15 and 19 years (see Figure 4.3).

The greatest gender discrepancies are found in the WHO South-East Asia Region and in the low-income and middle-income countries of the Eastern Mediterranean Region. In these regions, girls in the 15–19-year age bracket have death rates that are substantially higher than rates for the same age group in any other region (see Statistical Annex, Table A.1).

FIGURE 4.3

Fatal fire-related burn rates per 100 000 children by age and sex, World, 2004



Source: WHO (2008), Global Burden of Disease: 2004 update.

Morbidity

Global data on non-fatal outcomes from burns is not readily available. However, the WHO Global Burden of Disease project for 2004 makes it clear that burns are an important contributor to the overall disease toll in children in the low-income and middle-income countries of the African, South-East Asia and the Eastern Mediterranean regions (see Statistical Annex, Table A.2).

While burns from fire contribute to the majority of burn-related deaths in children, scalds and contact burns are an important factor in overall morbidity from burns and a significant cause of disability. Chemical and electrical burns among children, though, are relatively rare (*10–12*).

Age

In high-income countries, children under the age of five years old are at the highest risk of hospitalization from burns, although 15–19-year-olds, as already stated, are also a group at high risk. Nearly 75% of burns in young children are from hot liquid, hot tap water or steam. Infants under the age of one year are still at significant risk for burns, even in developed countries. The burns they suffer are most commonly the result of scalds from cups containing hot drinks or contact burns from radiators or hot-water pipes (*13*).

The following give an indication of the situation in some high-income countries:

- In Canada, in a single year, there were over 6000 visits to emergency departments in the province of Ontario (whose population is about 12 million) due to burns (*14*). Almost half the cases of burns are among children under five years of age (*15*).
- In Finland, an 11-year study found that scalds were responsible for 42.2% of children being admitted to two paediatric burns units. Among children under three years of age, 100% of burns were the result of hot water. In the 11–16-year group, 50% of burns were due to electricity, with the other 50% resulting from fire and flames (*16*).
- In Kuwait, the incidence of burns in children under 15 years of age was 17.5 per 100 000 population. Scalds (67%), followed by flames (23%), were the leading causes of burns (*17*).
- In the United States, one of the leading causes of injury from scalding in children is hot soup, particularly prepackaged instant soup (*18*).

In low-income and middle-income countries, children under the age of five years have been shown to have a disproportionately higher rate of burns than is the case in high-income countries. In Kenya, for example, 48.6% of children presenting to the Kenyatta National Hospital were under the age of five years. Although scalds were the most common type of burn, those caused by open flames were also prominent (*19*). Other examples from low-income

and middle-income countries show rather different age patterns and leading causes.

- In Shandong Province, China, a 5-year review of data from the burns unit revealed that children under the age of 10 years were admitted in the greatest numbers, followed by adults aged between 20 and 30 years. Scalds and fire-related burns were seen in roughly similar numbers (*20*).
- Burns from boiling liquids, most frequently water boiled for bathing, were among the leading causes of injuries to children under the age of 10 years in Cuernavaca, Mexico (*21*).
- In Maiduguri, north-east Nigeria, the commonest cause of burns was scalds (64.4%). Children under the age of three years were disproportionately represented (*22*).
- In Brazil, Côte d'Ivoire and India, infants account for nearly half of all childhood burns (*23–25*).
- In Fars Province in the Islamic Republic of Iran, the annual hospitalization rate for children under 15 years was 11.8 per 100 000 population. Scalds accounted for 46.2% of the burns, whereas flames accounted for 42.8%. Most burns occurred at home (*26*).

Similar results have been found in a recent study in four low-income countries. In this study, 53% of burns in children under 12 years of age were the result of a hot liquid, followed by fire and flame in 19% of cases and electricity in 14% of cases (see Statistical Annex, Table C.1).

Infants in Africa under one year of age have an annual incidence of fire-related burns of 35 per 100 000 – more than three times the world average for this age group (*27*).

Gender

The gender distribution of non-fatal burns differs between countries – a fact that may be related to cultural practices, particularly with regard to cooking. Some African and Asian countries – including Angola, Bangladesh, China, Côte d'Ivoire, Kenya and Nigeria – report a higher number of cases among males (*19, 20, 22, 24, 28, 29*). Others, such as Egypt and India, have a greater proportion among girls, particularly teenage girls (*30–32*).

The increasing proportion of burn injuries recorded in girls as they grow older might be explained by the changing activities of the two genders. While girls are increasingly involved in the kitchen, helping their mothers – and therefore more exposed to fire, and hot liquids and other substances – boys tend to stay more outdoors (see Box 4.2). In some cultures, "bride burning" is still practised and may be linked to a higher incidence of burns in adolescent females (*33*).

BOX 4.2

Burns to young working females in work and home settings

Burns are the leading cause of deaths from injury in many developing countries. Work-related burn injuries are relatively rare in children. Nonetheless, they are an important public health problem for young people employed in the catering industry and children working in residential kitchens. Work-related childhood burn injuries – in whatever setting – often go unreported, especially in developing countries, either because safety regulations are not being enforced, or because of a lack of regulation and supervision. Three types of workplaces are typically involved in employment-related burn injuries in children.

Catering and restaurant industry: The most common sources of burn injuries in restaurants and kitchens are cooking oils, hot water, steam and heating equipment. A study in the state of Washington, United States for the period 1989–1993, found that 2076 workers under 18 years of age suffered burn injuries, representing 7.6% of all work-related burn injuries. The most common sector in which they occurred was the food services industry. Young people working in fast-food outlets and restaurants made up 62% of these cases – as against only 32% of burn injuries in 125 other occupations combined (34). Similar findings for the state were also found for the period 1994–1998 *(35)*.

Other industrial settings, including metal industries: Children have the lowest rates of burns in large-scale industrial settings, presumably because they are generally unsuitable for this work and therefore have little exposure to its risks. Where they are involved and suffer burns, though, their burns are on the whole more severe than in other settings. In both industrial settings and in food services, males are more affected than females by burns.

House kitchens: Unlike the situation in other workplace settings, employment-related injuries in house kitchens principally involve girls. Girls working as house maids are generally responsible for cooking as well as other household tasks. They often work without contracts and may be deprived of legal support. Due to their young age, they are on average less skilful and more prone to burns than adults. In addition, their work conditions are frequently unsafe. Some young females are employed in households that are not their own, while others are obliged to work in their home as family members. The flammable and loose clothing often worn by young women in developing countries further increases the risk of burn injuries *(36)*.

In the Islamic Republic of Iran, burn injuries are the most common unintentional home-related injury *(37)*. Iranian injury registry databases show that during the period 1999–2001, 58% of all reported burn injuries were in children. In the Ardabil province of Iran, a recent study found that 65% of children suffering burns in the kitchen were girls, and that girls aged 16–17 years were three times as likely to be burned in the kitchen as were boys. The study also found that children younger than 12 years were having to help in cooking-related work in kitchens, with an average starting age of 8 years (see Table).

Children helping in household kitchen jobs, Ardabil province, Islamic Republic of Iran, 2006

Kitchen jobs	Proportion of children helping in kitchen (%)	Mean age of starting to help in kitchen (years)
Cooking	21.2	8.7
Preparing tea	37.2	8.0
Carrying hot food	37.5	7.9
Lighting the oven	24.0	–

Location

Most studies suggest that burns in children occur most frequently in the home, or else – among older children – in the workplace. A study in four low-income countries found that 65% of childhood burns had occurred in and around the home (Statistical Annex, Table C.1). The kitchen is usually the most common part of the house. In this room, children may upset receptacles with hot liquids, be injured by exploding stoves, stand on hot coals or be splashed with hot cooking oil.

Most burns occur in urban areas. Those burns that take place in rural areas with inadequate prehospital care, though, can lead to greater volumes of illness and disabilities.

Nature and severity of burns

Few empirical studies have described burn injuries by the body part affected. Among those that have, though, the most common sites are reported to be the following:

- from *scalds*: the trunk and upper extremities (*24, 38*);
- from *flame-related burns*: the lower extremities (*38, 39*);
- from *contact burns*: the hands (*40*);
- from *electrical burns*: there may be little external evidence of the burn but extensive internal damage. Small children who bite or suck on extension cords can burn their mouth and lips. Such burns may cause cosmetic deformities and impair growth of the teeth, mandibles and maxilla (*41*).
- from *chemical burns*: the site depends on whether the chemical is ingested, splashed or inhaled.

The total surface area of the body that is affected depends on the cause of burn, the mechanism of injury and the age of the child. In general, scalds and contact burns are less severe than fire-related burns. Lung damage, as a result of inhalation injuries, is the most frequent cause of death and is largely unpreventable (*42*).

Consequences of non-fatal burns

The study already mentioned that was conducted in four low-income countries found that the average injury severity score for children who had been burned was 5. In addition, 49% of affected children suffered some form of disability after a burn, with 8% being left with a permanent physical disability (see Table 1.5 in Chapter 1). There were similar results in Bangladesh, where a community-based survey revealed an annual disability rate of 5.7 per 100 000 children as a result of burns (*29*).

Burns can result in significant long-term consequences which – in the absence of a comprehensive and coordinated rehabilitation programme – can leave children scarred, physically and psychologically, for the rest of their lives. Most rehabilitation programmes seek to prevent long-term problems – such as scarring, contractures and other physical problems that limit functioning. However, attention should also be paid to managing pain as well as psychological issues such as anxiety, post-traumatic stress, phobias and isolation (*43, 44*).

The most common physical long-term consequences following a burn include hypertrophic scarring, extensive contractures, the formation of keloids and the need to amputate an extremity (*43*). Hypertrophic scarring in particular has been found to be one of the most significant long-term consequences of childhood burns, occurring in almost half of severe cases (*45*). Keloid formation is relatively more common among children of African descent (*46*).

> "My worst experience took place on a crowded bus. Other passengers kept looking at me so I took my jacket off and covered my head. I just wanted to be invisible and I wanted them all to disappear too." (Michael, aged 17, Changing Faces – a United Kingdom non-governmental organization for people with disfigurements)

The outcome following a burn depends on a number of interrelated factors. These include:

- the child's age;
- the body part affected;
- the proportion of body surface area burned;
- the length of time from injury to care;
- the type of care applied – such as dressings or debridement (the removal of damaged tissue from a wound);
- post-burn complications.

Burns to the face resulting in gross disfiguration can lead to poor self-esteem in children and adolescents (*47*). Children suffering burns when they are young, though, appear to be very resilient, adapting to their disfiguration with greater ease than those similarly affected during adolescence. A recent study from India showed that only adolescents in the study required psychosocial rehabilitation (*48*).

As one of the factors in the child's long-term social adjustment is that of self-esteem (*49*), social support networks may help the process. This is the case not only for the child, but also for parents, and in particular mothers, who often experience post-traumatic stress disorder after their child has suffered a large burn (*50, 51*). Nongovernmental organizations can play an important role in providing such support. So can "burn camps" for children, that were first set up in 1983 (*52*). Siblings of a child who has suffered burns should also be taken into consideration, as overprotecting the child can have an adverse behavioural impact on other children in the family (*53*).

Impact on families and communities

Evaluating the cost of burns and their treatment is difficult. It is certain, though, that burns create a heavy economic

load on health-care services. A study of hospitalizations in Bangkok, for example, found that the cost of burn injuries was not sufficiently reimbursed to the hospitals. As a result, the hospitals had to divert resources from other areas of care (*54*).

The cost of treating burns is dependent on the type and severity of the burn. In the United Kingdom, a recent study found the average cost of an uncomplicated minor paediatric scald to be £1850 (US$ 3618) (*55*). Another study from the United States found that the cost of hospitalizations from burns ranged from US$ 1187 for scalds to US$ 4102 for those resulting from fires (*56*).

In addition there are also costs to the families of children associated with hospitalization, the need for long-term rehabilitation, lost school days and education, possible future unemployment, social rejection and other psychosocial issues (*51, 57*).

The potential to reduce individual and societal costs by carrying out effective burn prevention interventions is huge. A recent study in Ontario, Canada (*58*), for instance, found that – through a combination of educational and legislative measures – preventing scald burns could save 531 Canadian dollars (US$ 507) per scald.

Limitations of data

There are wide differences between countries in data on childhood burns – as regards their availability, quality and reliability. The WHO Global Burden of Disease project data used in this chapter relies only on fire-related burns. Although these account for nearly 97% of fatal burns in children, the data still underestimate the total number of burns cases. This could be rectified if more countries submitted data that included the 4th digit of the ICD coding.

While there is no global morbidity database, there now exist many studies from both high-income and low-income countries on the epidemiology and risk factors for burns. Using these hospital-based studies researchers have tried to estimate the global extent of non-fatal burns. However, these attempts have been hampered by the lack of population-based information and also by the differing definitions of the age range of childhood (*59*).

Risk factors

Various studies, using descriptive and case-control designs, have found a range of risk factors for childhood burns. However, because of the way in which burns are coded in many countries, it is often impossible to distinguish between the different mechanisms that lead to burns. For example, the risk factors for burns caused by chemical agents, and the population most frequently affected by such burns, are both very different from the risk factors for and populations affected by scalds from boiling fluids. Thus, while the existing data identify children and young people as a high-risk population for burns, information on mechanisms and causal factors is largely missing. This section makes use of the Haddon matrix (*60*) to highlight the child, agent and environmental risk factors. Some risk factors are applicable, of course, only to certain types of burns (see Table 4.1).

TABLE 4.1

Haddon Matrix applied to the risk factors for fire-related burns among children

Phases	Factors			
	Child	Agent	Physical environment	Socioeconomic environment
Pre-event	Developmental issues, including experimentation; gender; vulnerability – including disabled children, refugees, street children; lack of supervision; parents smoking in the home or in bed; lack of knowledge about risks of fire in the home.	Storage of flammable substances in the house; combustibles, matches or lighters accessible to children; unsafe stoves or lamps; fireworks.	Housing in slums or congested areas; overcrowded households; no separation between cooking area and other areas; absence of flame-retardant household materials.	Poverty; unemployment, illiteracy among parents; sibling who died of burns; lack of fire-related building codes and their enforcement; lack of policies or laws on smoke alarms, sprinkler systems, access to hydrants; lack of policies or laws on flammability standards.
Event	Unmaintained smoke alarms and sprinkler systems; child not wearing flame-retardant clothing; poor knowledge about evacuation procedures.	Lack of sprinkler systems; lack of fire hydrants or other access to a supply of water.	Lack of functioning smoke alarms; lack of clear and easily accessible escape routes; lack of access to telephone to call for help.	Poor access to information and resources to minimize risk; inadequate communications infrastructure for calling emergency health services.
Post-event	Inaccessible first-aid kits; lack of knowledge by caregivers and community about what to do immediately after a burn.	Flammability of household materials and children's clothing; toxicity of smoke and burning household materials.	Poor emergency or fire department response time; poor rescue and treatment skills; lack of access to water; inability to transport to medical care promptly.	Inadequate burns care; inadequate access to burn centres and rehabilitation services; insufficient community support for those who have suffered burns.

Child-related factors

Age and development

Burns in very young children often occur from a mixture of curiosity and awkwardness. In children under the age of four years, the level of motor development does not match the child's cognitive and intellectual development and injuries can thus occur more easily (*61*).

Infants under the age of one year are in a particular category, as their mobility starts to develop and they reach out to touch objects (*13*). Consequently, burns to the palms of the hands are particularly common, as a result of touching heaters or hot-water pipes. Because a child has thinner skin on the palms and slower withdrawal reflexes, such contact burns may be deep and thus require prolonged and careful therapy during the healing phase to prevent flexure contractures of the hand (*40*).

Scald burns are the most frequent type of burn among children under the age of six years – an observation that appears to cut across geographic and economic groups. Typical scald burns occur when a child pulls down a container of hot fluid, such as a cup of coffee, onto his or her face, upper extremities and trunk. These are typically superficial second-degree burns. Apart from the pain they cause the child and the distress for the parents, these burns will typically heal within weeks, leaving little or no permanent damage.

As children grow older, they become less likely to be injured by common household objects and more interested in the world outside. There is then an increased likelihood that they will be involved in serious fires. In particular, boys older than 6 or 8 years of age often become curious about fire, leading to experimentation with matches, lighters or fireworks. In some cases, younger siblings are injured while watching the experimentation of an older brother or sister (*62*).

Gender

As already mentioned, burns are the only type of fatal injury that occurs more frequently among girls than boys in three WHO regions (see Table 4.2). For non-fatal burns, the pattern is not quite as clear, and in some settings boys may be at a greater risk of burns than girls, perhaps as a result of the more inquisitive nature of boys and their greater risk-taking behaviours (*63, 64*).

Local customs of using open fires for cooking and heating, together with the wearing of loose-fitting clothing, particularly among teenage girls in the South-East Asia and Eastern Mediterranean regions (*30*), are associated with an increased rate of burns among young women (*1*).

Vulnerability

Some children are more vulnerable to burns than others. Disabled children have a significantly higher incidence of burn injuries than non-disabled children (*65*). Although not specific to children, those who suffer from uncontrolled epilepsy appear to be at greater risk for burn injuries. Such injuries are often severe enough to require admission to hospital (*66*).

Other vulnerable groups – such as children of asylum seekers (*67*), those living in high-income countries but born to foreign parents (*68*), as well as children in rural areas distant from medical care – have higher incidences of burns and of their consequences (*69*).

Among street children, there have been numerous journalistic reports, though few scientific studies, on how they may be burned while sleeping in derelict buildings, underground sewers or close to open fires. Apart from the danger from flames, the inhalation of hydrocarbons or the sniffing of glue among street children can lead to burns of the trachea (*70*).

Studies have also found that the children of parents who smoke while in bed are at higher risk of burns than those who do not have parents who smoke (*71*).

Poverty

Mortality and morbidity from burns are strongly associated with poverty. In addition to the markedly higher incidence of burns among children in low-income and middle-income countries, there are also differences by socioeconomic class *within* high-income countries, with studies from Sweden and the United Kingdom showing an increased risk of burns among poorer children (*72, 73*). In Sweden, the relative risk of being hospitalized for a burn was 2.3 times higher for children in the poorest socioeconomic group than among those in the most prosperous group. Furthermore, within

TABLE 4.2

Fatal fire-related burn rates per 100 000 children[a] by sex, WHO region and country income level, World, 2004

	Africa	Americas		South- East Asia	Europe		Eastern Mediterranean		Western Pacific	
	LMIC	HIC	LMIC	LMIC	HIC	LMIC	HIC	LMIC	HIC	LMIC
Boys	8.9	0.7	0.7	3.3	0.2	1.3	0.6	3.6	0.3	0.4
Girls	8.5	0.6	0.6	9.1	0.2	1.0	0.1	5.8	0.3	0.8

[a] These data refer to those under 20 years of age.

HIC = High-income countries; LMIC = low-income and middle-income countries.

Source: WHO (2008), Global Burden of Disease: 2004 update.

the poorest group, the risk for burns was greater than for any other childhood injury (*73*). In Australia, too, the risk of fire-related burns and scalds requiring a hospital stay was found by one study to increase as income decreases (*74*). This finding was confirmed by a systematic review of the risk factors for injury in a house fire. The review found that those in the lowest quintile of income were 2.4 times more likely to die in a house fire than those in the highest two income quintiles (*71*).

Agent factors

Unsafe equipment

Heat, light sources and cooking equipment – especially those relying on fossil fuels – all carry inherent risks (*75*). In particular, heating or cooking on open fires that are not enclosed or that stand at ground level pose significant dangers to children. There are similar dangers in the use of small kerosene stoves or lanterns, candles for lighting, and other volatile or highly flammable fuels within the house (*75–78*). Easy access for children to cooking appliances or pots with boiling liquids is a further risk factor for burns (*76, 79, 80*).

Unsafe electrical appliances, plugs, wires and other connections all increase the risk of electrical burns for children (*21, 80*).

Flammable substances

Flammable substances such as kerosene and paraffin should not be stored in the house. However, for practical reasons, they are not usually stored in this way. Apart from the obvious danger of fire, they are also a poisoning risk for small children, being frequently kept in containers lacking child-resistant closures (see Chapter 6).

Fireworks

Many countries celebrate religious or national festivals by setting off fireworks and many burn injuries regularly occur around these holidays (*75, 81, 82*). Fireworks pose a significant risk for children, particularly adolescent boys. In Greece, 70% of firework burn injuries recorded by the country's injury surveillance system involved boys aged 10 to 14 years, usually as a result of setting off the fireworks themselves. Girls who were injured by fireworks were usually bystanders (*81*). In Australia, 50% of those injured by fireworks were boys under 18 years of age (*83*).

Fireworks have been banned in many high-income countries unless they are safely set off by professionals as part of a public display. In most low-income and middle-income countries, there are no laws restricting the use of fireworks. However, in some countries that ban the private use of fireworks, injuries from them nevertheless occur, usually in adolescent males (*62, 83, 84*). In the state of Minnesota in the United States, after a law banning private fireworks had been repealed, there was an increase in the number of children suffering burns (*85*).

Environmental factors

Cooking and living areas

The overwhelming majority of childhood burns occur in the home, and in particular in the kitchen. It has been suggested that the location within the home of the heating equipment and the structure of the kitchen may present significant risks to children (*86*). In South Africa, for example, many homes consist of one or two main rooms, that are divided by temporary internal divisions made of curtains or cardboard. These rooms are utilized for functions such as sleeping, washing, cooking and eating, depending on the time of day and the requirements of the family (*86, 87*), or else as a work space (*88*). This type of domestic arrangement may greatly increase the exposure of a child to domestic equipment and sources of heat (*89, 90*).

Socioeconomic environment

A number of case-control and descriptive studies conducted in different parts of the world have identified several socioeconomic factors that increase the risk of childhood burns (*74, 75, 77, 79, 91–93*). These factors include:

- a low rate of literacy within the family;
- living in overcrowded dwellings or with cluttered areas in the home;
- a failure of proper supervision of children;
- a history of burns among siblings;
- the absence of laws and regulations relating to building codes, smoke detectors and flammable clothing.

Time of incident

Two peak times of the day have been reported for incidents involving burns – the late morning, when domestic tasks are being done, and around the time for the evening meal (*29, 94*). There have also been peaks noted, in some regions of the world, by season of the year. In tropical climates, where heating, even in winter, is not generally required, there is a fairly even distribution of cases of burns throughout the year (*28, 38*). In places where the winters are cold, though, an increased incidence of burns tends to be recorded during winter (*94–97*). The association, in many countries, of incidence of burns with public or religious holidays has already been noted.

Lack of access to water

Inadequate access to a good supply of water – in the form of a tap, hosepipe or sprinkler system – to douse flames or stop the flames spreading, is a strong risk factor (*74*). Similarly, a lack of smoke detectors or the presence of non-functioning smoke detectors appears to be related, in some developed countries, to an increased risk for childhood burns (*98*).

Protective factors

Several protective factors have been shown to reduce the risk of burns or to minimize their consequences (*74, 75, 77, 99*), including:

– literacy, particularly among mothers;
– knowledge of the risk of burns and of health-care services;
– ownership of the house;
– having living rooms separate from the kitchen;
– the use of fire-retardant fabrics for clothes;
– the installation of smoke detectors and water sprinklers;
– appropriate first-aid and emergency response systems;
– the existence of good quality health-care services.

Interventions

This section summarizes some of the interventions to prevent various types of burn injuries among children. The main protective factors for burns are briefly listed, and three broad approaches for prevention are described, namely:
– engineering, design and environmental measures;
– the introduction of legislation and standards;
– educational measures.

A fourth, and effective, approach consists of a combination of the three earlier ones. The management of burns, in particular first aid, and the value of dedicated trauma centres and of proper rehabilitation are discussed in a separate section.

Engineering measures

Safer lamps and stoves

In many low-income and middle-income countries, the lamps and stoves for lighting and heating use fossil fuels. These lamps and stoves are commonly linked to childhood burns. Developing safe stoves and moving them out of doors and off the ground would not only reduce the number of burns sustained by children but also reduce their exposure to indoor fumes. A trial in rural Guatemala of an improved wooden stove produced a decrease in both acute lower respiratory infections and fire-related burns. Rigorous evaluation of this trial is still in progress (*100*).

In Sri Lanka, an intervention using safe lamps for lighting is being implemented (see Box 4.3). Although this project too is awaiting evaluation, the initial results appear promising.

BOX 4.3

Cheap and safe alternatives to traditional paraffin lamps

Paraffin oil (also known as kerosene) is a flammable fuel, used widely in some countries for lamps. According to the World Bank Global Data Monitoring Information System[1], only 29% of households in sub-Saharan Africa are electrified, while in most countries in South Asia two out of three houses have electricity. While there are efforts in all these countries to provide more homes with electricity, progress is often slow. The global use of paraffin is therefore likely to continue for many years. At the same time, there is an urgent need for cheap and safe paraffin lamps.

A properly designed paraffin lamp it is not by itself unsafe for use in the home, even though it carries a flame. Like the kitchen knife, it is safe if well-designed and used with the proper basic safeguards. Unfortunately, paraffin lamps designed with safety in mind are relatively expensive. Around the world, millions of families use makeshift paraffin lamps that are very cheap – but unsafe. Poverty is the main factor here, though ignorance of the fact that their lamps pose a serious danger also plays a part.

In Mozambique, people use a lamp known as a *xiphefo*, consisting of a tall bottle with a wick-carrier placed on its top. In Sri Lanka, some lamps are made out of discarded medicine bottles, while others are burnt-out light bulbs fitted with a wire frame and metal base. Both types are light in weight and could easily topple, igniting the clothes of a child sitting or sleeping nearby.

People in these places have been accustomed to their traditional lamps from childhood. Marketing a safe alternative that is radically different would be difficult to accomplish. A strong promotional campaign on safety is therefore needed. People should be told how to use paraffin lamps safely, and, among other things:
– not to add paraffin to burning lamps;
– not to place lamps at the edge of a table or other raised surface;
– not to hang the lamps on walls;
– not to use containers for paraffin that previously contained petrol.

The unsafe, makeshift lamps that are used by poor people cost very little. Therefore any alternative that is proposed has to be as cheap as possible.

There are two options. The first is the use of a safer oil, in place of the paraffin in the existing lamps. Vegetable oils such as those of coconut, sesame, neem and mustard are safe, but their disadvantage is that they do not rise in the wick-carrier.

The second option is for a lamp that is safe, even with paraffin. Such a lamp is, in fact, currently being marketed in Sri Lanka to good effect. Its principal features are:
- It is short and heavy, so that it does not easily tip over.
- It has two flat sides, so that even if it tipped over, it would not roll.
- It has a screw-on metal lid, to prevent oil spilling if it tips over.
- Its design is simple and it can be mass-produced at low cost.
- It has a near-globular shape and is made of thick glass, so that it does not crack if it falls.
- There are no delicate or moving parts, so that it can be used for several years.

The use of such a lamp, with appropriate basic care being exercised, could prevent the many paraffin burns that occur around the world each year, though its efficacy has yet to be subjected to rigorous evaluation.

[1] Available at web site: http://ddp-ext.worldbank.org/ext/GMIS/gdmis.do?siteId=1&menuId=IDA14RMS10

Families in many developing countries will continue to use fossil fuels for heating and cooking, until such time as the cost of electricity and of essential electrical appliances becomes affordable (*101*).

Smoke alarms

Evidence for the effectiveness of interventions exists most markedly in the case of smoke detectors, which have been found to reduce the risk of deaths by over 70% (*102*). The problem, though, is to make sure that all homes have working smoke alarms on all levels of the residence, including in the sleeping areas. People often remove the batteries from their smoke detectors to avoid the nuisance of false alarms, or else do not check the batteries regularly. For optimum protection, most smoke detectors require that they be tested monthly and that their battery be changed twice a year. However, there are new devices, which – while more expensive – make use of a 10-year battery. Fully integrated, hard-wired smoke alarms often now come with the new types of residential construction, at least in some developed countries.

A systematic review of controlled trials of interventions promoting smoke alarms found that approaches that used only education produced only modest benefits. Programmes that provided and installed smoke alarms appeared to reduce fire-related injuries (*103*). However, programmes that combined legislation on smoke alarms with installation and education seemed to result in the greatest benefit (*104*).

A study in the United States (*105*) evaluated the cost-effectiveness of smoke detectors and found the ratio of the cost of detectors to the saving in health-care costs to be 1:26.

Residential sprinklers

Fire sprinkler systems have been proved to be effective (*106*) and can now be found widely in public and commercial property in many countries. Home sprinkler systems, on the other hand, are recommended but not widely used, though in some countries governments require them to be installed in the construction of new homes.

Fire-retardant household materials

Modifying products associated with fire-related burns is a promising approach. Following the introduction in Australia of fire-retardant material for children's bedclothes in 1979, the annual number of burns related to clothing dropped from around 300 to 30 (*107*). In the United States, children's bedclothes are regulated by the United States Product Safety Commission. Certain types and sizes of clothes need to pass a flammability test or else be tight-fitting, so as to reduce the risk of burns (*108*). In addition, many countries require that bedding, mattresses and upholstered furniture be fire-retardant.

Environmental measures

Promising environment modifications that may reduce the incidence of burns include, among others:

- introducing new or stricter building codes and standards;
- modifying or improving construction materials;
- improving heating and lighting equipment in homes;
- raising cooking facilities off the ground;
- separating cooking areas from living areas.

Unfortunately, although promising, such prevention measures have not been well evaluated, particularly in low-income and middle-income countries.

A Cochrane review of interventions that altered the home environment to reduce all types of injury, including burns, concluded that there is still insufficient evidence to determine their effectiveness (*109*).

Laws and regulations

Laws and regulations are one of the most efficient ways to get people to adopt safe behaviours. In addition to legislation enforcing smoke detectors, which has proven effective in many high-income countries, three other measures appear to be effective – laws on the temperature of hot-water taps, banning fireworks and standards for child-resistant lighters.

Temperature of hot-water taps

Interventions to prevent scald burns focus primarily on education together with laws and their enforcement regulating the temperature of hot water from household taps (*110*). In the United States, the control of hot-water temperature in taps in the state of Washington reduced the number of domestic hot-water scalds by combining an educational programme with laws cutting the temperature in preset water heaters from 60°C to 49°C (*111, 112*). As a result, 84% of homes changed to lower temperature. Other educational interventions in Norway (*113*) and New Zealand (*114*) aimed at reducing the hot-water temperature were also successful in reducing burns. A Canadian study evaluated the effectiveness of a combined educational and legislative approach to reduce thermostat settings and found a 56% reduction in scald burns (*58*).

Child-resistant lighters

A survey in the United States in 1985 showed that children playing with lighters were the cause of residential fires resulting in 170 deaths and 1150 injuries annually in the country (*115*). As a result, the United States Consumer Product Safety Commission developed a standard for cigarette lighters that applied to all products manufactured or imported into the country. A study after this standard was introduced found that fires, deaths and injuries caused by young children playing with lighters had been reduced by as much as 58%, saving over half a billion US dollars in

societal costs in 1998 alone (*116*). Other countries followed the United States example. In 2007, the European Union introduced laws requiring manufacturers and importers to comply with the European standard for child-resistant lighters (*117*). Although child-resistant lighters are not a substitute for parental supervision, considerable savings to the health sector and society could be made if all countries adopted similar standards.

Banning of fireworks

Many high-income countries have banned firework purchase or ownership by children. A recent review in the United Kingdom revealed that since the introduction of the Fireworks Act in 2003 and the Fireworks regulation in 2004 which limited the sale of fireworks to the three weeks surrounding Bonfire Night, and banned the sale or possession of fireworks by under 18 year olds, more than 80% of children's firework injuries were seen in the three weeks surrounding Bonfire Night. They concluded that the law had a definite impact on reducing non-Bonfire related firework injuries, but that stricter enforcement was required (*118*).

Educational approaches

Increased knowledge about burns among young children has been shown to result from educational programmes in schools and communities (*119*). It is unclear, though, whether these programmes have any effect in reducing the incidence of burns, as they lack a rigorous evaluation of the long-term outcomes of burn injuries (*120*).

Community programmes to ensure good supervision of children, particularly those with disabilities, to educate parents about burns and to advise against the storage of flammable substances in the home, have all been proposed as primary prevention strategies for burns (*92*). A programme in Bangladesh involves children being placed in nurseries for a number of hours each day. The purpose is to give the mothers free time for their domestic tasks, so that they can be more attentive when the children return home. The programme has yet to be evaluated for its effectiveness in preventing burns or drowning.

Educating parents about the use of safety equipment has been shown to result in increased knowledge, but again it has not been possible so far to demonstrate that as a result there is better use of such equipment (*121, 122*). The effectiveness of home visitation programmes is similarly uncertain. In general, educational programmes appear more successful when coupled with increasing access to safety products or with changes in the law.

Combined strategies

Strategies which combine legislation and standards, product modification and education appear to have the most far-reaching effects in reducing the incidence of burns (see Box 4.4).

BOX 4.4

"Hot water burns like fire"

In 1992, the Australian state of New South Wales launched the country's first state-wide prevention campaign for scalds in children, entitled "Hot Water Burns Like Fire". This followed a report on injuries in emergency departments that showed scalds as the fourth-leading cause of hospitalization among young children. The main agents of scalds identified were: hot tap water, hot beverages, kettles and saucepans. As a result of this campaign, the whole of Australia now has laws mandating a maximum temperature of 50° C for hot water taps in bathrooms – for new installations fitted and old ones that are replaced.

The first phase of the campaign aimed to raise awareness about the causes of scalds to children, the most serious and preventable one being hot tap water. This phase involved community heath-care staff, health promotion personnel, retailers, plumbers and the members of the hot-water heating industry.

The second phase, beginning in 1994, focused on how to modify temperatures of hot-water taps in bathrooms. Following meetings involving experts in infection control and manufacturers of hot-water heating, an amendment to the national standards on hot water delivery for personal purposes was introduced. Each state was then obliged to change its plumbing code so that the delivery of hot water in homes was capped at 50° C. This involved the use of a temperature testing card and a brochure with instructions on how to test and modify the temperature.

Between 1989 and 1996, the rate of hospitalizations for scalds involving young children aged 0–4 years fell by 13%. In the same period, the duration length of hospital stay dropped by 18%. The combined effect of the reduced number and severity of cases resulted in a net 27% fall in the total number of hospital beds utilized. Rates for the most serious scalds (involving a stay of 10 days or more) showed the greatest decline – a reduction of 30% for the two years following the second stage of the campaign. In all, there was an annual saving to the health care system of between 3.8 and 6.5 million Australian dollars, based on an average cost of treating a serious scald.

Managing burns

Access to treatment and rehabilitation

Although the care of burns depends largely on the availability of financial and human resources, many countries still manage to deliver good quality care despite limited health budgets. A number of cheaper options for burns management are currently being evaluated. These include:

- open, as against closed techniques to manage wounds (*123*);
- less costly grafting techniques (*124*).

In addition, practical guides for managing paediatric burns are being promoted in developing countries (*125*).

In many places the cost of treatment is high and only those who are well-off can afford to take their children to hospital (*38*). This can result in delayed healing, contractures and superimposed infections.

Families frequently resort to using traditional methods of healing before attempting to access modern medicine, because of the difficulty of accessing such health care (*27, 126*).

First aid for burns

Following a burn, the child should be stabilized before being transported to hospital. This is usually done by family, bystanders or first responders and should follow the basic rules of what should and should not be done in these circumstances (see Table 4.3). The overall aim must be to cool the burn, prevent ongoing burning and prevent contamination.

There are many studies assessing the first aid of burns in high-income countries, and from these, examples of good practices – such as to "cool the burn" – are drawn. Cooling the burn surface is one of the oldest methods of treatment (*127*). However, only a handful of studies have examined burn interventions in low-income and middle-income countries. A survey in India found that only 22.8% of patients had received appropriate first aid for their burns. The remainder had either received no first aid or else inappropriate treatment – such as raw eggs, toothpaste, mashed potato or oil being rubbed into the burn (*32*). In Viet Nam, a study compared children who had received immediate cooling with water after a burn with those who had not. It turned out that those who had received proper first aid needed 32% less subsequent grafting (*128*). Education on the effect of immediate application of cool (not ice cold) water to burns should be promoted widely as an effective first-aid treatment.

Acute management of burns

Medical care for burns has markedly improved survival. In the United States in 1940, 50% of children with burns involving 30% or more of their total body surface died. In 2000, a study in the same country found no deaths in children with burns involving as much as 59% of body surface area (*129*). In Pakistan, on the other hand, burns of over 40% in children are still often fatal (see Box 4.5).

Once a child suffering burns has been transported to an acute care facility, assessment and stabilization initially focus on a survey of airway, breathing and circulation. There should also be a careful examination of the child from head to toe, looking for other signs of trauma. Children with second-degree burns usually present with intense pain and typically hold the affected limbs immobile in a position of comfort. The site of the burn should immediately be assessed to determine its severity. Pain management in such cases is essential.

For reasons that are not yet understood, when the size of a burn exceeds 15% to 20% of body surface area of the affected child, the inflammatory response extends beyond the local site of injury. Blood pressure becomes dangerously low, and if fluids are not given fast enough, the child will go into shock and die. If the child does survive the first 48 hours, there is still a risk of death from infectious complications, since the barrier to bacteria is broken and the immune system suppressed.

The overall aim of managing burn wounds is to close the wound as quickly as possible, either by allowing the

TABLE 4.3

First aid for burns

What not to do	What to do
• Do not commence first aid before ensuring your own safety (switch off electrical current, wear gloves for chemicals, etc.). • Do not apply paste, oil, kumkum (a paste made from turmeric) – or raw cotton to the burned area. • Do not apply ice. • Do not open the blisters with a needle or pin. • Do not apply any material directly to the wound as it might become infected. • Avoid application of topical medication until the patient has been placed under appropriate medical care.	• Stop the burning process by removing clothing and irrigating the wounds. • Apply cold water or allow the burnt area to remain in contact with cold water for some time. • In flame injuries, extinguish the flames by allowing the patient to roll on the ground, or by applying a blanket, or using water or other fire-extinguishing liquids. • In chemical burns, remove or dilute the chemical agent by copiously irrigating the wound with water. • Obtain medical care.

Source: reference *1*.

BOX 4.5

Managing burns in Pakistan

Burns are one of the most neglected areas of health care in developing countries. These countries have 90% of global burn injuries, with 70% of these injuries occuring in children. While there have been major improvements in burn care in many high-income countries, making it quite possible for patients with burns of more than 90% of body surface area to survive, in countries such as Pakistan, burns of over 40% are frequently fatal. Even minor burns can lead to significant illness as a result of recurrent wound infections, delayed wound healing and the formation of contractures.

There are various reasons for this poor outcome. Access to care may be impeded by difficult terrain, as well as by a lack of pre-hospital services and inefficient chains of referral. Even if the patient manages to reach a health-care facility, initial resuscitation procedures are frequently inadequate. Appropriate airway management, mechanical ventilation and aggressive fluid resuscitation are often not provided in the first few hours.

Burn care has become highly specialized and is performed at dedicated centres. These specialized institutions not only provide comprehensive clinical care but also serve as important research centres. In several developed countries, burn centres have existed for more than 60 years. Today, the United States has 70 burn centres. In Pakistan, there are only eight specialized burns units for a population of 150 million people. Their standards of care vary considerably, depending on the workload, the availability of funding and the quality of management. There are no nationally-agreed standards or ways in which to enforce standards. In the whole of Pakistan, there are currently only 15 to 20 surgeons who are burn care specialists.

The ability of health-care specialists to manage sepsis and inhalational injury often defines the eventual outcome in patients with burns. Managing sepsis requires meticulous aseptic wound treatment and surgical debridement, and the early recognition and aggressive treatment of sepsis and septic shock, as well as nutritional support. Similarly, inhalational injury often requires long periods of mechanical ventilation under the supervision of an experienced critical care worker.

Burn care is also expensive. In Karachi, the daily average cost of treating a patient with a major burn of 25% or more of body surface area is around US$120, and a hospital stay can last as long as 8 to 10 weeks. The economics of burn care discourages the creation of burns centres in the private sector and fails to attract committed staff.

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skin to heal by secondary intention (allowing the wound to heal over on its own) or through surgical closure (grafting). The management of small, deep second-degree burns has evolved into an efficient and effective plan of treatment that nowadays produces highly satisfactory cosmetic and functional results with minimal morbidity. The treatment plan has two components: excising the burn wound before suppuration occurs; and covering the excised wound with synthetic or biological wound coverings. However, large, deep second-degree or third-degree burns, particularly in children, continue to pose a significant problem for the burn surgeon.

The surgical approach to early excision and grafting of burn wounds involves trained personnel and safe and effective resources. As removing the burn wound is a procedure associated with a high volume of blood loss, the operation cannot be performed unless there are facilities in the hospital to provide blood for transfusions. The management of children around the time of such an operation is very complicated and requires collaboration with experienced anaesthesiologists (*125*). The post-operative care of the grafted wounds and the areas from which skin has been taken for the grafts calls for a team of trained nurses and occupational and physical therapists. For these reasons, early excision and grafting may not be an appropriate course to be taken in some low-income countries.

Sadly, the usual fate of a child with an extensive third-degree burn in a low-income country is death. The risk of mortality from burns covering over 30% of total body surface area is roughly 50%. The risk of burns covering more than 50% of total body surface area is nearly 100% (*56*). For those children who survive such severe burns, most are left with unsightly scarring, resulting in both physical and psychological disability.

Dedicated trauma centres

Not all children require treatment from a dedicated trauma centre. A large number of countries now have such centres and criteria exist for deciding which patients are transferred to them. The American College of Surgeons and the American Burn Association recommend that children with the following conditions should be treated in a burns centre (*130*):

- partial thickness (second-degree) burns greater than 10% of the total surface area of the body;
- burns involving the face, hands, feet, genitalia, perineum or major joints;
- full-thickness (third-degree) burns;

– electrical burns, including injuries from lightning;
– chemical burns;
– injuries from inhaling smoke;
– pre-existing medical disorders that could complicate the management of burns, prolong recovery or affect survival;
– accompanying trauma, where the burn injury poses the greater risk of morbidity or mortality.

While it is well established that trauma systems prevent unnecessary deaths in patients with blunt or penetrating injuries (*131*), there are few data to sustain this argument in the care of burn patients (*132*). Nonetheless, expert opinion supports the claim that patients with serious burns will have better outcomes and with less costly management if they are in a dedicated burn centre (*133*).

Rehabilitation facilities

Children who sustain burns deserve the best rehabilitation facilities available, so that they are able to return to productive and meaningful roles within their community. The requirements for rehabilitation should be discussed during the acute phase and should involve not only physical but also psychological therapy (see Box 4.6). Inadequate rehabilitation can result in physical and psychological damage with a serious lifelong effect.

BOX 4.6

Rehabilitation for paediatric burn survivors in South Africa

Burn injuries are tragic, largely preventable and frequently have lifelong consequences for the young patient. In South Africa these injuries are on the increase. This is due to factors such as poverty, illiteracy, a lack of resources, urban migration and the consequent rising number of makeshift housing settlements.

New developments and improvements in burn care generally have led to increased survival rates and a fall in the death rate. However, paediatric burn survivors need more than excellence in wound care, surgery and nursing. They also require in-depth rehabilitation, consisting not only of physiotherapy and occupational therapy, but also of emotional support and reintegration into the community.

An estimated 90% of children who have survived burns are not followed up. Once a child is discharged from hospital, the parents often do not recognize that follow-up rehabilitation or long-term reconstructive surgery may be needed. For those who do receive rehabilitation services, the emphasis is largely on physical rehabilitation, rather than emotional support and community reintegration. South Africa has an acute shortage of appropriately-trained professionals to provide for the complex rehabilitation needs of burn survivors.

At Cape Town's Red Cross Hospital burns unit, up to 96% of children admitted are from disadvantaged communities. A study at this hospital in the late 1970s found that up to 70% of severely burned children either attempted or actually committed suicide. In 2002, health professionals at the hospital set up a three-tiered pilot rehabilitation project for burned children and their families.

The first phase of rehabilitation starts as soon as possible during the admission stage. At this point individual physiotherapy, occupational therapy and the management of pain is arranged. A community worker will also become involved, responsible for parental support during this first phase and for long-term follow-up of disfigured children during the final phase of rehabilitation. The Red Cross Hospital is unique in including touch therapies – such as reflexology and aromatherapy – in the management of burns, along with more traditional treatments such as music and art therapy. This holistic approach thus attempts to deal with stress and anxiety, as well as with the general emotional well-being of the child.

The second phase is on an out-patient basis and continues what was started in the first phase. The previous therapies are again offered, along with such things as children's yoga and creative play. The use of the African drum (jembe) has been found to be particularly successful in music therapy.

The third and final phase of rehabilitation focuses mainly on community and school reintegration. Information is disseminated through the mass media on the situation of disfigured children and their needs. Teachers from 63 township schools have received training around the prevention of burns and the reintegration into the education system of children disfigured by burn injuries. Continuous education for children is the single most important outcome of their successful rehabilitation. Disfigured children are often reluctant to return to school for fear of being ostracized. If they stay uneducated they are more likely to be unemployable. In South Africa, this could lead to the child's ending up on the streets or in prison.

Through this programme, the Red Cross Hospital aims to provide for the emotional needs of children who have suffered burns and help them become fully reintegrated into society. For financial reasons, only the first phase of the three-phase programme is being offered at present. Community reintegration of burned children can be achieved, even in the developing world. However, this requires dedicated, trained staff and the substantial financial resources which are sadly lacking.

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Adapting interventions

The extent to which interventions that work in one socioeconomic setting can be effectively transferred to another depends on several factors. The advantage of transferring an established intervention – if that is possible – is that resources are conserved. A decision, though, to implement a particular intervention measure in a particular place should always be based on solid scientific evidence, considerations of cost, cultural appropriateness and sustainability (*134*).

Potentially harmful interventions

First-aid treatment for burn injuries is best accomplished with cool water (*127, 135*). Traditional treatments, though, continue to be practised. These include putting butter or oil on sunburn, and ice, aloe, sugar water, toothpaste or other household products on a second-degree burn. All these traditional practices can be harmful, as they can cause the skin to slough away, leaving the tender lower layers susceptible to infection. Although some agents – such as honey or commercially available cold packs – may indeed have some beneficial effects, they are better avoided. Instead, people should be advised to use only cool, clean water.

Evaluating interventions

A number of evaluation studies have been conducted in high-income countries. These include an economic analysis of 1990 that found that three quarters of childhood fire-related deaths in the home could be prevented if there were working smoke alarms, sprinkler systems, anti-scald devices, slow-burning cigarettes and childproof lighters (*136*).

There are no systematic evaluations, though, of burn prevention strategies in low-income and middle-income countries. Nevertheless, a number of interventions appear promising. Among them are: separating cooking areas from living areas; eliminating the storage of flammable substances in the house; placing cooking surfaces higher than ground level; introducing smoke alarms; making first aid available; and increasing awareness about burns and their prevention (*137*). At the same time, others, such as community-based interventions and campaigns (*138*) and home visitation programmes for at-risk families *(139)*, have insufficient evidence for them to be promoted as good practices.

Further research in these areas is needed so that model intervention programmes can be developed for implementation in countries that share a similar pattern of childhood burns.

Conclusions and recommendations

There is overwhelming evidence that childhood burns are largely environmentally conditioned and preventable (*93*). It would therefore seem natural that the prevention of burns should focus on a mixture of environmental modifications, parental education and product safety (see Table 4.4).

Special attention needs to be paid to the kitchen, the scene of the majority of burns. Programmes are needed to ensure proper supervision of children and their general well-being, particularly of those with disabilities. Parents should receive better information about all types of burns. There must be much greater awareness everywhere about the dangers of storing flammable substances in the home.

Recommendations

A range of measures to prevent burns have been discussed in this chapter. Many of these still require rigorous evaluation, particularly in low-income and middle-income countries.

- Those prevention interventions that have proved effective include:
  - laws and enforcement for the installation of smoke alarms;
  - child-resistant lighter standards;
  - laws to regulate hot-water temperature.
- A number of other prevention interventions are considered highly promising. These include:
  - the use of safe lamps;
  - the separation of cooking areas from living areas;
  - the development of safer stoves.
- As regards measures taken after the event, two fire related measures are strongly recommended:
  - smoke alarms;
  - residential sprinkler system.
- The management of burns, from first aid to rehabilitation, is an essential component of secondary and tertiary prevention strategies. Children who suffer burns require the best care available so as to minimize the potentially serious physical and psychological long-term consequences of this type of injury.
- Educational programmes convey knowledge to children and parents. They are useful for creating a climate in which campaigns for changes in behaviour and in products will be supported. For prevention purposes, educational programmes are often combined with programmes involving legislation and standards and product modifications. Education and counselling *on their own*, though, whether at the individual level or within schools, appear to be ineffective in reducing the incidence of burns.

"Thermal burns are a common cause of accidental death in children worldwide. Despite various methods of prevention and care, such injuries are on the rise. Only through a deeper understanding of the underlying causes can we develop truly viable alternative solutions. If the proposals outlined in this report are implemented correctly, they can bring about the necessary changes." Mehmet Haberal, President, International Society for Burn Injuries.

TABLE 4.4

Key strategies to prevent burns among children

Strategy	Effective	Promising	Insufficient evidence	Ineffective	Harmful
Setting (and enforcing) laws on smoke alarms	■				
Developing a standard for child-resistant lighters	■				
Setting (and enforcing) laws on hot-water tap temperature and educating the public	■				
Treating patients at dedicated burns centres	■				
Separating cooking areas from living areas		■			
Developing standards and codes for fire-retardant garments		■			
Banning the manufacture and sale of fireworks		■			
Promoting the use of safe lamps and stoves		■			
Providing first-aid for scalds – "cool the burn"		■			
Conducting home visitation programmes for at-risk families			■		
Installing residential sprinklers			■		
Distributing smoke alarms on their own (without accompanying laws)			■		
Conducting community-based campaigns and interventions			■		
Storing flammable substances correctly			■		
Modifying the environment, e.g. home alterations			■		
Conducting school-based burns prevention programmes			■		
Using traditional remedies on burns					■

Source: references *120, 137, 138*.

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