BURN PREVENTION

SUCCESS STORIES
LESSONS LEARNED

World Health Organization

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Burns are a major public health problem globally. Fire-related burns alone account for more than 300 000 deaths per year, with more deaths resulting from scalds, electrical, chemical and other types of burn. Most of these deaths (95%) occur in low- and middle-income countries. Deaths are only part of the problem. For every person who dies from burns, many more are left with lifelong disabilities and disfigurements. These in turn have further consequences, including stigma, rejection and economic loss, both for the burn victim and their family.

There are many committed individuals and organizations working to confront the burden of burns in their own locations and globally. In order to assist these efforts, the World Health Organization (WHO) in 2008 – in collaboration with burn experts from around the world – released *A WHO plan for burn prevention and care* – hereafter referred to as the *Burn plan*. This set out a broad-based strategic plan to catalyse burn prevention and care efforts globally. It highlighted the need for improvements in burn prevention and burn care, as well as better information and surveillance systems, and increased attention to research and training. The plan included actions for WHO to undertake, and other actions for those working in burn and public health communities everywhere to take on.

One of the needs identified in the *Burn plan* was for more implementation of burn prevention strategies globally, especially in low- and middle-income countries. Those who compiled the *Burn plan* felt this could be encouraged by sharing information about effective burn prevention strategies already underway, and how to implement them. Also identified was a strong need for information to help burn prevention groups carry out more rigorous programme evaluation and monitoring.

In response to these needs, WHO compiled this publication, which includes examples of successful burn prevention strategies from around the world, and from a wide spectrum of economic situations. Strategies that have been shown to lower burn rates in high-income countries include smoke alarms, lowering hot water heater temperatures, and regulating the flammability of clothing, especially children's sleepwear. Some of these interventions are applicable to burn prevention globally, especially in urban areas and middle-income countries, but for much of the world, additional risk factors for burns exist and additional strategies are therefore needed. Thus, this publication also contains examples of promising burn prevention efforts that specifically address the burn scenario in low- and middle-income settings, such as safe wood-burning stoves and a comprehensive programme to decrease acid-throwing against women.

These examples have common themes and lessons learned. Foremost among them is that, as with any other health problem, burns can be addressed effectively and scientifically. This includes identifying the risk factors for burns through surveillance and research; developing well thought out prevention strategies that target these risk factors; and evaluating the results of these strategies rigorously, so that those that work can be promoted and those that do not can be stopped, with resources shifted elsewhere. Developing effective interventions is only part of the picture. There is a need to implement them population-wide, which requires a public health approach combining engineering, legislation and enforcement, and education and social marketing. For all of this, there is a need for advocacy, coalition building, and collaboration between different sectors and groups who may not be used to working together.

On behalf of the many people who have contributed to this publication and the millions of people whose lives could be saved, I call upon all of those working in burn prevention, those working more broadly in public health, and all who would like to reduce the unacceptable burden of burns globally, to make use of the lessons learned from the examples in this publication.

Etienne Krug, MD, MPH
Director
Department of Violence and Injury Prevention and Disability
WHO, Geneva

Contributors

EDITORS

Charles Mock, Michael Peck, Catherine Juillard, David Meddings, Andrea Gielen, Lara McKenzie

CONTRIBUTORS of case studies, boxes, tables, and other written material (in addition to editors)

Rajeev Ahuja, Rob Baardse, Kendra Bowman, Nigel Bruce, Shobha Chamania, Wilma Lopez de Benavides, Joseph Molnar, Irma Oen, Monira Rahman, Frederick Rivara, Federica Sansone

PEER REVIEWERS (excluding editors)

Rajeev Ahuja, Mick Ballesteros, Douglas Bettcher, Welsly Bodha, Kendra Bowman, Nigel Bruce, Pascal Cassan, Shobha Chamania, Meena Cherian, Gregory Connolly, Shane Diekman, Etienne Krug, Jacques Latarjet, Grace Lo Yuen Fong, Wilma Lopez de Benavides, Sue Lukersmith, David Mackie, Andrew McGuire, Joseph Molnar, Nguyen Nhu Lam, Irma Oen, Alana Officer, James Partridge, Tom Potokar, Monira Rahman, Elizabeth de Guia Tecson, Gemma Vestal

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Cover photo: Bruce Sutherland

Executive Summary

Greater application of burn prevention strategies globally would go a long way towards lowering the unacceptable burden of death and suffering from burns. There are many strategies that have proved to be effective, but have not been sufficiently promulgated globally.

The goal of this publication is to disseminate information on burn prevention strategies that have been successful, as well as those for which there is preliminary evidence suggesting their effectiveness, especially in low- and middle-income countries. This publication focuses on practical, affordable, and sustainable solutions and provides useful "how to do" methods. It also seeks to dispel the belief that little can be done to prevent burns. By so doing, and by providing lessons learned about on-the-ground methods for promoting burn prevention, this publication also seeks to catalyze increased burn prevention activities globally.

The publication first provides an overview of the basic principles of injury prevention, as applied to burns. Injuries in general and burns in particular can be addressed scientifically and effectively, just like any other health problem. Case studies of burn prevention strategies are then provided in two main categories – those that have been proven effective or have promising evidence of effectiveness, and those with preliminary evidence of effectiveness. Evidence for those in the proven/promising category includes well-documented scientific studies showing their effectiveness, as well as population-wide rates of burns decreasing sustainably over years and decades in response to widespread implementation of the strategies. Most of the evidence for successful strategies (e.g. smoke alarms, hot water heater temperature regulation) comes from high-income countries. Many of these strategies are indeed relevant globally, in locations where the epidemiological patterns and risk factors for burns are similar, such as in urban areas of middle-income countries.

However, for much of the world, especially rural areas and low-income countries, different risk factors contribute to the incidence of burns and different epidemiological patterns apply. In some settings, these risk factors are additional to risk factors found in high-income countries. In some settings, a totally different set of risk factors applies. Hence, there is a need for different strategies. There are virtually no reports of well-evaluated burn prevention strategies in such locations. Hence, this publication gives several examples of strategies that have shown preliminary evidence of success, including those in low- and middle-income countries.

Major strategies that are in widespread use are covered, but this publication is not meant to be an exhaustive description of all burn prevention strategies in use. Each case study follows a similar structure. The nature of the problem is first presented, including risk factors that need to be addressed. The solution is next presented, from a technical viewpoint, showing evidence for why and how the particular strategy works to prevent burns. Finally, implementation methods are discussed, as to how the strategy has been promoted population-wide. This focuses on practical, real-world aspects, such as how burn prevention strategies can be implemented through advocacy and coalition building, legislation and law enforcement, as well as social marketing and education. Examples of such real-world implementation are presented for a range of countries.

STRATEGIES WITH PROVEN OR PROMISING EVIDENCE OF EFFECTIVENESS

SMOKE ALARMS Many people die in fires in homes or other buildings because they are trapped or overcome by smoke before they can escape. Smoke alarms provide an early warning system,alerting people and allowing them time to escape before the fire spreads. Implementing this technological solution involves drawing up laws that require smoke alarms in new buildings, and education and social marketing to persuade people to install them in older buildings and change the batteries regularly.

HOT WATER HEATER TEMPERATURE REGULATION Children are especially at risk of scald burns, from hot liquids such as water boiling on stoves or hot beverages. A major risk factor is tap water that is too hot. Lowering the set temperatures of hot water heaters can virtually eliminate this type of burn. Implementation of this simple technological solution has involved laws requiring manufacturers to set temperatures at a defined safe level (usually 50°C). This has been supplemented by social marketing to get people with already installed hot water heaters to decrease the thermostat settings to the safe level.

FLAME-RETARDANT SLEEPWEAR Some types of fabrics are more likely to catch fire than others. An especially notable problem had been burns to children from their night clothes catching fire, such as from contact with stoves or heaters. A change in the type of fabric and how close fitting it is can lower the flammability. Decreased flammability of sleepwear has been instituted by changes in laws and regulations for testing. These laws have been brought about through advocacy by coalitions concerned with reducing childhood burns. In jurisdictions where they have been enacted, these laws have been remarkably effective and have virtually eliminated this type of burn.

This publication also looks at strategies used to combat other causes of burns. This includes electrical safety, sprinklers, child-resistant lighters, fire-safe cigarettes, and banning the manufacture and sale of fireworks.

CASE STUDIES WITH PRELIMINARY EVIDENCE OF EFFECTIVENESS

SAFE STOVES AND LAMPS In many low- and middle-income countries, burns are often caused by stoves and lamps that are unsafe. This includes paraffin (kerosene) lamps and stoves that are prone to being knocked over – either burning a person directly or causing a house fire. Also included in this category are the many burns that occur from scalds from cooking pots on open wood fires at ground level that are easily knocked over, especially by toddlers. Several countries are now reporting preliminary progress with engineering designs for stoves and lamps that decrease these risks. This includes a safe paraffin lamp in Sri Lanka and a safe stove in Guatemala.

ACID-THROWING In several countries, a form of violence has become tragically common whereby acid is thrown on a person's face in order to disfigure him or her. The effect on the disfigured person is

usually devastating. In Bangladesh, this is often done by intimate male partners or by would-be suitors who have felt rejected. In an effort to prevent this crime and to provide assistance to survivors, the Acid Survivors Foundation (ASF) was founded. This has worked to prevent acid burns through efforts to establish legal disincentives to the crime (i.e. assuring more timely and certain prosecution of offenders), decrease the availability of acid on the open market,and change attitudes in society so that men attacking women in this way is no longer acceptable. As a result, rates of burns from acid-throwing have steadily decreased in Bangladesh over the past 5 years. This case study provides an example of a burn prevention strategy that confronts *intentional* burns, in comparison to the other case studies that address *unintentional* burns.

MULTIFACETED COMMUNITY PROGRAMMES In many of the above case studies, laws have proven more effective than educational campaigns. Yet educational campaigns can play a significant ancillary role, such as by getting people to maintain legally mandated devices (e.g. smoke alarms) or undertake other safe behaviours. In order for educational campaigns to work, they must be well designed, highly focused and rigorously evaluated. A model injury prevention/health promotion community-based project in Harstad, Norway, which significantly lowered rates of childhood burns, is described.

LOWERING THE BURDEN OF BURNS THROUGH CARE

Most of this publication is concerned with primary prevention. Nonetheless, gains are to be made in improving care of burn victims at all points along the spectrum, from first aid and prehospital care, to hospital care, rehabilitation and recovery. Given their reach into the community,prevention programmes can overlap with, and help to promote, better first aid. This includes elimination of harmful practices as well as increasing the availability of effective first aid measures, such as rapidly cooling the burn. Those involved with burn prevention can also help to advocate for improvements in other aspects of burn care. In hospital care, numerous advances have lowered burn mortality rates. These include better initial treatment to prevent shock and breathing problems, better infection control, increased use of skin grafts and assuring adequate nutrition.

Burn survivors can often be left with disability and disfigurements that hamper their return to active, fulfilling life. Rehabilitation measures such as physical therapy to keep joints mobile and muscle strength up, splints to prevent deformities, and addressing psychological issues,can assure a brighter future for burn survivors. Burn survivor self-help groups can also provide emotional support and practical assistance during the often long recovery period after hospital discharge. Almost all of these measures for improved hospital care and rehabilitation and recovery are feasible and affordable for countries at all economic levels, and especially need to be better promoted in low- and middle-income countries. Burn prevention advocates can play a major role in making this happen.

CONCLUSIONS AND LESSONS LEARNED

This publication ends with a summary of lessons learned from all of the case studies. Successful burn prevention strategies contain several common features. Among these is use of the scientific method. Risk factors for burns are identified from research and surveillance. Prevention strategies are developed to specifically address these risk factors. The fact that the effectiveness of these prevention strategies depends on solid evidence is stressed, including laboratory and engineering evidence, intervention trials, and monitoring of population-wide rates. Once the techniques of prevention strategies are worked out, they need to be implemented widely. This involves the need for advocacy and building coalitions, both to change and enforce laws and to promote safety-related behaviour change. For all of these, there are often frustrations and setbacks, and burn prevention experts and advocates must be prepared to be patient and persistent.

After the main publication, there is an annex on how-to-do methods for planning, implementing and evaluating burn prevention programmes. This emphasizes the importance of evaluation and monitoring – the all-too-often neglected components of burn prevention work. However, they are highly important for understanding what really works, so that it can be promulgated and scaled up, and what does not work, so that it can be modified or discontinued with resources shifted elsewhere. This annex contains guidance on techniques for evaluation and monitoring of burn prevention interventions, ranging from those whose effectiveness is well established to those that are experimental, and from small programmes to large, nationwide efforts.

In summary, this publication seeks to provide information on a range of burn prevention strategies. One or more of these can apply to countries at all economic levels. The general approach and scientific foundations of burn prevention are universally applicable. We hope that this publication fosters greater collaboration and exchange of ideas among those working in the field, and leads to more widespread and systematic efforts to prevent burns in all countries.

CHAPTER 1

INTRODUCTION

Burns are a serious global public health problem. There are over 300 000 deaths per year from fires alone, with more deaths from other types of burn, including scalds, and electrical and chemical burns. In addition, millions more are left with lifelong disabilities and disfigurements,often with resulting stigma and rejection. All of these result in further personal difficulties and economic losses for victims and their families.

The vast majority (over 95%) of these burns occur in low- and middle-income countries. Rates of fire-related burn deaths in low- and middle-income countries are 5.5 deaths/100 000 people per year (1). This is nearly six times higher than the 0.9 deaths/100 000 people per year in high-income countries. This is one of the largest discrepancies for any injury type. Further, burn victims in low- and middle-income countries are often among the poorest and most vulnerable – those least able to cope with the often devastating economic consequences.

The high rate of burn death and disability in developing countries is all the more tragic because it is so avoidable. Burn prevention efforts in high-income countries have effectively and sustainably lowered burn rates over the past 30 to 40 years. This has included a variety of strategies, aimed at the risk factors prevalent in those high-income societies. These strategies have included smoke alarms, hot water heater regulation, codes for electrical and other aspects of housing construction, among others. Thus far, similar strategies have been addressed only in a preliminary way for most low- and middle-income countries.

To confront the unacceptable burden of burns in low- and middle-income countries, WHO,the International Society for Burn Injuries (ISBI), and other partners met in 2007 to establish A *WHO plan for burn prevention and care* (2). This meeting established an agenda for action for stakeholders worldwide. One of the key action items that the plan recommends is greater implementation of burn prevention efforts in low- and middle-income countries. One of the barriers to greater implementation is the lack of widely available information on what constitutes effective burn prevention strategies and programmes. The current publication is designed to confront this barrier. It aims to provide information on effective burn prevention strategies,written in a "how-to-do" fashion. The publication is intended to demonstrate benefits of burn prevention strategies (including real-world case studies), provide guidance on how to implement them, and to stimulate the field of burn prevention globally.

One challenge to this is that many of the burn prevention strategies used in high-income countries are not universally applicable – even though a few of them could address the risk factors for burns in some low- and middle-income settings, especially urban environments and middle-income countries. These include strategies such as smoke alarms, regulation of hot water heater temperature, and housing codes to make electrical wiring safer. However, in many low-income countries, especially in rural areas and among the urban poor, the

epidemiological patterns for burns – and their risk factors – differ notably from those in high-income countries. Thus, very different strategies are required. Some of the risk factors that need to be confronted include: use of cooking pots at ground level (that are easily knocked over and can cause scalds,especially among toddlers); use of kerosene (paraffin) stoves and lamps that are easily knocked over and can then ignite; and wearing of loose fitting cotton clothing which can ignite while cooking on an open fire. Rigorous documentation of the effect of prevention efforts aimed at these risk factors and scenarios is, to date, very limited.

Thus, this publication contains descriptions of successful, well-documented burn prevention strategies in high-income countries. These will be of direct relevance in some settings (e.g. urban, middle-income). They will also be of more general interest in all settings, in terms of using research to discern the risk factors that lead to burns, developing interventions that confront these risk factors, evaluating the effect of such interventions to be certain about what works, and widely implementing strategies that really do work. This publication also contains examples of burn prevention strategies that specifically confront the difficult and sometimes unique circumstances of low- and middle-income countries, and that have shown preliminary evidence of effectiveness. Although specific strategies cannot yet be recommended for widespread implementation, the scientific principles upon which they are based and the careful manner in which they have been carried out are indeed widely applicable.

The intended target audience for this publication includes public health and other professionals working in ministries of health, hospitals, clinics, and other health care settings. It also includes people from many other backgrounds working in non-government organizations, in civil society,or even on their own. The case studies emphasize the need for multidisciplinary collaboration and the role that people from many walks of life can play in developing and implementing burn prevention strategies.

CHAPTER 2

BASIC PRINCIPLES OF INJURY AND BURN PREVENTION

This chapter starts with an overview of the field of injury prevention, specifically in relation to burns, so that those not familiar with this field may obtain a working knowledge of it. Examples from burn prevention will be emphasized, with other examples from the wider field of injury prevention used to help place burn prevention in a broader context. This chapter will show that injuries in general, and burns in particular, can be most effectively addressed when they are approached like any other disease, using the scientific method.

It was not until the 1960s and 1970s that work by Haddon (3) and others introduced the application of epidemiological principles and scientific methods to the problem of injuries. Injuries came to be understood as resulting from an uncontrolled transfer of energy to the human body in amounts that a body cannot tolerate. This can involve several types of energy, such as kinetic energy (as in a motor vehicle crash or fall) or thermal injury (as with burns). Injuries are defined as "any unintentional or intentional damage to the body resulting from acute exposure to thermal, mechanical, electrical, or chemical energy, or from the absence of such essentials as heat or oxygen" (4). These transfers of energy are the disease-producing agent, just as with a bacteria or toxic chemical. Moreover, they can occur either unintentionally or intentionally (such as through acts of violence). Because we can study how these transfers of energy occur, injuries – both unintentional and intentional – can be predicted and prevented (4–9). Today, we have textbooks and academic programmes devoted to the science of injury and violence prevention (7, 8, 10–13), making it ever more likely that this public health problem will ultimately be more effectively controlled.

UNDERSTANDING BURNS USING THE HADDON MATRIX

The factors leading to a burn or other injury may be best understood using Haddon's Matrix (Table 2.1). This framework explains that injuries result from an interaction of a host (human), an agent (energy), and an environment (physical or social). The second dimension of the matrix is the time sequence of events with the potential to produce an injury: pre-event, event, and post-event periods.

The pre-event phase is concerned with whether an event that could cause a burn will occur (e.g. will the pot with boiling water be tipped over?). In the event phase, the central interest is whether an injury will occur (e.g. will the child be scalded when the pot is tipped over?). In the post- event phase, we are concerned with how severe the injury and its consequences will be (e.g. how severely will the child be burned and will the child receive adequate treatment for the burn?).

The importance of these distinctions is that they lead to multiple intervention options – we can change the likelihood of an injury-producing event, the likelihood of an injury, and the consequences of an injury. We can do this by changing the individual (and their behaviour), the agent of injury or the environment (14, 15).

Table 2.1

THE HADDON MATRIX APPLIED TO THE RISK FACTORS FOR BURNS

PHASES	FACTORS			
	HOST (PERSON)	AGENT	PHYSICAL ENVIRONMENT	SOCIOECONOMIC ENVIRONMENT
PRE-EVENT	Use of fireworks. 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.	Housing in slums or congested areas. Overcrowded households. No separation between cooking area and other areas. Unsafe electrical wiring. High (unsafe) temperatures of hot water heaters.	Poverty, unemployment, illiteracy. Lack of fire-related building codes and their enforcement. Societal attitudes on acceptability of acid-throwing.
EVENT	Poorly maintained smoke alarms and sprinkler systems. Child not wearing flame-retardant sleepwear. Poor knowledge about evacuation procedures	Lack of sprinkler systems. Lack of fire hydrants or other access to water supply.	Lack of functioning smoke alarms. Lack of clear and easily accessible escape routes. Lack of access to telephone to call for help.	Lack of policies or laws on smoke alarms. Inadequate communications infrastructure forcalling emergencyservices.
POST-EVENT	Lack of knowledge of first aid.	Flammability of household materials and children's clothing. Toxicity of smoke and burning household materials.	Low level of first aid, emergency medical services, and hospital burn care.	Inadequate access to burn centres and rehabilitation services. Insufficient community support for those who have suffered burns.

Source: adapted from reference (23)

INJURY COUNTERMEASURES

The principles summarized in the Haddon Matrix help to explain factors that lead to injury. These principles serve as guidelines for the development of prevention efforts. From these can be derived 10 prevention strategies, also called countermeasures or interventions (9, 14, 15). Most current strategies for prevention and control of injuries are conceptually derived from these 10 strategies, which are listed in Table 2.2 with examples.

In general, interventions can be thought of as either being active or passive on the part of the person being protected. *Active* interventions involve a behaviour change and require people to perform an act such as putting on a helmet, fastening a seat-belt, or not smoking in bed. *Passive* interventions require no action on the part of those being protected and are built into the design of the agent or the environment, such as separation of vehicle routes and pedestrian walkways, lower (safer) temperatures in hot water heaters, or safer electrical wiring in housing. In general, passive interventions are more reliable and effective than active ones when they function properly because they require no human action or reaction (9, 15). In reality, passive strategies often require behavioural compliance of some type; for instance, people must be convinced to lower the temperature of their hot water heaters. Likewise, passive strategies often require an action on the part of decision-makers such as policy-makers and manufacturers who can mandate built-in passive protection (e.g. newly manufactured water heaters pre-set at safer hot water temperatures) (12).

IMPLEMENTING COUNTERMEASURES USING THE 'THREE Es'

While the countermeasures described above are logical and understandable, implementing such strategies in the real world involves a variety of practical considerations and challenges. In general, implementation takes place through the "three Es":

- ENFORCEMENT (including legislation)
- EDUCATION
- ENGINEERING

LEGISLATION and ENFORCEMENT can work at different governmental levels. For example, national-level legislation often regulates safety features built into the design of products (such as flame-resistant sleepwear). Legislation has been quite successful in supporting injury prevention goals, both in terms of changing the risk environment as well as in mandating individual safety behaviours (8). Enforcement of effective legislation is key to the effectiveness of policy solutions. For instance, laws requiring landlords to install smoke alarms will have little impact if there is no monitoring and enforcement of compliance. States or provinces and local governments often have responsibility for defining and establishing safety-related laws (e.g. building codes) and products that can be sold (e.g. fire-safe cigarettes) and products that must be included in new home construction (e.g.

Table 2.2

STRATEGIES TO DISSOCIATE POTENTIAL INJURY-PRODUCING "ENERGY" FROM THE HOST
both for general injuries and burns (in italics)

PRE- EVENT PHASE	Prevent the creation of the hazard; prevent the development of the energy that would lead to a harmful transfer, e.g. prevent manufacture of certain poisons, *fireworks*, or handguns. Reduce the amount of the hazard, e.g. reduce speeds of vehicles, *reduce temperature of water in hot water heaters.* Prevent the release of the hazard that already exists, e.g. placing a trigger lock on a handgun, *safe stoves that decrease the likelihood of burns.*
EVENT PHASE	Modify the rate or spatial distribution of the release of the hazard from its source, e.g. seat-belts, airbags, *installing thermoscopic or thermostatic mixing valves in the hot water supply pipe, so that extremely hot water from water heater is diluted and is lower in temperature by the time it reaches the tap.* Separate in time or space the hazard being released from the people to be protected, e.g. separation of vehicular traffic and pedestrian walkways, *smoke alarms that alert people to a fire early on when there is still time to escape.* Separate the hazard from the people to be protected by a mechanical barrier, e.g. protective helmets, ***insulation of electrical wires,*** *fire-protective equipment (including self-contained breathing apparatus) for fire fighters.* Modify the basic structure or quality of the hazard to reduce the energy load per unit area, e.g. breakaway roadside poles, rounding sharp edges of household tables, *dilution of strong acids (e.g. hydrochloric acid) for distribution as a household cleaning agent.* Make what is to be protected (whether alive or inanimate) more resistant to damage from the hazard, e.g. prevention of osteoporosis, *fire and earthquake resistant buildings, flame-retardant sleepwear.*
POST- EVENT PHASE	Detect and counter the damage already done by the environmental hazard, e.g. *first aid, emergency medical care.* Stabilize, repair, and rehabilitate the damaged object, e.g. *acute burn care, reconstructive surgery, physical therapy.*

smoke alarms, residential sprinkler systems). Of course, what level of government enacts what types of laws varies between different countries.

EDUCATION has been a mainstay of injury prevention work. Education typically seeks to inform and persuade individuals to make informed decisions about adopting specific safety behaviours (16). In injury prevention, this has been focused on at-risk individuals or the general population, and on legislators to educate them about specific injury risks and policy solutions (17–19). Education is most often considered necessary, but insufficient, for behaviour change (16). For example, educating people as to the importance of installing smoke alarms might need to be coupled with efforts to promote greater availability of these devices. Educational efforts need to be based on solid principles of social marketing[1] and to be well planned in order to be effective and sustainable (12).

ENGINEERING and technology address a variety of issues, such as development of safer roadways, smoke alarms and automatic protection for manufacturing equipment. There have been numerous injury prevention success stories that illustrate the impact of engineering and technological fixes. In fires and burns, for instance, engineering advances have included smoke alarms, flame-resistant sleepwear, fire-safe cigarettes, and flame-resistant household materials (20). An engineering solution is most often the recommended first line of defence against an injury hazard because if effective, it can more passively protect individuals. Engineering solutions can also make it more difficult or impossible to behave in an unsafe manner (e.g. child-resistant cigarette lighters to reduce the likelihood that a child will be able to start a fire).

These three main modalities are frequently complementary. For example, smoke alarms and seat- belts are technological developments. Convincing people to adopt the behaviour of using them requires education and is reinforced through legislation. Convincing legislators to pass seat-belt laws or housing codes to require smoke alarms requires lobbying, advocacy, and education (4, 9).

THE NEED FOR MONITORING AND EVALUATION

Certain common principles run through many successful injury prevention programmes. These include a multidisciplinary approach, community involvement, and ongoing evaluation of both the process and outcome of the programme. Depending on the nature of the problem, a programme might involve contributions from health care professionals, public health practitioners, epidemiologists, behavioral scientists and psychologists, lawyers, manufacturers, law

[1] Social marketing in this context implies scientifically based efforts designed to help people adopt behaviours that are safe, healthy, or otherwise positive. It uses many of the same principles of advertising and marketing, but with the goal of behaviour change for social good, rather than making sales or profits.

enforcement officials, health education and health communication specialists, journalists, advertisers, and public relations professionals. Health care professionals might include those in primary care, such as paediatricians, and those involved in acute trauma/burn care. Finally, individual members of the public might be involved.

Importantly, community organizers, leaders, advocates and members of the public should be involved in the planning process. Community involvement is a long-standing principle of community-based public health work for both ethical and pragmatic reasons (16). Ethically, those who are the intended audience of a programme should have a say in what constitutes the programme, and, pragmatically, this involvement will result in more effective programmes.

One cannot stress enough the importance of monitoring and evaluation. This starts with a solid understanding of the burn problem in a given area or community, including knowledge of the epidemiological pattern of burns in the area (e.g. burden and major causes and risk factors) (21) . Once prevention activities are underway, care should be taken to document the effectiveness of these efforts, so as to know what efforts are effective and thus should be continued or even expanded. Likewise, it is important to know which efforts are not successful and hence should be adjusted or even discontinued, with resources shifted elsewhere.

The above is meant to be only a very brief introduction to the fields of injury and burn prevention. The Annex in this publication gives more detail on building and evaluating burn prevention programmes. Those requiring more information are suggested to read these cited references: (7, 8, 11–13, 22–24).

CHAPTER 3

Strategies with Proven or Promising Evidence of Effectiveness

Included in this chapter are summaries of burn prevention strategies whose effectiveness has been documented using several types of data. These include laboratory evidence (where required), data from individual epidemiological studies or controlled trials, and, for some, evidence of sustained decreases in population-based burn rates over 10 or more years in wide areas or entire countries. All of these examples are from high-income countries, in part because that is where the strategies have been implemented and in part because these countries have well developed data sources with which to track the effectiveness of the interventions. These burn prevention strategies can be strongly recommended for use in other locations, if the epidemiological pattern of burns and risk factors are similar to those of the high- income countries where they have been proven effective. Even in locations where the specific interventions are not directly applicable, these case studies nonetheless have useful information for any burn prevention effort, including how to identify risk factors, how to develop an intervention to target these risk factors, and how to rigorously evaluate the effectiveness of the intervention.

SMOKE ALARMS

Figure 3.1 Smoke alarm on ceiling
Source: Nationwide Children's Hospital, Columbus, USA

NATURE OF THE PROBLEM

In most industrialized countries, house fires account for the majority of burn deaths. Many of these deaths from fires actually result from smoke inhalation (25–27). Most house fire deaths occur because victims do not know their building is on fire until it is too late to escape or to call the fire department. Either they become trapped or they are overwhelmed quickly by smoke and related hypoxia (low oxygen) and carbon monoxide poisoning. When fires occur at night, many people either wake up when it is too late, or do not wake at all, dying in their sleep from the hypoxia and carbon monoxide.

Many injuries and deaths could be prevented if people knew sooner that a fire had started and thus had time to escape. Therefore, a key component for injury prevention for house fires is an early warning system, which is provided by smoke alarms. In this case, the preventive measure does not stop the fire but it does prevent the injury by allowing individuals to escape.

SOLUTION

A variety of devices have been invented to allow such early warning in the case of a fire, based on either detection of heat, smoke, or carbon monoxide (Table 3.1). All work on the same principle of giving off a loud sound to alert occupants to the presence of a fire. These are typically installed on ceilings in houses and other buildings, ideally in every separate sleeping area and on every separate level of the dwelling (28–30) (Figure 3.1). Smoke alarms can be battery operated with either an alkaline or, better still, a 10-year lithium battery; they can also be hardwired into the home's electrical system with a battery back-up.

Detection devices (primarily smoke alarms) have been shown to be effective in preventing fire- related deaths and injury (27, 29, 31). A working smoke alarm decreases the risk of death in a residential fire by at least 50% (27, 29), with some studies showing decreases in risk

of death of up to 86% (4). Moreover, smoke alarms are also a very cost-effective intervention. One study showed that every US$1 spent on smoke alarms saves US$28 of health-related expenditures on burn care (32).

IMPLEMENTATION OF THE SOLUTION

Although smoke alarms are an extremely effective injury prevention tool they are of no value if people do not use them correctly. This requires the proper placement of the alarms, regular testing, and changing the batteries at the proper intervals. Installation and maintenance of smoke alarms has been effectively implemented by both education and legislation. Educational campaigns have been run on a regular basis by local fire departments and non-profit groups. These activities educate people about fire and other safety topics, including the importance of having working smoke alarms in their home and the need to change the batteries (22).

Canvassing programmes in which fire department personnel go door-to-door distributing (and sometimes installing) alarms have been well evaluated (31, 33, 34). For instance, a smoke alarm give-away programme, accompanied by a publicity campaign, in one area with a high rate of residential fires led to a decrease of 80% in fire-related injuries in the following four years (35). These efforts to promote smoke alarms may be enhanced by training residents to develop and rehearse escape plans in advance, and considering whether ancillary devices, such as escape ladders, might be necessary (29). A considerable amount of work has been undertaken in the UK to reduce the risks of house fire deaths. Researchers have demonstrated the high need for smoke alarms among low-income families (36), and that a free distribution programme can significantly increase their usage in low-income communities (37).

Educational programmes run in clinics and hospitals have also been evaluated. In one early study, a simple one-to-one advice session led to nearly half of families purchasing a smoke alarm, compared to none in a control group (38). However, a more recent study in an emergency department serving low-income, inner-city families found that individual education and referrals to the fire department for free alarms had no effect on use of smoke alarms (39). Rates of self-reported smoke alarm use were more than 85%, making it difficult to achieve an impact with the intervention. Because earlier work with this community suggested that almost half of the families thought their smoke alarms were working, future educational programmes and evaluation need to emphasize issues of changing the battery and testing the smoke alarms to make sure they are in fact working (40). This also reinforces the importance of linking educational efforts with broader efforts, such as assuring that devices to be promoted are indeed available and affordable (as discussed below in the case study of Mexico).

In terms of legislation, many local or state/provincial governments have enacted laws that require placement of smoke alarms in all new buildings

and/or in all homes. In 1978, one of the first area-wide (county) laws stipulated the use of smoke alarms in all homes, resulting in a nearly 50% reduction in fire deaths over the following 5 years (41). While installation may be the responsibility of the builder and/or landlord, maintaining alarms by changing batteries at proper intervals remains the responsibility of residents.

Taken together, these measures have been extremely effective in increasing protection in high- income countries. For example, in the United States, where smoke alarms have been extensively studied, the percentage of homes with smoke alarms rose from 5% in 1970 to 67% in 1982, and to 95% in 2010 (4, 10, 29). During this same period, residential fire-related deaths decreased from nearly 5000 (2.2 per 100 000 people per year) in 1981 to 2704 deaths (0.9 per 100 000 people per year) in 2006, a decrease of 59% (42). There were other factors contributing to this decline, including safer heating and cooking appliances, child-resistant lighters, a decrease in smoking rates, and flame-resistant mattresses, furniture, and clothing (as discussed in a later section). While it may be difficult to assess the independent contributions of smoke alarms and the other interventions, it is certain that smoke alarms played a significant role (4, 10, 29, 43).

Nonetheless there is unfinished business. In the USA, it is estimated that smoke alarms are missing from 5% of homes, and this group accounts for 39% of reported home fires and nearly half of all reported home-fire deaths. There are over 4 million housing units without smoke alarms. If all homes had working smoke alarms, it is estimated that fire deaths would decrease by 30% and 890 lives would be saved per year (29).

Despite the fact that 95% of homes in the USA have smoke alarms, only about 75% of those are functional. These numbers are even worse among rural and low-income homes. A study in an economically depressed urban area found that 80% of homes had smoke alarms, but only 50% were working (40). This is particularly troubling because homes in these areas are at increased risk of home fires (44).

Addressing these remaining challenges requires a multifaceted approach, leadership, and strong collaboration, especially at the local level. As one example of a response to these issues, in 1998 the US Centers for Disease Control and Prevention (CDC), the US Consumer Product Safety Commission, the US Fire Administration and several other national organizations began to combine efforts to address the fire issue in the US. The CDC developed the Smoke Alarm Installation and Fire Education (SAIFE) Program (27, 45). It recommended six components as guidelines for other groups attempting to undertake similar work (Table 3.2). In summary, this programme involves recruiting local communities and community partners, hiring a local coordinator, canvassing neighborhood homes, installing longer lasting (10-year) lithium-powered smoke alarms, and providing general fire-safety education and 6-month follow-up to determine alarm

TYPES OF FIRE DETECTION SYSTEMS

FIRE DETECTION AND ALARM EQUIPMENT	SMOKE ALARMS	CARBON MONOXIDE ALARMS
Fire detection and alarm equipment refers to equipment designed to rapidly detect unwanted fires and to notify occupants. Detection systems are of several different types. The earliest versions were *heat detectors*, which were essentially basic thermometers with associated alarms for threshold temperatures. Used in the 1950s and 1960s, they are no longer in common use.	*Smoke alarms* come in two types – ionization and photoelectric. Ionization alarms have two electrically charged plates and a small amount of radioactivity that ionize the air and allow a current flow between the two plates. Smoke disrupts the current flow, activating the alarm (29). Photoelectric alarms have a light source aimed away from the detector. In the presence of smoke, the reflected light triggers the alarm. These two types of alarm have a different sensitivity – photoelectric alarms are more sensitive to smoldering fires and ionization alarms are more sensitive to flaming fires. Both types generally provide adequate warning.	*Carbon monoxide* alarms indirectly detect the fire by sensing a dangerous gaseous by-product. While not more effective than smoke alarms at preventing fire-related injury, they have been shown to be a helpful adjunct to preventing carbon monoxide poisoning. They are especially useful in circumstances where carbon monoxide alone, rather than within smoke, is the main risk, such as from gasoline-powered generators, motor boat engines, and other gasoline-powered appliances and heating equipment (28–30)

functionality. As of May 2010 this programme has demonstrated 90% functional alarms in follow-up surveys (of those the programme installed), potentially saving over 3000 lives in all the states that have been involved since the programme began. All of the elements of the SAIFE programme are eminently transferrable to the circumstances of low- and middle-income countries, with the exception that the commercial availability and affordability of smoke alarms would need to be assured, as pointed out in the example of Mexico below.

In addition, there are several technical features that help to achieve increased use and functionality of alarms (29). First, addressing nuisance false alarms is possible by moving the alarm further away

from cooking areas and using alarms that have a "hush" button to turn off the nuisance alarm easily. Second, installing multiple interconnected alarms can help, because when the first alarm is activated by the fire, all the alarms in the house respond, making it faster to alert all household members. Finally, replacing 9-volt alkaline-battery operated alarms with 10-year lithium battery alarms is a recommended practice.

There is virtually no literature on the use of smoke alarms in low- or middle-income countries. In one of the few studies on this topic, from Monterrey, Mexico, the presence of smoke alarms in homes was found to be very low, and to vary with socioeconomic strata, going from 9% (upper tertile of household income) to 4% (middle tertile) to 0% (lower tertile). There was no change in any group in response to an injury prevention educational campaign that included smoke alarm promotion. This failure was attributed to a near total lack of smoke alarms for sale in the local area. Thus, at least in this environment, there is considerable potential for improvement with effort to address availability and affordability of the safety product (46). Risks for house fire deaths in low- and middle-income countries may be derived in part by looking at the extent to which the housing stock in this location (construction materials) and neighborhood environments (economically poor, use of dangerous alternative heating sources, proximity to vacant housing, etc.) are similar to those that are at high risk in developed countries. These areas should be high- priority targets for the promotion of smoke alarms.

In conclusion, smoke alarms are a proven, cost-effective method to prevent deaths and injuries from house fires, the leading cause of burn-related death in most high-income countries. Likewise, proven methods exist to promote the implementation of this countermeasure, including both legislation and education. Importantly, increasing access to alarms, especially in resource- poor settings, is a critical element in successful community programmes.

Table 3.2

6 KEY COMPONENTS AND 17 ELEMENTS OF THE SMOKE ALARM INSTALLATION AND FIRE EDUCATION (SAIFE) PROGRAM

COMMUNITIES AND COMMUNITY PARTNERS

- Select target communities at greatest risk – such as those with fire mortality and incidence rates greater than state or national averages.
- Develop strong collaborations with individuals and organizations in target communities, including firefighters, health departments, schools and churches.
- Partner with fire departments. Firefighters are typically dedicated individuals working to serve their communities who the public associates with fire safety. In addition, they are respected members of their communities which can help them gain access to homes.

Source: adapted from reference (45)

LOCAL COORDINATORS

- Identify coordinators at the local level who are experts with regard to their community.
- Make local coordinators responsible for ensuring the success of projects at the community level; empower them to make decisions about the project design and implementation and to resolve problems as they arise.

ACCESS TO THE HOMES OF TARGET POPULATION

- Prior to visiting homes, inform the public about programme availability and logistics. Programmes have relied on local media, church bulletins, local health clinics and fire department news releases to raise awareness.
- In urban and suburban areas, use door-to-door canvassing. Two-person teams can efficiently canvass neighborhoods of homes that are within close proximity of the other.
- In rural areas it is more efficient to schedule appointments with residents.
- Leave written information on door hangers (i.e. knobs or handles) when no one is home so that residents can learn how to contact programme staff to reschedule a visit.
- Use alternative times such as weekday evenings and weekends. It may be easier to reach residents during alternative hours, and such hours are often better for volunteers with full time jobs.

PROGRAMME ACTIVITIES IN THE HOME

- Gain residents' verbal consent to participate in the programme.
- Once inside homes, programme staff can assess for existing alarms, determine their operational status, and install the necessary number of new long-lasting lithium-powered alarms.
- Deliver fire safety education with a core set of messages, but allow for variability depending on the circumstances in each home. In addition to tailoring messages for specific residents, states and/or communities may address topics of particular concern in their area.
- Have programme staff work in pairs to increase efficiency and safety; one person can install smoke alarms while the other delivers fire safety education.

INCENTIVES AND REWARDS

- Provide incentives to programme staff, especially to volunteers. Community programmes have purchased equipment for local fire departments, offered gift certificates to volunteers or have provided programme t-shirts.
- Formally recognize programme staff for their participation with certificates of appreciation, a recognition dinner, plaques for fire departments, or write-ups in local papers.

EVALUATION

- Develop an evaluation plan to measure progress toward programme goals and objectives

PREVENTION OF SCALD BURNS THROUGH REGULATION OF HOT TEMPERATURE

Figure 3.2 Setting the temperature on a hot water heater
Source: Michael Peck

NATURE OF THE PROBLEM

Scald burns are nearly as common as flame burns, especially in children. Across the globe approximately 5% of all burn deaths are from scalds, but they account for a much higher proportion of non-fatal burns (23). In high-income countries, hot tap water causes about one quarter of all childhood scald burns (most occur in the bathroom) and the damage of hot tap water scalds tends to be more severe than other types of scalds (47). For example, in Finland, 100% of children admitted to two burn centres between 1994 to 2004 were from hot water scalds (48). In the Netherlands, the most common cause of burn admissions for children aged 0–4 years is scalds (88% of burn admissions) (49).

SOLUTION

Burns can happen quickly with very hot water. For example, water at 60°C causes a burn within *3 seconds* of exposure (50). However, water at 49°C takes approximately 10 minutes to cause significant thermal injury to the skin. Hence, hot water heaters are ideally set at this temperature to give people time to escape the damaging effects before a burn occurs.

Thus, the solution to scald burns from hot tap water is technologically very straightforward. It is to lower the set temperature of the heaters to a safe temperature (generally 50°C) at which scalding would take more than 10 minutes to occur (Figure 3.2). Research has shown that widely implementing this temperature in hot water heaters can significantly reduce scald burns. For example, a Canadian study found a 56% reduction in scald burns from a programme to decrease hot water heater temperatures (51). Although there are costs associated with public health efforts to bring such changes into effect, the strategy itself (i.e. limiting the temperature) incurs no cost.

IMPLEMENTATION OF THE SOLUTION

Combined strategies using legislation and standards, as well as product modification and education, appear to have the most far-reaching effects in reducing scald burns. An example of how this can be achieved comes from Australia (Box 3.1 on page 18).

Successful solutions to reduce scald burns from hot tap water have also been documented in the US, Norway, New Zealand and Canada (52). In Washington state, USA, the number of domestic hot water scalds was reduced by combining an educational programme with a law that reduced the pre-set water heater temperature from 60°C to 49°C (53). As a result, 84% of homes changed to lower water heater temperature. Other educational interventions in Norway (54) and New Zealand (55) which sought to reduce 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 (51).

In the mid-1980s, one educational campaign was implemented that distributed thermometers along with utility bills. This campaign resulted in a reduction in the temperature of an estimated 20 000 hot water heaters (56). A similar study of a national media campaign, combined with an educational intervention, was conducted in Dunedin, New Zealand in the early 1990s. The majority of households still had temperatures above 55°C at the end of the intervention. However, there had been a 50% reduction in the number of households with hot water heater temperatures over 70°C (55).

In conclusion, lowering the temperatures of hot water heaters to safe levels (50°C or lower) is a proven method to prevent scald burns, especially among children. Likewise, proven methods exist to promote the implementation of this countermeasure, including both legislation and education. Legislation can especially address the set temperature of newly manufactured or newly installed hot water heaters. Educational efforts are needed to convince people to check and, if needed, lower the temperatures of existing hot water heaters. More broadly stated, such educational efforts also apply to the need to convince policy-makers on the need to implement related legislation.

Box 3.1

REDUCING SCALD BURNS IN AUSTRALIA

THE "HOT WATER BURNS LIKE FIRE" PROGRAMME

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

The first phase of the campaign aimed to raise awareness about the causes of scalds among children, the most serious and preventable one being hot tap water. This phase of the intervention involved community health-care staff, health promotion personnel, retailers, plumbers and members of the water heating industry. The second phase, which began in 1994, focused on how to modify temperatures of hot water taps in bathrooms. Following meetings with experts in infection control and hot water heater manufacturers, an amendment to the national standards on hot water delivery for personal purposes was introduced. Each state was then required 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 (a type of thermometer) and brochure with instructions on how to test and modify the temperature. Between 1989 and 1996, the rate of hospitalization for scalds involving young children aged 0–4 years decreased 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-bed days taken up. 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 (23).

Flammable sleepwear is a major contributor to burns in children.
Source: Shutterstock/Nadya Puris

NONFLAMMABLE FABRICS

NATURE OF THE PROBLEM

Another leading cause of burns is flammable clothing. This may happen from contact with stoves, heaters, cigarettes, matches or other sources. The two major groups this affects are young children, who do not realize the dangers, and the elderly, in whom reaction time is slowed. A major contributor to such clothing burns has been burns to children in their sleepwear.[2] In the 1960s an all-too-common cause of severe burn injury in children in high-income countries was ignition of their sleepwear (most often by stoves, heaters, and matches), leaving the young survivors with scars and other complications. One study found that the average sleepwear fire caused burns over nearly one-third of the child's body surface, two-thirds of which was third degree in depth (i.e. the most severe type) (57). In part, these problems arose from the high flammability of the fabrics from which sleepwear was made.

SOLUTION

Making fabrics less flammable reduces the likelihood that clothing will catch fire, and decreases the extent to which fire spreads over the garment – and thus the extent of any burn caused. Evidence on the varying flammability of fabrics had been accumulating since the 1940s and 1950s (58). A variety of factors can decrease the flammability of garments, including the type of fabric from which they are made – e.g. several types of synthetic fibres (such as polyesters) are less flammable than cotton. In addition, tighter fitting garments are less flammable than loose fitting ones, as the latter allow greater passage of air (needed to keep the fire burning) through the cloth. The question then is how to get lower flammability fabrics into general usage (58, 59).

[2] "Sleepwear" is defined as any article of clothing intended to be worn primarily for sleeping or activities related to sleeping.

IMPLEMENTATION OF THE SOLUTION

Unlike the previous case studies, where behaviour change among those to be protected could be encouraged (e.g. by installing smoke alarms), promoting low-flammability fabrics required a totally legislative approach. In this case study, we report on advocacy for legislation in relation to one particular issue, that of children's sleepwear. This also represents a model study of the creation of coalitions for advocacy for burn prevention.

Since the early 1950s there had been legislation related to flammability of fabrics in several high-income countries, including the USA and UK. In 1954, a law relating to flammability of women's night dresses was passed in the UK. In the same year a law on the flammability of types of fabrics was passed in the USA after several incidents of rapid burning of brushed rayon sweaters. More comprehensive legislation came the following decade in the USA in the form of the 1967 Flammable Fabrics Act, which regulated the flammability of materials in carpets, mattresses, upholstered furniture, tents, curtains and sleeping bags (58).

One component of the clothing- and fabric-related burn picture that had not yet been addressed by these earlier pieces of legislation was children's sleepwear, which was associated with particularly severe burns. Advocacy to create flammability standards for children's sleepwear was carried out by a multidisciplinary coalition of health care experts, safety advocates, and technical experts. In response, in the early 1970s the US Secretary of Commerce delivered a flammability standard for children's sleepwear in the Flammable Fabrics Act. In 1973 the responsibility for administration and enforcement of this act was passed to the US Consumer Product Safety Commission (CPSC). The primary aim of the standard was to minimize the risk of ignition of children's sleepwear; the secondary aim was to diminish the extent of injury by reducing the speed at which fire could spread after ignition occurred. The mandatory resistance to flammability was applied to all children's sleepwear garments with sizes that would be suitable for children aged approximately 12 years and under (60).

This act established a test that bone-dry sleepwear garments must pass before being marketed. In this test the garment is held to a small open flame, similar to that of a match or cigarette lighter, for three seconds. The garment must stop burning after removal from this exposure. The exact fabric is not specified. In general, clothing made of untreated cotton will continue burning and will not pass the best. Clothing made of several synthetics (such as polyester) or cotton treated with flame retardant will pass the test (61).

The effect of this legislation has been dramatic. The National Fire Protection Association (NFPA) estimated that the enactment of the flammability standards for sleepwear in 1971 resulted in a 10-fold decrease in childhood deaths caused by ignition of sleepwear (62). Death from ignition of all types of clothing (which had previously

been heavily comprised of burns to children from their sleepwear) decreased by 66% (a two-thirds reduction) between 1972 and 1982. During this time, overall fire-related burn deaths declined by only 16% (58), indicating the high likelihood that the legislation itself was directly responsible for the decrease in childhood deaths from clothing ignition. The effect of the legislation can also be demonstrated by looking at the data from one burn centre. A study of children admitted to the Shriners Burns Institute of Boston showed that the promulgation of flammability standards reduced the incidence of flame burns from the ignition of sleepwear from around 10–15 admissions per year in the early 1970s to near zero in 1976 (57).

The success of this legislation persisted for several decades. However, in the 1990s, legal support for low-flammability children's sleepwear began to be eroded mainly because of industry pressure. Fortunately, this has not yet led to increases in rates of childhood sleepwear burns, but it highlights the need for vigilance by safety advocates, even after initial victories have been won (9).

In conclusion, decreasing the flammability of the fabrics of garments has been shown to be an effective method to prevent burns from clothing ignition. Legislation to accomplish this, especially with regard to children's sleepwear, has been shown to be an effective implementation method in high-income countries. There is considerable evidence suggesting that flammability of fabrics is a risk factor for burns in several low- and middle-income countries. For example, loose saris worn by women in India have been implicated in burns related to cooking fires. This is in part related to the flammability of the material, and also to the large area of loose-fitting material from which the sari is made, and the exposure to flames that comes with cooking over an open-air fire. Similar considerations have also been implicated for burns in other areas, such as from loose-fitting clothing worn by women in Algeria (58, 63–65). Thus, flammability of fabrics would seem to be a potential risk factor to address in low- and middle-income countries as well. However, thus far, there are no reports of successful efforts to do so, whether through social marketing or legislation.

ELECTRICAL SAFETY

Figure 3.3 Tangled exposed wires can easily injure people who come into contact with them.
Source : Tom Potokar/Interburns photo library

NATURE OF THE PROBLEM

In the late 1800s, electricity became increasingly available for lighting and other home and industrial uses. With it came the consequences of building fires and electrical injuries. As early as the 1890s such fires and injuries were becoming more and more common in what are currently high-income countries. With increased electrification, such electrical injuries are now becoming more common in low- and middle-income countries. This is compounded by the unregulated manner in which electrical wiring is often installed in homes and other buildings (Figure 3.3).

SOLUTION

Ensuring electricity is delivered and used safely is a highly technical process. Electrical safety itself involves both prevention of fires in houses and other structures, as well as prevention of electrical burns and electrocution resulting from human contact with electrical wires. Techniques for electrical safety address issues such as insulation of wires, fuse and circuit-breaker systems that prevent overloading from electrical surges, methods to safely route electrical wires within structures, and safe design of electrical appliances. The question is then how to systematically understand unsafe practices, develop safe practices and standards, and how to promulgate and enforce them.

IMPLEMENTATION OF THE SOLUTION

In part, the impetus for establishing safety standards came from insurance companies who wanted to minimize their risks from insured properties. In response, organizations were formed to develop electrical safety standards. Underwriters Laboratory was established in the USA in 1894 as a private agency that tested and standardized the safety features of electrical products. In order to unify the many competing electrical codes that developed in different locales, the National Fire Prevention Agency (NFPA) (66) was established as a non-governmental organization in 1896. The NFPA first published the National Electrical Code (NEC) in 1897, and (updated every three years) it is still the standard for safe installation of electrical wiring in many countries today. While the NEC itself is not law, it does set a legal standard for liability in the event of electrical fire or injury, and many jurisdictions adopt NEC standards into local laws. It established a precedence of research, development, and implementation that is still useful today.

HOME AND BUILDING ELECTRICAL SAFETY

The NEC has enshrined several electrical safety measures into building codes that have reduced electrical fires in homes and other buildings – a trend best documented over the past 30 years. Two circuit breakers are in part responsible for the decline in electrical fires: The Ground Fault Circuit Interrupter (GFCI) prevents electrocution by shutting off a device when escape of current is detected, such as when an electric appliance falls into water. The GFCI was introduced into the NEC in 1971 and became a requirement in an increasing number of outlet types up to 2002. Since 2002, the NEC has recommended that all outlets in areas close to a water source include a GFCI, such as bathrooms, kitchens and outdoor areas. The more recent Arc Fault Circuit Interrupter (AFCI) prevents fires by shutting down a device when an arc[3] is detected. Since the advent of GFCI and AFCI in the 1970s, the number of electricity-related house fires in the USA has fallen by almost half, from 100 700 in 1980 to 52 500 in 2006 (67). Other longstanding measures of the NEC include insulated and colour-coded wiring, standards for electrical grounds, and specifications for how wiring is encased and routed in a building.

OCCUPATIONAL ELECTRICAL INJURY

In high-income countries, most fatal electrical accidents happen in the workplace, and so they can be reduced by better occupational safety. For example, in the US, the establishment of the Occupational Safety and Health Administration (OSHA) in 1971 introduced safety standards in the workplace that reduced work-related electrical injuries. OSHA mandates workplace safety measures that include employee training in basic electrical theory, safe work procedures, hazard identification, proper use of protective equipment, and first aid such as cardio-pulmonary resuscitation (CPR) and rescue procedures. A

[3] An arc is where an electrical current passes through the air (or other substance) between two structures (such as wires), creating an unintentional flow of current.

key component of improvement in safety regulations is investigation of serious injuries and deaths in order to determine the causes related to the event – based upon the findings, OSHA updates safety regulations. From 1980 to 1992, workplace deaths by electrocution decreased by more than half, from 580 to 210 deaths annually (68).

ELECTRICAL APPLIANCE SAFETY

Electrical injuries from appliances have been reduced by product redesign and public education campaigns (68). In Denmark, a study of electrical injuries during the 1960s found that among children who sustained oral electrical burns, 90% occurred as a result of chewing on the cord or plug of a commonly used Danish vacuum cleaner (63). This product's faulty design allowed the cord to remain live after the appliance was turned off. In addition, the cover of the plug (which connected the cord to the vacuum cleaner and which could be detached while the current was still live) tended to break, leaving exposed live leads. This combination led to four or five severe mouth burns to children every year. A public campaign was initiated to replace the flawed plugs with redesigned plugs at no cost to consumers, and the number of injuries was reduced 87%, from 23 per 5-year period to less than one per year.

Underwriters Laboratories is one of several international agencies that tests products for safety using accepted standards such as the NEC. A product that meets safety regulations is certified with a UL trademark as a sign to vendors and consumers of compliance with safety standards. A European counterpart to the UL trademark is the CE marking certification, which is required by law in many countries.

In summary, the primary strategies for prevention of electrical injury have been electricity building codes, mandated occupational safety programmes, and standards for electrical product design that are certified by independent testing agencies. Similar strategies are needed to address electrical fires and burns in low- and middle-income countries.

Water sprinklers are usually located on the ceiling.
Source: Shutterstock/ Justin Kral

SPRINKLERS

NATURE OF THE PROBLEM

As discussed in the section on smoke alarms, house fires are a major source of burn-related death. Virtually all start small, then spread. The injuries and property damage done by fires in buildings could be prevented by equipment that quickly detects fire and puts it out automatically, such as by dousing with water. Automatic sprinkler systems are one way to do this. These work in the event phase of Haddon's Matrix, by limiting the extent of the problem (a fire) once it has started.

SOLUTION

Sprinkler systems channel water to sprinklers inside buildings (usually located on the ceiling) so that all areas can be doused. The sprinklers are trigged by smoke alarms and there is growing evidence of their effectiveness.

Field tests and evaluations of residential sprinkler systems have been conducted and reported on since the late 1970s and early 1980s. A total of 60 full-scale tests were conducted in single- family homes and 16 full-scale tests were conducted in mobile homes. The sprinkler scenarios were chosen to represent the most common fire scenarios in which residential fire deaths occur. The effectiveness of the sprinkler system for one- and two-family dwellings and mobile homes was measured in terms of its ability to control the fire (that is, to protect the structure from damage by fire) and to maintain a survivable environment within the structure for a sufficient time to allow occupants to escape. For example, the smouldering-started bedroom

fire tests: in two out of three smouldering-started bedroom fire tests, the fire was extinguished by the activation of one sprinkler. In both cases, the critical limits for tenability (survivability) were not exceeded (69–71).

The effectiveness of the above field tests has been substantiated by real-world experience (72) . In actual fires, the risk of death to occupants in a home is 80% lower in structures protected by sprinklers. Moreover, sprinklers and smoke alarms used together have even greater effects. In homes with both smoke alarms and sprinklers, the chance of surviving a residential fire is nearly 97% (73, 74).

In addition to saving lives during a fire, property loss in buildings with a sprinkler system is just one fifth of what it is in buildings without one. Recent research has demonstrated that fires in sprinklered homes have a much less negative environmental impact compared to non-sprinklered homes, which provides an added benefit – greenhouse gases released by burning buildings can be reduced by 98% when automatic sprinklers are activated (75).

IMPLEMENTATION OF THE SOLUTION

Despite evidence of their effectiveness, people have been slow to embrace residential sprinkler technology. There are myths about effectiveness and people worry about the cost of installation in new or old buildings. The cost of installation of sprinkler systems in new houses is approximately US$ 11 to US$ 22 per square metre (in high-income settings), and the cost of retrofitting sprinklers in existing buildings is somewhat more expensive, but is comparable to the cost of buying and laying new carpets (76). The reasons people give for not wanting sprinklers are similar to those given 30 years ago by people who did not want to install smoke alarms, including reasons such as lack of perceived risk, and views that the devices would be unsightly in their homes (74). Hence, a combined educational and legislative approach may be the most effective way to implement widespread adoption of residential sprinkler systems.

There are examples of cases where legislation has been successfully implemented. It is the official position of the US Fire Administration that "all citizens should be protected against death, injury and property loss resulting from fire in their residence. All homes should be equipped with both smoke alarms and automatic fire sprinklers, and all families should have and practice an emergency escape plan," (77). The International Code Council (ICC) was established in 1994 as a non-profit organization that has developed comprehensive model construction codes (78). Relevant to home fires is the ICC's International Residential Code (IRC) – a model code that sets suggested standards for one-family and two-family new home construction.

The IRC now includes a provision that all new one- and two-family homes be equipped with a home fire sprinkler system (79). State and local laws dictate whether and to what extent home builders must follow the IRC codes, resulting in a patchwork of coverage. There are efforts by advocacy organizations to assure full compliance with the residential sprinkler code.

An early adopter of residential sprinklers, Prince George's County, Maryland, USA, mandated their use in all newly constructed homes beginning in 1992. Importantly, there have been no reported fire deaths in a sprinkler-equipped home in the county (80). Many Maryland localities have enacted similar laws. However, similar laws have not been enacted statewide or nationwide (81).

Unfortunately, fewer than 2% of single-family dwellings in the USA are fitted with sprinkler systems (82). A similar situation exists in other high-income countries. Further, we could find no documentation of the evaluation of residential sprinklers in low- and middle-income countries. Sprinklers may not be feasible in most single-family homes, but indeed could be feasible in apartment buildings and large public buildings. Clearly, there is untapped potential for implementation of sprinklers in countries at all economic levels.

CHILD-RESISTANT LIGHTERS

Figure 3.4 Cigarette lighter with a child-resistant mechanism
Source : Terri Bleeker

NATURE OF THE PROBLEM

When children play with cigarette lighters they often cause fires that result in devastating burn injuries, deaths and property damage. Cigarette lighters and matches are often readily available to children, are present in many homes worldwide and are easy for young children to operate. Children playing with cigarette lighters and matches is a frequent cause of residential fires and related deaths and injuries (83). Likewise, although fire-play is a small part of the overall fire problem, it is a predominant cause of residential fire injuries and deaths among young children (84). Fires that led to child burn deaths in UK were most commonly caused by cigarette lighters (for boys) and matches (for girls) (85). It is estimated that between 1500 and 1900 injuries and between 34 to 40 fatalities per year in the European Union are the result of fires caused by children playing with cigarette lighters (86).

SOLUTION

The solution is cigarette lighters with a child-resistant ignition mechanism. Typically the metal shield must be depressed before the sparkwheel can be turned to produce a spark (see Figure 3.4). The force and dexterity required to depress the shield make it difficult for young children to turn the lighter on.

IMPLEMENTATION OF THE SOLUTION

As with flame-resistant children's sleepwear, getting child-resistant lighters into use required legislation and regulation of product design. As a result of the number of residential fires that resulted from children playing with lighters, the United States Consumer Product Safety Commission (CPSC) developed a standard for cigarette lighters (87) that applied to all products manufactured or imported into the country. The standard covers more than 95% of the 600 million lighters purchased in the USA each year. The standard for child-resistant lighters went into effect on 12 July 1994 (87). The child resistance of a cigarette lighter is determined by tests that are conducted by cigarette lighter manufacturers who use panels of children between the ages of 42 and 51 months. The cigarette lighters used for these tests do not have fuel, when they are activated, but they produce an audible or visual signal. To meet the criteria for a child- resistant lighter, they must be designed so that at least 85% of children included in the test panel are not able to operate the lighters under a timed test condition (88).

A study after this CPSC standard was introduced found that fires, deaths and injuries caused by young children playing with lighters and had been reduced by as much as 58%, saving over half a billion US dollars in societal costs in 1998 alone (88). Other countries have likewise implemented regulations on the child resistance of lighters. In 2007, the European Union introduced laws requiring manufacturers and importers to comply with the European standard for child-resistant lighters (86). Cigarette lighters that are dangerous to children are no longer sold in the European market. Those on the market must be child-resistant, and the standard forbids the sale of novelty lighters (novelty lighters may be either disposable or refillable, and are defined as those that resemble or depict articles appealing to children).

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. Many casualties could be prevented in other countries by adoption of a child-resistant lighter standard with similar requirements to those in the UK and USA (88). Media campaigns are needed to inform caregivers and parents that some young children, and most older children, can still operate lighters. Lighter safety campaigns should specify both cigarette lighters and multipurpose lighters. Canada, Australia, and New Zealand have had similar standards in effect for years (88). Parents and caregivers are urged to buy child-resistant lighters (these are child-resistant, not child proof) and to keep lighters and matches out of the reach of children (87).

FIRE-SAFE CIGARETTES

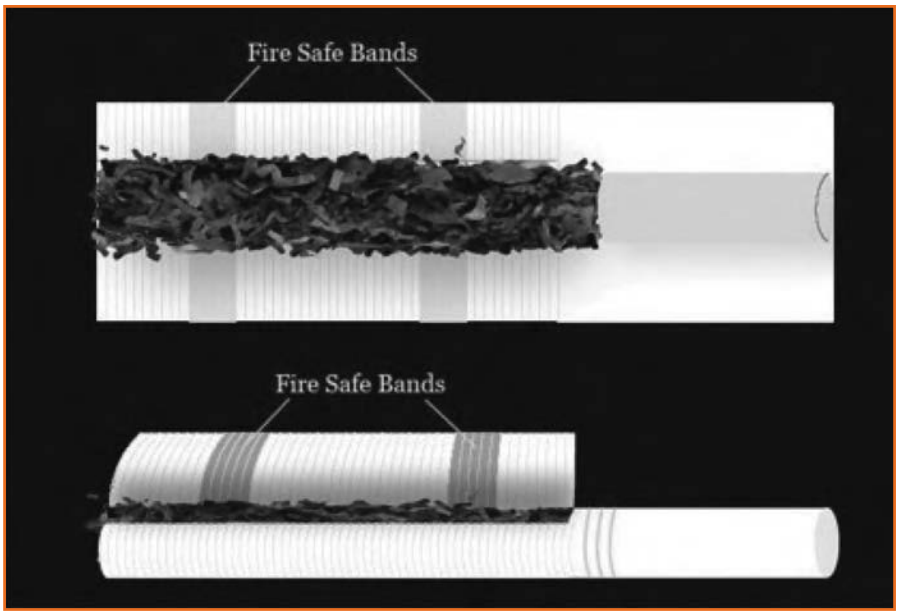


Figure 3.5 Illustration of a fire-safe cigarette
Source: (90)

NATURE OF THE PROBLEM

Cigarettes and other lighted tobacco products are a leading cause of fire-related deaths and injuries worldwide. For example, in North America, fires caused by cigarettes kill more than 700 people annually and injure more than 1500 others, representing about 20% of overall fire-related deaths in residential structures (89). Similarly, it is estimated that in the European Union in 2006, cigarettes caused 12 900 fires which resulted in 650 deaths, 2400 injuries, and €48 million in property damage (89, 90). One in every four fatalities in fires related to smoking materials is someone other than the smoker whose cigarette started the fire (89).

SOLUTION

The best way to stop cigarettes causing fires is to reduce smoking to as near zero as possible. Thus, efforts to stop people smoking – and broader tobacco control strategies – also serve as burn prevention strategies, reducing other serious health problems caused by smoking, such as lung cancer and heart disease. Other possible solutions to decrease cigarette-induced fires include educational messages on safe handling of tobacco products, such as not smoking in bed or when sleepy, making sure cigarettes are extinguished completely before they are thrown out, and smoking outside rather than indoors (89). Such educational efforts have not been well evaluated, and as with other burn and injury prevention efforts, it could be expected that educational efforts would not be very effective if used on their own.

Another possibility is an engineering solution that reduces the likelihood that a cigarette will continue burning if not puffed (e.g. would be self-extinguishing), or is less likely to set other materials (such as furniture or bedding) on fire. Cigarettes designed to do this go by different names, including reduced ignition propensity, self-extinguishing, low fire risk, reduced fire risk,and most commonly, fire-safe cigarettes (90).

Several factors influence the likelihood that a cigarette will continue burning and ignite other materials. These include cigarette circumference, tobacco density, and wrapping-paper properties such as permeability and use of chemical additives (e.g. citrate is sometimes added to the paper as a burn accelerant). These factors can be adjusted. The main idea is that a fire-safe cigarette stops burning automatically if it stops being puffed. The most commonly used method to do this is to place several bands of less porous paper in the wrapping of the cigarette (Figure 3.5). These act as a "speed bump" to slow the rate at which the cigarette burns by restricting oxygen to the burning tip. If a fire-safe cigarette is left unattended, the burning tobacco will self-extinguish when it reaches one of these bands (90–92).

Figure 3.6 Standard method for testing the ignition-propensity performance standard of cigarettes, in which a lit cigarette is placed on multiple layers of standard filter paper
Source: (90)

Several types of laboratory test can confirm the ignition propensity of cigarettes. The test used most extensively is the "cigarette extinction method", which provides a standard measure of the capability of a cigarette to generate sufficient heat to continue burning, and thus potentially cause ignition of bedding or upholstered furniture. In this test, a lit cigarette is placed on a set of stacked filter papers (Figure 3.6). A normal cigarette would burn down to the end or filter, while a fire-safe cigarette should self-extinguish before fully burning. This method has been standardized by the American Society for Testing and Materials as ASTM E2187 (93). New York State, USA, has stipulated a stack of 10 filter papers, although the US National Institutes of Standards and Technology leaves the option at 3, 10 and/or 15. This test further specifies that in order to be considered fire safe, no more than 25% of 40 cigarettes tested of a particular brand would burn their full length in a draught-free environment.

IMPLEMENTATION OF THE SOLUTION

As with several other burn prevention engineering successes discussed in this book, after the technology has been developed, there is the challenge of getting it into use. This most often requires legislation and related enforcement.

Attempts to pass legislation to implement fire-safe cigarettes represent an ongoing struggle between safety advocates and the tobacco industry. As early as the 1930s, evidence was accumulating on the feasibility of creating fire-safe cigarettes. Efforts to introduce legislation on fire-safe cigarettes took shape in the 1970s, with the support of coalitions involving a wide spectrum of advocates from the health sector (both preventive and curative), firefighters, consumer protection advocates, lay people, and representatives of some industries affected by cigarette-induced fires, such as the hotel industry. Despite their efforts, pressure from the tobacco industry prevented any actual enactment of fire-safe cigarette standards for years (94).

A major step towards making fire-safe cigarettes a reality was the passage of a law in New York State, USA, which required that all cigarettes sold in the state should be fire-safe by the ASTM standard mentioned above. This law took effect in June 2004. As a result, smoking-material fire deaths decreased from an average of 43 per year in 2000–2002 to an average of 25 per year in 2006-2008, a 41% reduction (89).

Since the passage of the New York State law, all states in the USA and numerous other countries have enacted laws that require reduced ignition propensity for cigarettes. For some USA states, the laws have yet to take effect, but all will do so by 2011. Most of these laws are modeled after the New York State law and many rely on testing done in New York State. In terms of implementing the law and assuring compliance, industry is required to submit reports on their testing. New York State validates industry reports by independent testing done every three years, comparing these to industry reports. Around 1200 cigarette brands have been certified as compliant in New York State (90, 94).

Canada was the first country to enact nationwide law mandating that all cigarettes manufactured domestically or imported must meet fire-safe standards, and used the ASTM standard mentioned above. This law took effect in 2005. Australia enacted a similar law in 2008 (90, 94). In 2007, the 27 European Union member states approved a European Commission proposal which would similarly require that only fire-safe cigarettes could be sold within EU countries. The first step was the development of a European standard by the European Committee for Standardization, a process which is still underway. Pending the development of European-wide standards, Finland developed its own nationwide standard in 2008 (based on the ASTM standard), which took effect in 2010 (95). Similar laws have been developed and are set to be implemented in Belarus, Kazakhstan, Kyrgyzstan, Russia, South Africa and Tajikistan (96, 97).

Such laws should be considered for implementation in all countries, particularly those in which there is a high burden of death and disability from cigarette-induced fires. The early results from New York are positive in demonstrating a reduction in fire deaths. These findings, as well as National Institute for Standards and Testing research, provides ample evidence for legislation. However, as more research becomes available, particularly on population effect, countries should build flexibility into law so that regulators may strengthen the standard if needed. Model legislation to assist development of national policies has been created and is similar to the Canadian and New York State laws. Such national legislation should identify parties or agencies responsible for certification and auditing of cigarette brands, and sources of funding that these agencies can tap into to finance their work. It should also identify the type and frequency of audits, how to evaluate the impact of the legislation on the population, and the level of fees and fines for non-compliance (90, 94).

MAKING FIREWORKS SAFER

Fireworks pose a significant risk for children, particularly adolescent boys.
Source: Shutterstock/ AISPIX

NATURE OF THE PROBLEM

Fireworks are associated with national and cultural celebrations and holidays throughout the world (98–101). For example, as a prelude to the arrival of spring, people in Iran have celebrated Chaharshanbe-Suri on the last Wednesday night of each year since at least 1700 BC. The festivities include participants jumping over bonfires in the streets and setting off fireworks – both hazardous activities. Despite the ubiquity of these practices in Iran and their persistence since ancient times, only 1% of surveyed families in Tehran said they'd had any education on the safe use of fireworks (102).

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 fireworks by themselves. Girls who were injured by fireworks were usually bystanders (100). In Australia, 50% of those injured by fireworks were boys under 18 years of age (103).

The injuries caused by fireworks can be very severe because of heat production (temperatures of ignited devices may exceed 650°C) and blast effect. Approximately 50% of treated firework injuries are burns and approximately one third of these are contusions or lacerations. Especially affected are the hands and eyes (104–106). The risk of injury and death relative to exposure makes fireworks one of the riskiest types of consumer product available (105).

SOLUTION

One of Haddon's "10 strategies to dissociate potentially injury-producing energy from people" in the pre-event phase is to prevent the creation of the hazard (Table 2.2). A perfect example of this is the restriction or outright banning of fireworks. In theory, the banning or severe restriction of fireworks should considerably reduce or even eliminate injuries from these products. This has been the case in the examples in this section of countries that have done so.

IMPLEMENTATION OF THE SOLUTION

Fireworks have been regulated in the UK since 1875, starting with laws covering the manufacture, storage, supply and behaviour in the presence of gunpowder. The last decade has seen the passage of several additional pieces of firework legislation in the UK (107) and in the USA the Consumer Product Safety Commission has regulated consumer fireworks safety since the 1970s. Current regulations prohibit the sale of the most dangerous types of fireworks, including large reloadable shells, "cherry bombs", aerial bombs, M-80s, "silver salutes", and aerial fireworks containing more than two grains (130 mg) of powder. Other firecrackers and ground devices are limited to only 50 mg of powder, which is the pyrotechnic composition designed to produce an audible effect (a "bang"). Also regulated is the length of time for which fuses must burn (at least 3 but no more than 9 seconds), and the stability of the bases. In addition to these nationwide restrictions, some states impose tighter restrictions or outright bans (108).

The impact of legislation on the incidence of fireworks-related injuries shows a related decline in injuries. In association with recent legislation, the number of fireworks injuries in the UK dropped from 707 in 2001 to 494 in 2005 (107). In addition, the Fireworks Act in 2003 and the related Fireworks Regulation in 2004 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. A review of the effects of these changes showed that more than 80% of children's firework injuries were seen in the three weeks surrounding Bonfire Night. The authors concluded that the law had a definite impact on reducing non-Bonfire Night related firework injuries, but that stricter enforcement was required (107).

Another opportunity for studying the efficacy of fireworks legislation occurs when restrictions are repealed. Often, after the repeal of a law restricting fireworks, there is an increase in the number of children suffering fireworks-related burns (109).

A particularly noteworthy example of combining education and legislation/enforcement in the prevention of firework-related injuries nationwide in Denmark is described in Box 3.2.

Passing and enforcing fireworks related legislation globally, and especially in low- and middle-income countries, is often challenging. Some education programmes have shown very preliminary evidence of use.

In India, fireworks injuries commonly occur during Diwali (Festival of Lights). The experience at one hospital in Mumbai from 1997 to 2006 was that the prevalence of fireworks injuries was decreasing because of aggressive education campaigns by government and non-governmental organizations. Forty-one injuries were treated at the beginning of the study period and only three injuries were treated in 2006 (110).

Box 3.2

REDUCTION IN FIREWORK-RELATED BURNS IN DENMARK

INFORMATION, PRODUCT RE-DESIGN, NEW LEGISLATION, AND INCREASED VIGILANCE BY POLICE

Fireworks-related injuries occur mostly at New Year in Denmark. At two Danish burn units (Hvidovre and Odense hospitals), an unprecedented number of patients with burns caused by fireworks were admitted during the 1991-1992 New Year. The casualties were male and had carried fireworks in their clothes; 88% were minors and 87% purchased the fireworks themselves in ordinary shops (despite the sale of fireworks to minors being prohibited in Denmark).

A group from the two hospitals studied the specific type of firework involved (whistles) and found that the fuses were highly combustible because they were coated with gunpowder. This information was provided to the relevant authorities and action was urged. As a consequence of this investigation, a new government directive required whistles to be equipped with safety fuses. The safety fuses are covered with plastic, thereby allowing ignition only from the tip. New legislation was introduced, allowing only whistles equipped with safety fuses to be sold. A collaboration between the police, administrative leaders of the counties, the National Health Service and a private organization called "Fight for Sight" aimed to reduce the number of firework burn injuries. As part of the effort do this, a total of 25 tons of unauthorized fireworks were confiscated by the police and destroyed.

New educational campaigns were conducted at all Danish schools, on national television stations and in the newspapers, providing information about the dangers of carrying fireworks close to the body and manufacturing fireworks at home. These campaigns reached 575 000 children aged 9-16 years.

The result was that the following year, only four children were admitted with firework burns; the number of patients was lower and the extent of burns was less severe. The patients were all younger than the age group that had been targeted with the school campaign. A year later, only three children were admitted with firework burns. These combined actions were effective in reducing the number and severity of burn injuries caused by fireworks.

Source: (111)

CHAPTER 4

Case Studies with Preliminary Evidence of Effectiveness

This chapter includes summaries of burn prevention strategies that have shown promise, especially in low- and middle-income countries. Some of these strategies specifically address causes of burns that are common in these countries, and that are different to those in high-income countries, as discussed in Chapter 3. The evidence for these interventions is preliminary. To date there are no burn prevention efforts in low- and middle-income countries with the level of evidence supporting those discussed in Chapter 3, i.e. the combination of laboratory evidence, data from individual epidemiologic studies and controlled trials, and sustained decreases in population-based rates over 10 or more years, substantiated by reliable data. Nonetheless, all the interventions that follow are ones that show promise. All are instructive as to how to approach a burn problem by discerning the potential risk factors, developing a prevention strategy to address them, and thoughtfully evaluating the prevention efforts to know what has been successful and what has not. The examples that follow are especially notable as they include some of the best examples of burn prevention strategies applied to actual circumstances in low- and middle-income countries.

SAFER STOVES AND LAMPS

Figure 4.1 Traditional open 3-stone fire used in most households in rural Guatemala. Open fires such as this are also used in a high proportion of homes using solid fuels for cooking throughout developing countries.
Source : Nigel Bruce

NATURE OF THE PROBLEM

Many households in low-and middle-income countries, particularly in rural areas, depend on open fires for cooking and heat. The risk of house fires and burns from these sources is compounded by several factors, including lack of enclosure of open fires, fires located on the ground/floor, instability of appliances (e.g. lamps and stoves), nearby storage of flammable substances and fuels, flammable clothing worn by appliance users, and lack of exits (112). The majority of childhood burns occur in the home – especially in the kitchen. It has been suggested that the location of cooking/heating equipment within the home and the structure of the kitchen may present significant risks to children (113). In South Africa, for example, many homes consist of one or two main rooms divided by temporary partitions made of curtains or cardboard. These rooms are used for sleeping, washing, working, cooking and eating, depending on the time of day and the requirements of the family (113–115). This type of domestic arrangement may greatly increase the exposure of a child to domestic equipment and heat sources (116, 117).

The use of kerosene (paraffin) stoves and lanterns, and open fires for cooking – particularly at ground level - are major risk factors for burn injuries (21), (118–122). Government regulations and standards for these appliances are non-existent or not adequately enforced (123). And there is slow progress in providing electricity to residences – for example, less than one quarter of people in Africa had access to electricity in 2005 (124). The global use of kerosene in lamps and

stoves will no doubt continue for years to come. Unfortunately, many low-income families use makeshift lamps made from wicks placed in discarded beverage or medicine bottles, and even from burnt-out light bulbs (23). Burns caused by homemade bottle lamps or commercial wick lamps are common in low- and middle-income countries (125-126).

Egypt, Ethiopia, India, Nigeria, Pakistan and other low- and middle-income countries have documented serious injuries from kerosene stoves (123, 125, 127–132). The problem with stove- related fires in particular includes design and construction of the appliance, the combustibility of the fuel, and the instability of the device. These stoves often leak fuel and this is especially common when stove reservoirs are being filled. Kerosene can leak onto clothing or its vapors can ignite when heat and flames are present. These small portable stoves are unstable, and easily tipped over when being moved or even when resting in place.

SOLUTION

Creating safe products was a major issue in several of the proven/promising case studies in Chapter 3 (e.g. flame-resistant clothing, child-resistant lighters). Thus, a potential solution to the problem of burns from unsafe stoves, lamps and other appliances is to create safer products. There have been several innovative efforts to create safe stoves and lamps. Here we describe two of the most promising.

AN IMPROVED STOVE IN GUATEMALA

Much of the world's population (3 billion people) relies on solid fuels used in open fires and traditional stoves for their cooking and heating needs. An arrangement of three stones on the floor is a primary method of cooking in rural Guatemala (Figure 4.1). This is a risk factor for burns, especially for small children who come into contact with, or even fall into, the fire. A safer cooking arrangement can reduce this risk. One project evaluated an innovative improved, safer, and locally appropriate stove (23). It was intended to have several benefits, including reducing indoor air pollution as well as burn prevention, and was rigorously evaluated.

A randomized exposure study of pollution indoors and respiratory effects trial (RESPIRE) of 534 households was recently carried out in rural, highland Guatemala to determine the impact of an improved wood stove with a chimney (the 'plancha' – Figure 4.2) on young children aged up to 18 months, in comparison with continued use of open fire. This provided an opportunity to record the frequency of burns in children (both the study children and their older siblings), and the effect of the improved stove on the incidence, severity and causes of burns. Information was collected on burns and scalds in the

siblings by recall at interview with the mother before the new stoves were introduced, and at 6 and 12 months afterwards. For the young children, information was collected on the incidence of pneumonia as well as burns and scalds, at each of the weekly household visits.

Over the 6 months prior to the introduction of the new stoves (during which time all households were using open fires), 22 burns were reported among the 1044 older siblings – those under 8 years of age – in the study homes (including intervention homes and those that were controls). This represented an incidence rate of 42.1 per 1000 per year in this age group. Fifteen incidents (68%) left scars, more than half of which were large in size (more than 2 cm in diameter).

Following the introduction of new stoves, the incidence of burns among the older siblings in the control group (homes continuing to use the open fire) stayed nearly the same at 35.2 per 1000 population, while the plancha stove group had decreased to an incidence of burns of 18.1 per 1000 population over the same period – almost half the risk. Moreover, the causes of burns in the two groups were quite different. Thus, while 7 of the 16 burns in the open fire group were caused by falling into the fire, none of the 8 burn injuries in the plancha group was so caused. On the other hand, there were three scald injuries in both groups. The main cause of burns in the intervention group was "touching a hot object" (4 out of the 8 total), usually the door of the plancha combustion chamber. Thus, the mechanisms of burns in the plancha group tended to be less serious than in the open fire group. As a result, the consequences of the burns were less severe. Ten control but only 5 intervention cases resulted in scarring.

For the young children aged up to 18 months, there were 23 burn and scald injuries in the open fire homes, and 22 in the plancha homes. Although the overall rates were therefore similar, there were important differences in causes and severity. Well over half (17 out of 23) of the burns in open fire homes occurred when the child fell into the fire, compared to only 2 out of 22 in the plancha-using homes, and this was because some of the intervention homes continued to use open fires for some purposes. Three burns were severe enough to require prompt medical attention, and all occurred in the control group. The main reason for burns in the plancha group was touching the hot metal surface (14 out of the 22 cases), and clearly there is a need for education about this risk.

This study shows the potential for the prevention of burns, including very severe cases such as may occur with young children falling into open fires at floor level, or being seriously scalded by knocking over pots of boiling liquid balanced on stones. It also highlights the importance of considering safety in the design, promotion and educational aspects of improved stove programmes, and of evaluating the impacts of newly introduced interventions.

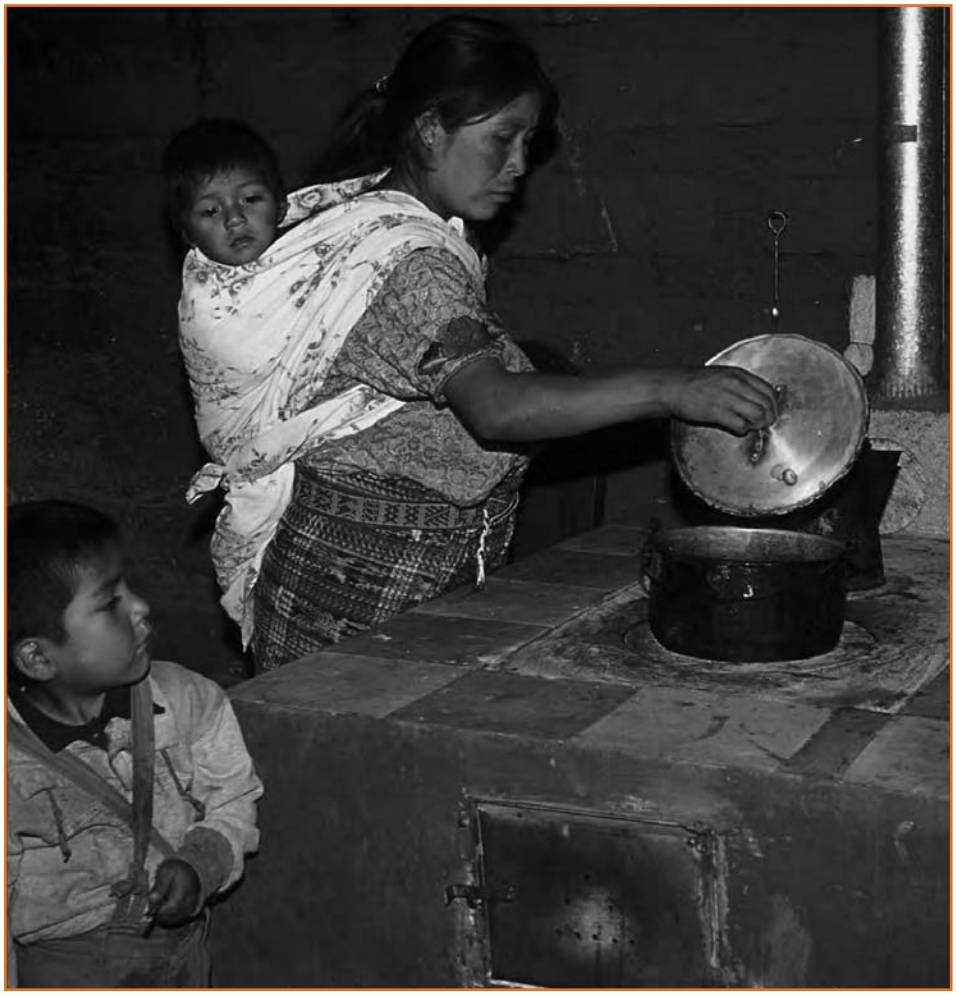


Figure 4.2 The 'plancha' wood stove. The combustion chamber is enclosed, and the cooking surface is made of steel with three pot holes at waist height. Although the hot surface and pots are out of reach of young, walking children, babies (carried on the mother's back while cooking) sometimes reach out and touch hot metal surface.
Source: Nigel Bruce

Source: Safe Bottle Lamp Foundation

A SAFE BOTTLE LAMP IN SRI LANKA

In Sri Lanka, many burns occur from kerosene lamps that are easily tipped over, either starting house fires or causing kerosene spills that then ignite. A product improvement is to make the lamps more resistant to tipping over. Such a lamp is, in fact, currently being marketed in Sri Lanka, and is:

- short, heavy, and not easily tipped over;
- flat-sided, so if tipped, it does not roll;
- made of thick, recycled glass that does not crack if it falls;
- simply designed with a screw-on lid to prevent spillages and no moving parts, so it can be mass-produced at low cost;
- durable and can be used for several years;
- made at the low cost of only US $0.35 per unit, and its production provides a boost to the local economy (133).

The use of such a lamp, with appropriate basic care being exercised, could prevent many of the paraffin burns that occur around the world each year, though its efficacy has yet to be subjected to rigorous evaluation (23).

IMPLEMENTATION OF THE SOLUTION

The above examples represent burn prevention strategies that show preliminary evidence of usefulness. However, without wider evaluation, these are not strategies that can yet be widely recommended for implementation by government policy.

Another aspect of product safety to consider is the fuel used, as paraffin/kerosene is widely implicated in burns. There are several examples of policy for control of paraffin that are useful examples to examine, as regards population-wide efforts to decrease burns from unsafe paraffin appliances and practices.

Much could be achieved by addressing safety of fuel storage and use, and use of appropriately designed appliances. Compulsory standards covering the performance, safety and approval requirements for non-pressure, paraffin-fuelled cooking stoves and heaters intended primarily for domestic use were brought into effect by the South African government on January 1, 2007 (134). These standards were developed after evaluation of nine commonly used stove designs in 2003 showed that none of them met the current national standards. Currently the South African National Standard (SANS) 1906:2006 standard for non-pressure stoves and heaters is the only compulsory standard in place. Only one heater has a licence to trade under this standard – the Goldair Heater model RD85A. The new PANDA stove holds a temporary license under this standard. The standard for pressurized kerosene-fuelled appliances (SANS 1243:2007) is currently voluntary, and approval from the South Africa Bureau of Standards Commercial for these appliances has been neither sought nor granted. Voluntary standards for non-pressurized paraffin-fuelled stoves became a compulsory specification/ regulation (VC9089) on January 1, 2007, but the problem is that illegal appliances and stoves have flooded the market – these illegal stoves are sold much cheaper and poor people are likely to continue to buy them. The National Regulator for Compulsory Specifications (NRCS) recently raided almost 400 shops and importers and confiscated over 18 000 sub-standard appliances. Enforcement of the regulation is therefore a big challenge (135).

COMBATING
ACID-THROWING

Throwing acid on a person's face in order to disfigure him or her has become tragically common in several countries.
Source: Shutterstock/AISPIX

NATURE OF THE PROBLEM

This case study describes efforts to address a type of burn caused by violence. Thus these efforts are inherently different to most of the other burn prevention strategies described elsewhere in this book, which focus on unintentional burns. In several countries, a form of violence whereby acid is thrown on a person's face in order to disfigure him or her has become tragically common. Globally, a wide variety of different scenarios are involved in terms of perpetrators, victims, and their relationship. In Bangladesh, acid attacks are most often against women (136). The perpetrators are often male partners or suitors. The attack involves throwing acid on the face of the woman in an attempt to disfigure her. Too often the attack has its intended consequence, leaving survivors vulnerable to disfiguration, disability, destitution and social exclusion. The attacks need to be viewed in the wider context of gender discrimination and the low social status and disempowerment of women, wherein perpetrators feel that there is little chance that they will be punished for their crime.

SOLUTION

Confronting any type of violence involves several parts of society. These include the criminal justice sector, which has traditionally been the foundation of violence prevention. In addition, the health sector, with its public health approach, has recently been shown to be an important component of preventing violence. The public health approach involves several steps, including:

- understanding the extent and nature of the problem;
- investigating why violence occurs, especially addressing factors that might be modifiable through interventions;

- exploring ways to prevent violence using the information from steps 1 and 2 to design, implement and evaluate interventions;
- implementing and widely disseminating interventions that work.

The public health approach is characterized by its emphasis on prevention, rather than accepting or reacting to violence. Moreover, the public approach should be applied at an individual and relationship level, and to communities and society in general (137).

An excellent example of the above principles as applied to violence prevention is the work of the Acid Survivors Foundation (ASF) in Bangladesh. The ASF was founded in 1999 with the broad goals of assisting victims of acid attacks and preventing – and hopefully eliminating – such attacks. The ASF adopted a holistic approach, including helping survivors medically, socially, legally and financially; assisting their rehabilitation and reintegration into mainstream society; and preventing further attacks by confronting the problem society wide. The foundation has worked with medical professionals, both from Bangladesh and internationally, to build local capacity to provide medical care and rehabilitation services for women with facial disfigurement from acid attacks. It also helps the women gain access to legal and social services. In addition, ASF promotes financial independence for survivors, through job placement, income-generating schemes, and, when needed, direct financial assistance to survivors and their families.

The preventive aspects of ASF's efforts are the focus of this case study. ASF has mounted a social movement against acid violence involving all segments of society, including government, media, celebrity groups, students and NGOs. This has sought to address the root cause of acid violence, which is the system of patriarchy in which men possess all of the power and use it to their advantage, with consequent powerlessness and vulnerability of women. Efforts to address acid violence must thus work to change the position of women in society. With this broad goal in mind, ASF's work has involved the development and implementation of laws, policy and procedure for combating acid violence. It has also successfully advocated for more effective laws, including stricter penalties and special courts to expedite prosecution. This movement has also worked to change social attitudes through social marketing and mobilization.

SPECIFIC ACTIVITIES UNDERTAKEN

LOBBYING GOVERNMENT AT NATIONAL AND LOCAL LEVELS

As well as judiciary and executive branches. This has sought to increase decision-makers' awareness of the devastating consequences of acid violence and to motivate them to increase government action to stop it. Activities have ranged from one-on-one advocacy at the local level to national workshops. Such advocacy was instrumental in the passage of the Acid Control Act of 2002 and the Acid Crime

Control Act of 2002. These acts sought to increase the certainty and swiftness of prosecution of perpetrators of acid crime. The acts addressed compensation to victims, duties of investigating officers, bail, medical testimony, protective custody, and severity of penalties for convicted offenders. The acts also sought to better regulate the availability of acid. Finally, the acts established a National Acid Control Council with the Minister for Home Affairs as the chairperson. Other members of the Council include several other ministries (Women and Children's Affairs, Law, Health, and Social Welfare) and several other relevant groups, including NGOs. The council is mandated to develop policies and monitoring systems for the production, trade and deposit of acid, and to develop medical, rehabilitation and legal support services for the victims of acid violence (138, 139).

LEGAL INTERVENTIONS

Despite laws, many victims shy away from bringing legal action against perpetrators. ASF has a legal wing to encourage and assist victims in taking on prolonged and often difficult proceedings. ASF lawyers and legal partner organizations correspond with local police, public prosecutors and local administrators, attempting to fill gaps and encourage authorities to fulfill their duties. For example, ASF lawyers seek to ensure that physicians treating survivors overcome their common reluctance to provide expert testimony during court proceedings, at times providing logistic and financial support for them to be able to travel to the trial. Another gap is that many victims and their families are reluctant to endure prolonged court proceedings because of loss of income while off work. ASF has addressed this by providing emergency financial assistance, as needed, to allow survivors to continue their case. ASF similarly provides short-term shelter to victims threatened by perpetrators wanting them to drop charges.

MONITORING

ASF monitors the overall numbers of acid attacks in the country as well as the outcome of court proceedings, thus allowing a better understanding of how well the laws are being enforced. It does this in part through its membership in the Central Monitoring Cell of the National Acid Control Council. Outcomes of court cases are especially publicized at the community level to discourage potential perpetrators.

CHANGING SOCIETY'S ATTITUDES TO MAKE ACID VIOLENCE UNACCEPTABLE

ASF has undertaken a wide range of public information activities to change attitudes. This has included mass media advertising, press conferences, newsletters, establishing a media award for journalists who make special effort to publicize the problem, and development of campaign tools such as posters, leaflets and public dramas. This work has especially emphasized the capacity building of local NGOs to engage in on-the-ground activities. The work involved several high-profile national events, such as International Women's Day in 2002, when thousands of men – including business leaders, intellectuals,

media personalities and sportsmen – gathered to condemn acid violence. ASF's efforts have led to the creation of parallel groups such as Students Against Acid Violence (SAAV) and Stars Against Acid Throwers (SAAT). The latter is a forum of celebrities, founded in 2002, which has spoken out against acid violence and initiated a movement in which men and boys pledge to combat acid violence (Figure 4.3). Most importantly, ASF has transformed many acid survivors into "change-makers" through capacity building and engaging them in advocacy and public awareness programmes.

IMPLEMENTATION OF THE SOLUTION

Efforts to change attitudes in society are difficult to assess and quantify. Monitoring legal efforts shows that the majority of perpetrators are still not prosecuted. Despite the Acid Control Act of 2002, acid remains freely available on the open market. Nonetheless, all the activities taken together have had a considerable effect. There has been a steady decrease of 15–20% per year in reported acid attacks – in 2003 the number of acid attack victims peaked at 490, and by 2007 this had decreased to 192. Although it is difficult to discern which of the activities of ASF and its partners may have been the most effective in contributing to this decrease, the aggregate effects are noteworthy. This success has in part contributed to the development of similar efforts in other countries, including Cambodia, India, Nepal, Pakistan and Uganda (138–140).

This case study has demonstrated the effectiveness of a multipronged, holistic approach to a very difficult problem. In addition to meeting the needs of victims, the ASF and its partners have engaged in a range of preventative activities using the tools of injury prevention described earlier in the book, including legislation (to create more stringent laws against the crime of acid attack), enforcement (to assist survivors in seeking justice and to send a warning to would-be attackers that the crime is not tolerated by society), and education (in a wide variety of efforts to change social values and decrease the acceptability of acid-throwing). In addition, the ASF has monitored the effect of these efforts, especially through nationwide data on acid attack rates. These fundamental principles are of relevance to others who seek to confront acid attacks in particular, or other types of burns, in their own locations.

Figure 4.3 Acid Survivors Foundation's White Ribbon Campaign for men and boys. "We make this vow – no more violence against women and girls."
Source: Monira Rahman, Acid Survivors Foundation

MULTIFACETED COMMUNITY- BASED INTERVENTIONS

Many of the examples in Chapter 3 demonstrated the effectiveness of specific burn prevention strategies and the success of efforts to promote them. These methods can thus be recommended in areas that share a similar pattern of burns (e.g. scalds from hot tap water, house fires, burns from flammable children's sleepwear). It should be noted that most of the efforts described above focused on one strategy at a time, and were nationwide or state/province-wide. When working at a local level, there are often benefits to be had in confronting several types of burn at the same time. Such combined efforts can make optimal use of local resources, such as media time and volunteer labour. Described below is a model community-based burn prevention programme in Norway that successfully and simultaneously addressed several types of burn (54, 141, 142).

The programme primarily used educational methods. It is important to note that the evidence base for burn prevention programmes that rely solely on educational interventions is slim, and few have been rigorously evaluated (143–146). However, in health-promotion campaigns and in injury-prevention work more generally, it is important to emphasize that educational campaigns work best if they are well designed, highly focused, and rigorously evaluated, all of which are the case with the following example.

NATURE OF THE PROBLEM

This case study is from Trondheim and Harstad in Norway. In these locations, burns were an important cause of severe injury among children. They were second only to fractures as a type of injury requiring hospital care. The two most common burn mechanisms for children in the study area were scalds and contact with hot surfaces. A wide variety of individual types of mechanisms accounted for each of these. Scalds were caused by:

- upsetting cups, especially containing hot tea and coffee;
- upsetting large containers of boiling liquid from stove tops;
- upsetting large containers of hot liquids from other places, such as pots of hot coffee on table tops;
- hot tap water.

Contact burns occurred from:

- irons;
- stoves, especially electrical coils on the stove surface;
- stoves used for heating.

There were additional burns from miscellaneous mechanisms such as playing with matches or falling into open fires.

SOLUTION

Almost all of the above burn mechanisms have pre-existing, effective, and passive prevention solutions, such as stove guards and lowering hot water heater temperature. In addition, active interventions, such as greater care when drinking or handling hot beverages if children under 2 years old are present, can address some of the other common mechanisms (e.g. causes). The issue became how to implement several such burn prevention strategies together, on a local basis.

IMPLEMENTATION OF THE SOLUTION

A community-based injury prevention programme started in Harstad in 1985, addressing several types of injury, including burns. A local Injury Prevention Group was founded, consisting of representatives of the local hospital, several public and private organizations, and concerned individuals. This was initially led by the local consumer office (a publicly funded office for protection of consumer rights), and meetings were held on an ad hoc basis. As funds were raised and project activities increased, a separate administrator was hired and meetings of the Injury Prevention Group became more frequent (bi-monthly). Eventually a comprehensive community programme was established (54, 141, 142).

The Injury Prevention Group was able to make use of high-quality, readily available data from the local hospital about burned children who were treated in the emergency department (including those subsequently admitted). Variables for use in the injury prevention programme were selected in cooperation with the National Institute of Public Health, as part of the national injury surveillance system (54, 141, 142).

Burn prevention strategies were selected to address the most common causes of childhood burns identified from the local data. A multifaceted burn prevention programme was developed using a broad public health approach, drawing on both active and passive strategies. Injury prevention messages were delivered through several channels, including hospitals and clinics, the media, and during home visits by public health nurses. The burn prevention messages piggy backed on, for example, public health nurses' scheduled visits to the homes of pregnant women two weeks before birth and at vaccination time, and when they are providing the four-monthly parent and child appointments that then continue for four years. In the Harstad programme, home safety assessments were also carried out and counselling delivered on the subject of burn and other injury prevention methods. It was felt by members of the Injury Prevention Group that social legitimacy of the burn prevention strategies delivered was helped by the involvement of the local hospital.

Through these channels, several main burn prevention strategies were promoted, including passive interventions such as lowering hot water heater temperatures to 55°C and the installation of safe guards around the edges of stoves. Active interventions were based

on well-established health education models and sought to increase parental caution while handling hot liquids, as well as identification and removal of (or other efforts to protect children from) burn hazards in the home. Specific practical advice included avoiding drinking hot beverages while holding a child, placing containers with hot tea or coffee out of reach of children, and not using a tablecloth when tea or coffee is served. Although it was acknowledged in advance that such active strategies were likely to be less effective than passive strategies, it was felt that these active strategies were necessary given the considerable number of burns resulting from tipping over cups and other receptacles of hot liquids.

In addition to these parent-orientated efforts, corresponding efforts by the local Red Cross, the consumer office and public health nurses sought to increase the availability of cooker safe guards in local stores. All programme efforts emphasized public participation and community empowerment.

These measures were extremely effective and sustainable over the long term. The mean burn injury rate (i.e. a burn requiring an emergency department visit) for children (0–4 years old) in Harstad decreased from 52 burns per 10 000 children a year before the start of the programme (18-month baseline) to 25 burns per 10 000 children a year during the 10 years after the programme started (a 53% decline). In comparison, a control city (Trondheim, where there had been no similar programme) showed a slight, but non-significant increase in childhood burn rates of 18% (from 62 burns per 10 000 children a year to 73 burns per 10 000 children a year), indicating it was likely the burn prevention programme had led to the decrease in Harstad. In addition to the overall burn rate decrease, there was a shift in types of burn, away from the more severe scalds towards less severe, contact-type burns. The more severe scald burns that occurred from hot tap water and from pulling receptacles full of hot water off stoves were completely eliminated. Further, no child from Harstad needed admission for a burn during the last three years of project monitoring and no child required a surgical procedure requiring general anesthesia in the last six years of project monitoring, both of which represented considerable financial savings (54, 141, 142).

There were some limitations in the project, especially in that, as it was multifaceted, it was difficult to know for sure which particular components were most effective. It relied heavily on home counselling – a strategy that has been shown to be moderately, but not extremely, effective in other studies and injury areas (62, 146–153). As would be expected, burns that were amenable to passive interventions (scalds from hot tap water and from stove tops) were most significantly decreased by the project. Nonetheless, burns that were primarily targeted through active interventions (e.g. scalds from pulling over cups and receptacles from tables) were also decreased by the project.

In summary, this project showed the effectiveness of a multi-faceted, community-based burn prevention strategy aimed at several of the most common causes of childhood burns in the project area. Several key elements that are likely to have contributed to the project's success include:

- understanding the community's burn prevention needs;
- community empowerment, with creation of an Injury Prevention Group consisting of local people concerned about the issue;
- use of proven burn prevention strategies;
- a well-defined target group, among which burns were indeed amenable to the burn prevention strategies used;
- ongoing evaluation of the effectiveness of the interventions, which was in turn helped by the availability of reliable local data.

These key elements are likewise those that make for successful burn prevention strategies in general, as discussed in greater detail in the Annex.

None of the above activities is high in cost, and all should be possible in low- and middle- income countries. Thus far however, there are very little data reporting on the outcome of such community-based interventions in any low- or middle-income country. In one of the few studies on this topic (mentioned under smoke alarms in Chapter 3), a community-based intervention in Mexico demonstrated an increase in parental self-reported vigilance and caution (among which was caution during use of hot liquids), but no increase in the more effective passive measures such as installation of smoke alarms or lowering the setting of hot water heater temperature (45, 154).

CHAPTER 5

Lowering the Burden of Burns Through Care

The emphasis of this book is mainly on primary prevention of burns, but improving the care of burn casualties can also lower the burden of death and suffering from burns. This includes care in prehospital and hospital settings. Care in the prehospital setting includes first aid performed by members of the lay public and more formal prehospital care provided by emergency medical services. Hospital-based care includes initial measures to stabilize burned patients, and definitive care, such as surgery. Rehabilitation overlaps with this care and continues – sometimes for long periods – afterwards. Rehabilitation addresses physical recovery as well as psychological recovery, and the person's return to activity and participation in their community. This chapter discusses some of the basic principles of burn care, from prehospital care to hospital care, and to rehabilitation. It also provides examples of programmes that have successfully improved one or more components of this spectrum. In all of these examples it can be seen that improvements are possible, even in low-income settings. In this way, this chapter also seeks to dispel the misconception that little can be done, affordably or sustainably, to improve burn care in low- and middle-income countries.

FIRST AID AND PREHOSPITAL CARE

NATURE OF THE PROBLEM

Much of the death and disability caused by burns could be avoided through appropriate care in the prehospital setting. For much of the world, where there is little access to formal emergency medical services, it is often lay-people, including relatives and bystanders, who initially assist burn victims, even though they have very little knowledge of what to do. One survey in India found that only 23% of burn patients had received the recommended first aid (155). Lack of awareness, misconceptions and tradition lead many people to use potentially harmful alternatives such as butter, ice, aloe, sugar water, or toothpaste.

SOLUTION

The first responder – be it a family member, bystander or emergency medical technician (EMT) – needs to be adequately trained in what to do in the event of a burn (see Table 5.1). To prevent continued burning and contamination, cooling the burn is essential. The recommended first aid treatment for burns is cool water (23, 156). Education on the effect of immediate application of cool water to burns should be promoted widely as an effective first aid treatment with emphasis on the fact that the water should be cool (e.g. tap water temperature, 15 – 25 degrees centigrade) and not ice cold. Likewise, ice should not be applied directly to burns.

Table 5.1
FIRST AID FOR BURNS

WHAT NOT TO DO	WHAT TO DO
▪ 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 (medication applied directly to the skin) until the patient has been placed under appropriate medical care.	▪ Ensure your own safety before commencing first aid (switch off electrical current, wear gloves to protect against chemicals etc.). ▪ 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. ▪ Stop the burning process by removing clothing and irrigating (rinsing or washing) the wounds. ▪ Apply cool water or allow the burned area to remain in contact with cool water for some time.* ▪ In chemical burns, remove or dilute the chemical agent by irrigating the wound with copious amounts of water. ▪ Obtain medical care.

Source: adapted from reference (23)

* Avoid applying cold water to large areas of the body, especially in the very young or very old, to minimize the risk of hypothermia.

IMPLEMENTATION OF THE SOLUTION

This section describes many successful efforts to promote the wider availability and use of appropriate first aid measures in communities, in several different locations. The burn prevention programmes described in the earlier sections of this book could work well alongside efforts to promote greater availability of first aid, as both sets of activities rely on education and social marketing.

A programme run by the Medico Social Welfare Unit and the Burn Centre in India (155) was designed to promote domestic burn prevention and raise awareness of the importance of correct first aid. The 5-year programme included health education curricula for schools, and community-based educational programmes, community drama sketch competitions and drawing and slogan competitions for school children. The campaign reached an estimated 10 000 people directly and many more indirectly through people "spreading the word". Although there was no formal evaluation of the programme, there were apparent changes in first aid practices in the community, including an increasing number of cases where patients coming to a burns centre had used water as first aid because someone from the neighborhood who had participated in awareness programmes had suggested doing so.

The "First Aid for Scalds" campaign (157) aimed to increase parent and caregiver knowledge of proper first aid treatment for scald burns among non-English speaking minority ethnic groups in Australia. The campaign targeted these groups through radio and newspaper advertisements, and knowledge of the correct first aid treatment was measured before and after the campaign. There was no effect among Arabic-speaking residents. However, among Vietnamese, correct knowledge increased from 23% at baseline to 87% after the campaign. Among Chinese residents, correct knowledge increased from 45% to 72%.

Interventions such as these are possible in low- and middle-income countries, as most countries, regardless of their economic level, have an existing infrastructure for first aid and related training, for example, through national Red Cross and Red Crescent Societies. Partnering with these organizations to develop, implement, and evaluate community programmes is an inexpensive, simple and logical next step. Moreover, improving the availability of quality first aid through low-cost training programmes has been shown to improve care and outcomes for several types of injuries in low- and middle-income countries, including road traffic crash and landmine injuries (158).

Finally, much of the above refers to first aid – whoever delivers it – but with an emphasis on the community. Similar principles apply to more formal prehospital care, as provided by emergency medical services (EMS) or ambulance services. In many locations, these are integrated within fire departments. In other locations, EMS, fire departments and police work together as part of overall emergency services – especially pertinent as fire departments are directly involved in rescuing people from burning structures. Hence, rescue and first aid are closely linked. For such rescue, there are additional considerations such as fire protective gear and breathing apparatus for firefighters to allow them to enter burning structures and those with smoke, superheated air and carbon monoxide. For burn victims who are transported by formal EMS, there is the possibility of additional treatments above and beyond basic first aid, such as manoeuvres and equipment to keep obstructed airways open (especially relevant for people caught in fires in enclosed structures, as will be discussed in the next section) and administering oxygen. However, it should be noted that starting formal EMS where none previously existed can be expensive and should be done with careful consideration of whether money could be more effectively spent elsewhere.

In summary, several easily performed first aid measures can decrease the pain and risk of death and disability for burn victims. Availability of these measures can be increased by programmes that train lay persons in basic first aid, and measures that increase the presence of more formal emergency medical services. Increased availability and quality of first aid is applicable and feasible in countries at all economic levels.

HOSPITAL CARE

NATURE OF THE PROBLEM

Following a burn, casualties may suffer several life-threatening, disabling or disfiguring problems. Initially, burn wounds result in tremendous loss of body fluids. This occurs through evaporation (because the protective covering of the outer layer of the skin is burned away) and through swelling into the remaining skin or other tissues. This can result in dehydration and shock, the main cause of early death for burn casualties.

For people who are burned in fires, especially in enclosed spaces, a further threat to life is smoke inhalation. This can damage a person's airway, leading to swelling which may cause obstruction. It may also damage the lungs themselves. Even if people are simply exposed to smoke and hot air, and not actually burned, damaged airways and lungs can prevent people breathing adequately, and this is another major cause of death from fires.

For those who survive the initial 24 hours, the next main problem is infection. This includes infection of the burn wound itself, due to loss of the protection that the intact skin provided. It also includes infections that arise from the fact that many burn patients become debilitated and have decreased immune status or ability to fight infections such as pneumonia. Such infections are the major killers of burn patients after the first few days.

An additional problem is the healing of the burn wound. As seen from Box 5.1, burns can be classified by their depth and extent. First degree burns do not lead to skin loss and heal by themselves. Second degree burns usually heal well on their own but third degree burns do not. Healing can take months, especially for larger burns, because third degree burns heal from the edges of the wound, where living skin remains. During this time, considerable scarring and contractures (e.g. tightening and shortening of tissues) can result. This can lead to poor functional results, such as loss of joint mobility, and disfigurement. Further, during the time that the burn wounds remain unhealed, they are prone to repeat infections, increasing the risk that the burn victim may die.

Throughout the course of burn treatment, many patients suffer from progressive malnutrition. The healing of the burn wounds and the fighting of infections demand a tremendous amount of energy from the body. During this time, many severely burned patients are unable to eat adequately. The result is malnutrition, which creates a vicious cycle of further delayed wound healing and decreased ability to fight infection. Such malnutrition is often a contributing factor to death in burn patients.

SOLUTION

Through considerable research, modern burn care has developed treatments to successfully deal with many of the problems above. This includes the development of formulas to assure early administration of fluids, usually intravenously, to replace the fluid losses from burns and to prevent shock. These formulas (e.g. the Parkland formula and the Brooke formula) are based on the extent of the burn, as estimated by the rule of nines, as described in Box 5.1. Adequate resuscitation of burn victims also relies on close monitoring of their vital signs and evidence of adequate hydration, such as urine output.

Box 5.1

CLASSIFICATION OF BURNS

DEGREE AND DEPTH OF BURN

FIRST-DEGREE	Superficial burns are those to the epidermis – or outer layer – of the skin. This usually results in redness of the skin, but no loss of the skin tissue itself. They heal spontaneously with no permanent changes in skin colour, texture or thickness.
SECOND-DEGREE	Partial-thickness burns. These are where damage to the epidermis extends to the underlying layer of the skin, the dermis. Portions of the epidermis die and peel off from the body, leaving the exposed dermis. However, islands of epidermis remain in the roots of sweat glands and hair follicles. These islands are the basis for subsequent healing of the burn wound.
THIRD-DEGREE	Full thickness burns. This involves damage to the epidermis and dermis, with loss of the hair follicles and sweat glands. Third degree burns cannot regenerate themselves, except by slow ingrowth of new skin from the edges of the burn wound where unburned skin remains.

EXTENT OF BURN

The extent of the burn is defined as the proportion of the body burned. This is also referred to as the total body surface area burned, and can be estimated using the "rule of nines". This method assigns 9% to the head and neck, 9% to each arm, 18% to each side of the trunk (back, chest, abdomen) and 18% to each leg. This formula needs to be adjusted for children, as the head is relatively larger and the rest of the body relatively smaller the younger the child. A method to assess the extent of a burn in a child is based on the fact that the child's palm is approximately equal to 1% of the total body surface area. Extent of burn for second and third degree burns together is used in estimation of fluid requirements for burn treatment (as discussed in the Solution section).

Attending a burn patient immediately after the burn incident requires an awareness of possible airway obstruction, and the need for early airway treatments. These include interventions such as placing a plastic tube in the patient's trachea (endotracheal intubation) to make sure they can breathe if swelling occurs – a particular problem for patients exposed to smoke or superheated air (159- 161).

Prevention of infection is the next major priority. This is achieved by assuring cleanliness in the handling of burn victims, especially while changing dressings. It is also achieved by use of topical antibiotics (i.e. those applied directly to the skin). Prevention of infection can also be promoted by assuring early closure of the burn wound, as described below.

For third degree or even deep second degree burns, wound healing can be prolonged or non- existent. Healing can be promoted by skin grafting, which involves taking a partial thickness sheet of skin from elsewhere in the body. As the sheet of skin removed is partial thickness, the area from which the skin is taken heals quickly. Placement of a skin graft over the area of third degree burns can achieve healing in a week or so, compared with often months without it. A variety of instruments (e.g. dermatomes, used for taking the graft) and techniques have enabled skin grafting to be much more widely performed. Skin grafting is a procedure that can be undertaken safely and effectively, even in small, rural hospitals in low- and middle-income countries (162).

A further advance in the care of burn wounds is "early excision and grafting". Using this technique, areas of third degree burns (i.e. dead tissue) are removed (e.g. debrided or excised) and the underlying living tissue covered with a skin graft within the first few days after the burn, rather than waiting for weeks to see if healing happens. This runs the potential risk of considerable blood loss, but a variety of

Figure 5.1 Skin grafting for burns can speed recovery and improve outcome. It is straightforward to perform, requires only simple equipment, and can be done even in rural hospitals.
Source: Tom Potokar/Interburns photo library

surgical techniques can be applied to minimize blood loss. In centres where this technique is frequently used, large third degree burns can usually be excised without the need for blood transfusion. Such early excision and grafting decreases the risk of infection and disfigurement, and improves functional results. It has been found to be especially useful for burns over joints, to maintain as much of their range of motion as possible (159–163).

Skin grafting in general needs to be more widely used for burn patients worldwide, and is highly suited to being practiced safely in small, rural hospitals (Figure 5.1). However, *early excision and grafting* is a more complex procedure and should, in general, be performed only in larger hospitals, with fully trained surgeons and anaesthetists who are experienced in its use, and where there are adequate support facilities such as a blood bank.

Through all of the above, the patient's nutritional status needs to be assured. Understanding the importance of this is critical, in and of itself. Adequate nutrition can often be achieved with the patient eating on their own, sometimes with additional dietary supplements. In some cases, adequate nutrition needs to be given through a small plastic feeding tube inserted in the patient's nose and into his/her stomach. When needed, it is best to start this as early as possible in the course of the patient's treatment. In rare cases, it needs to be promoted through intravenous feeding (total parenteral nutrition). It is possible to assure adequate nutrition to almost all burn patients, and to prevent malnutrition and its consequent effects of poor wound healing and infection, and thus increased risk of death (159-163).

IMPLEMENTATION OF THE SOLUTION

All of the above should be seen as elements in a spectrum of care, and undertaken in a holistic, integrated way, often by multidisciplinary teams. In well-resourced environments, team members might include doctors (especially burn surgeons), nurses, dieticians and physical and occupational therapists (to assist with rehabilitation). Other team members might include anaesthetists (to help prepare patients for the operating theatre and also to help with pain control), respiratory therapists, pharmacists, social workers, as well as physiotherapists and psychologists, to improve long-term functional outcome, as addressed in the next section.

Obviously, in most low- and middle-income country settings and especially in smaller hospitals, many of these practitioners are not available. In these cases, other team members need to fulfil a range of roles in addition to their own. It should also be noted that key members of any team caring for burn patients are the patient and their relatives.

Implementing the above elements of care has resulted in considerable improvements in outcomes for burn patients in a range of

circumstances. For example, in a burn centre in the USA, mortality for burned children decreased from 9% in 1968–1970 to 1% in 1981–1986. This was the result of advances in the overall spectrum of care, including highly skilled nursing care, attention to nutrition and respiratory care, and better infection control, especially through isolation rooms. Also emphasized was greater use of early excision and grafting (164). Similar findings have been reported from burn centres throughout other high-income countries (159–161).

Similar improvements have been reported from several low- and middle-income countries. For example, in Turkey, one hospital reported a steady decrease in childhood burn mortality from 23% in 1998 to 5.6% in 2005. This was the result of several factors, including the use of isolation rooms and better, cleaner facilities, especially during dressing changes. The hospital had also instituted a burn team during this period, which allowed for more focused attention by a group of providers specifically concerned with the care of burn patients. As with the preceding example, there was greater use of early excision and grafting (165).

Burn surgeons in India found that excision and grafting could be performed safely in their environment, with mortality rates of around 10% compared to much higher rates of 43% among all other burn patients. They also found that such improved surgical care led to better functional and aesthetic results, as well as decreased length of hospital stays – and thus cost (166).

In summary, a range of advances have improved care of burned patients in hospital. These have resulted in lowered mortality and improved functional results. Most of these advances are broadly applicable in all settings, including low- and middle-income countries. These advances are also affordable and sustainable, as the example above from Turkey shows, with steady improvements over nearly a decade. Such examples help to dispel the misconception that little can be done to improve care of burns in low- and middle-income countries. Similar issues relate to the possibility of improvements in rehabilitation, discussed in the next section.

REHABILITATION AND RECOVERY

NATURE OF THE PROBLEM

Apart from the problems that threaten a burn victim's life, described in the previous section, there are also problems that threaten a burn survivor's long-term functional recovery and return to society. These include the way in which the burn wound heals – often, considerable scarring can result, and can be associated with contracture, or tightening and shortening of the tissues. When this occurs around a joint, it can deform it and decrease its mobility. When it occurs on the face or other visible parts of the body, it can result in distressing disfigurement.

These bodily changes can result in burn survivors being unable to perform their usual activities. Often they are unable to continue in their usual life roles, or in the case of a child, their future role in society may be compromised. The disfigurement also leads to reluctance to be seen in public, and to exclusion from society. These effects combined can deny a burn survivor the ability to make a living, and can lead to a host of psychological problems, including depression, anxiety and loss of self-esteem. These psychological problems are often accompanied by persistent pain from the burn wounds, as well as the mental trauma resulting from the event that caused the burn. All of these physical, psychological, and social issues can lead to a cascading effect of poverty for burn survivors and their families.

SOLUTION

The advances in acute burn care described in the preceding section have been accompanied by advances in burn rehabilitation and recovery. Although considered a separate topic from acute burn care, it is important to note that burn rehabilitation needs to start on the first day of burn care and continue throughout the course of the care and beyond.

Burn rehabilitation includes measures such as training, exercises and compensatory strategies; pain management; support and counselling; education; environmental modifications and provision of resources; and assistive technology. Taken together, these have the combined goals of increasing physical and psychosocial functioning of the person within their environment.

Below are some examples of major components of burn rehabilitation, although this does not include all components and depends on individual circumstances.

TRAINING, EXERCISES AND COMPENSATORY STRATEGIES

- Keeping joints mobile (and preventing deformities), maintaining muscle strength, stretching burned tissues and early-developing scars to prevent contracture, and improving lung function to prevent pneumonia are very important in the early stages. This physical component of burn rehabilitation pertains even to the most severely burned patients, for whom a passive range of motion manoeuvres (i.e. when a therapist moves the patient's joints for them) on their joints can prevent subsequent deformity. Additional to these measures is the use of splints and pressure garments. These can be used to maintain joint alignment, reduce scarring and prevent joint contractures. They can also be used to help protect skin grafts while they are healing (161, 167).

- Therapy can also be used to aid both swallowing and speaking for patients with facial and mouth burns, and for patients who have been on ventilators (breathing machines) for long periods of time (161, 167).
- Performing rehabilitation activities as soon as possible is important for physical and psychological recovery. Therapy may involve teaching compensatory strategies to help the person perform activities such as changing their dressing, and to accommodate limitations in limb or hand function.

PAIN MANAGEMENT

Uncontrolled pain is a major problem for burn patients. In addition to the suffering it causes and the long-term psychological issues it can lead to, it also impedes other aspects of rehabilitation. For example, it can interfere with exercise. Three types of pain are often described as needing to be controlled: background, breakthrough, and procedural. Background pain is present throughout the day and night. Breakthrough pain occurs during activities of daily living when the person moves their burned body parts. Procedural pain occurs during treatments such as dressing changes. There are techniques for handling each type. Optimizing pain management means it is important to have staff with experience in these techniques, as well as institutional policies or protocols on pain management for burn patients (161, 167).

SUPPORT AND COUNSELING

As noted above, the deformity, disfigurement and loss of a place in society can lead to several psychological problems for burn survivors, including depression, anxiety and guilt. There is a need for psychological support services early on in the course of rehabilitation, and this support should extend to the family. These services often need to be continued long after the patient is discharged from hospital. Persistent pain can exacerbate psychological problems, and so adequate pain control is an integral part of addressing psychological issues (161, 167).

EDUCATION

Another component of burn rehabilitation includes education on key concerns such as adequate skin care to prevent breakdown and ulceration, and sun protection, because healed or grafted skin is not as strong as normal skin.

ENVIRONMENTAL MODIFICATIONS

Where there is permanent impairment, modifying the environment can remove barriers so that the person can perform activities and participate in day-to-day life. For example, for a person whose hand grip is impaired, modifications might involve changing the kitchen tap from a knob that is gripped and turned, to a lever tap that is operated by pushing up and down. For a person with contractures and limited motion in their knees or ankles, heightening a chair by standing it on a wooden block enables the person to sit and stand from the chair independently. These modifications can also be instituted in the workplace. When a burn survivor has limitations that prevent them performing their previous work, rehabilitation can provide devices to compensate for loss, modify the person's technique or workplace, or provide re-training for alternative work. It may include building on existing work skills or learning new ones, together with help finding a new job.

ASSISTIVE TECHNOLOGIES AND DEVICES

Assistive technologies refer to any piece of equipment, or product system, whether made, modified, or customized specifically for people with disabilities or in general use. These may be needed to compensate for loss of function. Such devices are often simple. For example, feeding yourself is not only important for nutrition and overall physical recovery, it is also important for self-esteem and psychological recovery. For a person with a shoulder, elbow or wrist joint affected by the burn, a simple device such as an angled spoon and a plate with a lip, or building up the spoon handle to make it thicker where hand grip is restricted, may allow the person to feed themselves.

Even with adequate acute burn care and rehabilitation, some survivors develop deformities and disfigurements that considerably limit their recovery. At times, these can be helped by reconstructive surgery, which is surgery after the burn wounds have fully healed. This surgery can be considered a component of the long-term rehabilitation process.

It is also important to note that all of the above issues are relevant to smaller burns as well as to major, life-threatening burns. Even small burns to the face, hand, or over joints can have significant functional and psychological effects that need rehabilitation.

IMPLEMENTATION OF THE SOLUTION

Rehabilitation is part of the spectrum of burn care and needs to be closely integrated with all other aspects of burn care, even during the very earliest phases. In well-resourced environments, multidisciplinary burn teams include several categories of professionals who look after the rehabilitation aspects of care, including nurses, occupational therapists, physiotherapists, psychologists, and, at times, psychiatrists and physician rehabilitation specialists (physiatrists). Those providing acute burn care are attuned to the importance of rehabilitation and the need for the input of these other professionals.

Using such approaches, the above-noted burn rehabilitation services have now become standard for most hospitals providing burn care in high-income countries. Through this, burn victims who might formerly have led disadvantaged lives of exclusion and unemployment can now return to their former place in society and lead productive, happy lives (161, 167).

In most low- and middle-income countries, burn rehabilitation services are currently minimally developed. However, fortunately, an increasing number of hospitals that care for burn patients are developing such rehabilitation services. This includes hospitals in a range of economic and geographic locations, including both urban and rural. For example, at the main burn unit in Colombo, Sri Lanka, rehabilitation has become an integral part of burn care, with occupational and physical therapists, psychologists, and specially trained counselors forming part of the burn team and involved even in the early phases of care. These same individuals follow the burn patients throughout their hospital course and during outpatient rehabilitation follow-up (168).

Similarly, in Chennai, India, one hospital that treats a large number of burned children has placed a special emphasis on rehabilitative aspects, especially

psychosocial counseling and the development of reconstructive surgery for poorly healed wounds. They also include a stress management programme for parents, which helps to calm their own fears and enables them to contribute more actively in their children's care and rehabilitation (169). Improvements in burn rehabilitation have also been addressed in rural areas. One provincial hospital in Papua New Guinea prioritized the availability of basic physiotherapy (the only place in the province where it was available). This was for a range of conditions, including burns, neurological disabilities, orthopaedic injuries, arthritis, and others (170).

All reports on the above three programmes have highlighted the importance of rehabilitative services in allowing better functional recovery and return to activity and participation in society for burn patients. These programmes also pointed out the sustainability, affordability and feasibility of providing these services, even in smaller rural hospitals, such as in Papua New Guinea. However, all three programmes also experienced barriers that needed to be addressed – especially significant was to the lack of follow-up for many patients who would have benefited from outpatient rehabilitation (168-170).

Hence, in addition to rehabilitation services offered in hospital, efforts to improve burn care and related rehabilitation globally need to address long-term, post-hospital rehabilitation, recovery, and return to society. In this regard, burn survivor self-help groups can make an important contribution. Such groups emphasize self-help and peer support from other people with first-hand experience of living with burn-related disability or disfigurement. They especially emphasize developing or regaining self-esteem and self-confidence.

The Changing Faces group in the UK is a model example of this. It is a registered charity founded by a burn survivor that supports and represents people who have disfigurements of the face or body, from any cause, including burns. Among its many activities it offers expert advice and resources, and training programmes to help teachers and students manage and prevent ostracism and bullying in schools, and ensure that disfigured students have equal opportunities. It also undertakes advocacy and publicity to change the sometimes negative opinion of society towards people with facial disfigurement, including working with the media to make sure journalists are better informed about the causes and effects of disfigurement and have an open mind about the life and prospects of people with disfigurements (171).

Self-help work for burn survivors desperately needs to be expanded to low- and middle-income countries, where it is almost completely absent. The WHO *Burn plan* identified this as one of the major aspects of burn care that needed to be advanced globally (2). It is encouraging to see that some such groups have indeed been founded – a burn self-help group in Indore, India is a good example (Box 5.2 and Figure 5.2).

In summary, burn rehabilitation offers the burn victim improved function, mobility, psychological well-being and return to activity and participation in society. In addition to medical rehabilitation at the time of hospital admission or in follow-up, peer self-help groups for burn survivors offer needed emotional and practical support during the often long recovery period after discharge from hospital. Such advances in burn rehabilitation and recovery are applicable in countries at all economic levels.

Box 5.2

BURN SURVIVORS GROUP IN INDORE, INDIA

Choithram Hospital in Indore has been treating burn patients for the past 25 years and has a reputation as a referral burn centre where affordable, holistic care is available. The rehabilitation component of burn care is managed in follow-up outpatient clinics in the hospital, where patients meet the burn-care team to find solutions for their everyday problems. This is very a demanding time physically, emotionally and financially for the patient and their family, and a challenge for the under-staffed burn centre. Initially the burn-care team encouraged survivors, especially those who had experienced successful recoveries and returned to active life, to spend some time in the burn centre with acute burn patients. This was reassuring for the burn patients as it helped them imagine their own successful future. These visits also encouraged and motivated members of the burn team who could see the success of their hard work.

In September 2009, the burn-care team encouraged burn survivors to form a more formal group that could provide ongoing psychological support and practical assistance to members. This idea was well received and some of the better educated and financially well-off volunteers offered to fund future activities. The first meeting was an introductory one where volunteers voiced their fears, hopes, and how they were coping. Then there were some spiritual groups who provided a bonding game. Finally a dance teacher played music and encouraged everyone to dance, teaching them simple steps. This encouraged participation from all members who left the meeting energized, happy and wanting to connect with the group's activities.

The burn survivors group now has around 50 members, including some treated at other hospitals. Future activities include forming smaller, age-related groups to promote more open and candid discussions, and to try to include more burn survivors from rural, poor areas, as many miss out on hospital follow-up.

Figure 5.2 Burn survivors dancing during a group meeting.
Source: Shobha Chamania

CHAPTER 6

CONCLUSIONS AND LESSONS LEARNED

The case studies in this book provide important lessons for future efforts to improve burn prevention globally. The case studies cover a wide spectrum of burn mechanisms, including house fires, scalds, clothing burns, electrical burns, burns from acts of violence, and others. They also cover a wide geographic spectrum, drawing on examples from most WHO regions. Although most of the examples of burn prevention efforts with solid evidence of effectiveness come from high-income countries, the case studies contain important lessons that apply to burn prevention efforts worldwide.

SCIENTIFIC METHOD

As with the prevention of any disease, burn prevention can be approached using the scientific method. First, risk factors for burns are identified through surveillance and research. As discussed in the Annex, an adequate understanding (e.g. diagnosis) of a community's burn needs is the foundation on which subsequent burn prevention efforts are based. Prevention strategies are then developed to specifically address these risk factors. The effectiveness of these prevention strategies depends on solid evidence, including laboratory and engineering evidence, intervention trials, and monitoring of population-wide rates. The implementation of the strategy, whether in small trials or large, nationwide programmes, is evaluated and monitored. Such evaluation is important in order to know what strategies are truly successful in real-world circumstances and thus should be continued and promulgated. It is similarly important to know what strategies have failed, so they can either be modified or discontinued, with resources shifted to more effective uses. Examples of this scientific method include the use of smoke alarms, which target the risk factor of people not having sufficient warning time to escape from burning buildings. This has been well evaluated through individual intervention trials and ongoing monitoring of house fire deaths in populations over decades. Similarly, the Guatemala safe stove targeted the risk factor of small children falling into ground level, open cooking fires. It has been preliminarily investigated in a rigorous field trial.

METHODS OF INJURY PREVENTION: THE "THREE Es"

Injury prevention often involves the methods of engineering, laws and enforcement, and education and social marketing. These methods are complimentary and in most instances are best used together. Most of the case studies in this book are based on one or more of these methods. For example, the development of smoke alarms, non-flammable fabrics, sprinklers, child-resistant lighters, safe stoves, and the many features of electrical safety are all based on engineering. Implementing these engineering advances usually requires either or both of the other "Es". Widespread use of smoke alarms has been most effectively achieved through laws that make them compulsory in all new buildings. However, educational campaigns are also needed to convince people to put them into their existing homes and to maintain them, changing the batteries regularly. The same general principles

apply to a very different burn scenario, that of confronting acid-throwing against women in Bangladesh. Here the complementary approaches of reducing the availability of acid in the marketplace (laws), increasing the penalties for and prosecution of perpetrators (laws and enforcement), and reducing the social acceptance of this act of violence (education and social marketing) were all used as part of a holistic approach that successfully decreased the incidence of this crime. Although these strategies can be used independently, they are generally best applied together, given their mutually beneficial effects. It should be noted that in the past (and occasionally today) in burn and injury prevention, there has been an over-reliance on unevaluated educational methods. For example, road safety campaigns in the past often relied on putting up signs that said "drive safely" without evaluating their effectiveness, and without using the scientific methods of injury prevention stressed in this book. If educational approaches are to be used in injury prevention, it is generally best to use them in a well thought out, comprehensive fashion (as with the example from the programme in Harstad, Norway) or to combine them with the passing of related laws (as was done with the examples of smoke alarms and hot water heater temperature regulation).

PASSIVE VERSUS ACTIVE INTERVENTIONS

Injury and burn prevention methods can be thought of as either active or passive on the part of the person being protected. *Active* interventions involve a behaviour change and require people to perform an act such as not smoking in bed. *Passive* interventions require no action on the part of those being protected and are built into the design of the agent or the environment, such as child-safe lighters or safer electrical wiring in housing. In general, passive interventions are considered more reliable and effective than active ones because they require no human action or reaction. Passive interventions are not always possible, but should be used whenever they are possible. Moreover, active and passive interventions are not mutually exclusive and can complement each other.

POPULATION-WIDE IMPLEMENTATION

Once the techniques of the prevention strategies are worked out, they need to be implemented widely. This involves the need for advocacy and building coalitions, both to change and enforce laws and to promote safety-related behaviour change. For all this, there are often frustrations and setbacks, and burn prevention experts and advocates must be patient and persistent. The examples of advocacy for reduced flammability of children's sleepwear and action against acid- throwing both provide great examples of broad, multidisciplinary coalitions that have worked against considerable odds and in the face of significant frustrations to achieve their goals. Likewise, these and other examples show the importance of ongoing evaluation of programme activities and monitoring of population-wide rates to assure that the desired effect is being achieved and maintained, as is explained in further detail in the Annex.

SUMMARY

This publication provides information on a range of burn prevention strategies, some of which are applicable to countries at all economic levels. The general approach and scientific foundation of burn prevention are universally applicable. Some of the proven methods, such as smoke alarms and hot water heater temperature regulation, are applicable in many areas globally, such as in urban areas of middle-income countries. These and other proven strategies need to be used more broadly where the risk factors and the epidemiologic patterns of burns are similar to those in high-income countries, where these strategies have proved successful. In some cases these strategies would require significant modification. For example, flammability of clothing is a risk factor in many locations, and decreasing the flammability of fabrics is a proven burn prevention strategy. However, implementation of a strategy to address the loose-fitting cotton clothing worn by women in some countries (that can easily catch fire while cooking over open flames) would be very different from the approach used in high-income countries to address the flammability of children's sleepwear.

Moreover, for much of the world, especially in low-income and rural areas, there are different risk factors and epidemiologic patterns and for these, there is an urgent need for more research and for development of strategies that confront them in these locations. For such strategies, there is likewise a need for careful evaluation to truly know what is effective and worthy of investment of very limited resources. The examples of the safe stove in Guatemala and the work of the Acid Survivors Foundation in Bangladesh are both prime examples of the types of research, implementation and evaluation that are desperately needed.

There are also several aspects of burn care that need to be implemented more broadly globally, be it in first aid, prehospital, hospital or rehabilitation/recovery setting. Given their interface with the community, prevention programmes can overlap with and help to promote better first aid. This includes elimination of harmful practices as well as increasing the availability of effective first aid measures, such as rapidly cooling the burn. There is also much that can be done to improve hospital care and rehabilitation and recovery. In hospital care, numerous advances have lowered burn mortality. These include better initial treatment to prevent shock and breathing problems, better infection control, increased use of skin grafts, and assuring adequate nutrition. Burn survivors can often be left with disability and disfigurement that hamper their return to active, meaningful life. Rehabilitation measures such as physical therapy to keep joints mobile and muscle strength up, splints to prevent deformities, and addressing psychological issues can assure a brighter future for burn survivors. Burn survivor self-help groups can also provide the necessary emotional support and practical assistance during the often long recovery period after hospital discharge. Almost all of these measures for improved hospital care and rehabilitation and recovery are feasible and affordable for countries at all economic levels, and need to be better promoted in low- and middle-income countries. There are many examples of successful implementation of these improved burn care measures globally. Those involved in burn prevention can assist these efforts by advocating for the affordable and sustainable improvements in burn care discussed above in their areas.

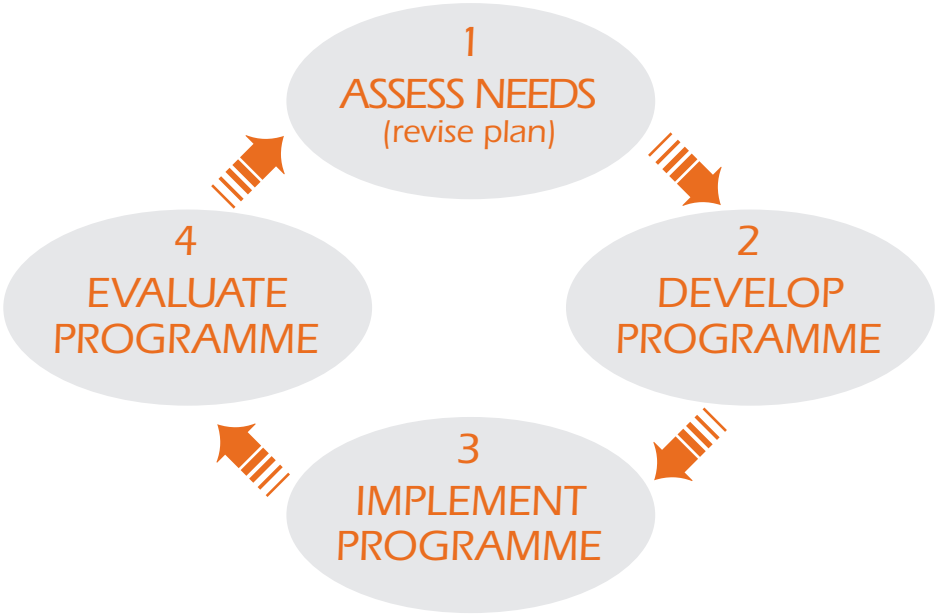
ANNEX

GETTING STARTED ON PLANNING, IMPLEMENTATION AND EVALUATION OF BURN PREVENTION PROGRAMMES

The success of injury-prevention programmes is largely dependent upon careful planning and implementation. Yet, most journal articles reporting on the results of interventions do not contain detailed information about how the programme was designed and delivered, so planning and implementation can seem like a mysterious "black box". Luckily, however, good practice in planning and implementation follow a logical and generic set of steps that can be used for any type of injury-prevention initiative. Essential to the programme planning process is evaluation. Careful evaluation will demonstrate the impact of the programme and help assure that resources are being used effectively and efficiently. The purpose of this annex is to provide a guide to the general steps involved in programme planning, implementation and evaluation. What follows has been adapted from sources (172) and (16) which are particularly useful for planning burn prevention initiatives in community or health-care settings.

Programme planning for burn prevention may seem like a complicated process, but it does not have to be. Programme planning is a cyclical process, beginning with an assessment of real or perceived needs. After careful assessment of the need, a programme plan can be developed to address that need. Next, the programme is implemented and its progress and impact evaluated. The programme may be revised based on implementation and evaluation results. Through continuous needs-assessment and implementation monitoring, the programme can be modified and subsequent plans developed to address new or emerging problems or needs (See Annex Figure 1).

Annex Figure 1
CYCLICAL PROGRAMME PLANNING MODEL



Source: Andrea Gielen

The following *eight steps* are offered as a way to help maximize the impact of your burn prevention programme. These steps are not meant to be a rigid model. You may find it easier to address them in a different order to that outlined here. You will also find it helpful to review decisions made in previous steps in the light of subsequent decisions. Approach your programme planning as an iterative process rather than a linear one (i.e. one where all steps can be revisited during the process regardless of what stage you are at), and as a collaborative process rather than an individual one – the planning and decisions you make will be the better for it. For each step in the process we provide a list of questions designed to help you develop a burn prevention programme tailored to the unique needs of your community and the specific burn topics you select, using the resources available to you. Consult early and often all parties involved in the development of your programme – fostering this kind of involvement will increase each group's investment in its success.

Step 1: Describe your community's burn prevention needs
Step 2: Identify potential partners and rally community support
Step 3: Identify and prioritize your intervention options
Step 4: Create measurable objectives
Step 5: Create implementation (or action) and evaluation plans
Step 6: Determine and obtain the necessary resources
Step 7: Create the materials needed for implementation and evaluation
Step 8: Implement, monitor and evaluate

STEP 1 DESCRIBE YOUR COMMUNITY'S BURN PREVENTION NEEDS

Before deciding on an intervention, the problem needs to be clearly defined. What are the burn prevention needs of your community and which are your priority populations? Here are some questions to guide you – the answers to some may be in existing data, but often you will need to collect new data to inform your decision-making. Sources of data typically used include: medical records, vital statistics, literature, survey data, interviews with key informants (i.e. community leaders and other people knowledgeable about the community and its needs), and focus groups. A critically important first step in programme planning is identifying your intended audience and engaging them in programme planning right from the start.

- What burn problems are most prevalent, and serious in your community? What data sources can you use to find out?
- Who is your priority population? What age groups, sex and locale are at greatest risk for burn problems? How does your organization currently interact with your priority population? What other opportunities does your organization have to interact with your priority population?

- What unique cultural, social, economic, educational or attitudinal issues exist within your priority population that might have an impact on burn prevention?
- How does your priority population perceive these burn problems? What do they know, believe, and do in relation to them? What do they need to know, do and/or believe in order to prevent them?
- What are the environmental barriers to prevention? What are the potential solutions to overcoming or eliminating them? What services or products would help prevent these injuries?
- How will you engage your priority population in defining the problem and developing solutions? Commonly used options are: task forces, coalitions and advisory groups.

STEP 2 IDENTIFY POTENTIAL PARTNERS AND RALLY COMMUNITY SUPPORT

Partners are important to help spread the message, share resources and provide new perspectives on a problem. They often expand your access to the population you seek to serve and can enhance the credibility of your programme. It is important, however, to choose partners carefully so that the people around the table can all agree on a shared goal. Partners will have their own organizational mandates and missions, but there should be overlapping interest in burn prevention to enable effective partnerships.

- What other organizations, agencies, or groups in the community regularly interact with your priority population? Do they provide services that would complement burn prevention efforts?
- What other organizations, agencies or groups are interested or involved in burn prevention?
- What other organizations, agencies, or groups have resources that might be useful to your programme, and how can you access them?
- What are the benefits and drawbacks of partnering with any of the organizations, agencies, or groups you identified?
- What other organizations, agencies, or groups in the community would be important to involve in terms of rallying support for your programme?

STEP 3 IDENTIFY AND PRIORITIZE YOUR INTERVENTION OPTIONS

Once you have identified the burn problem and priority population, and aligned your partners, your task is to identify effective solutions that can work in your setting. You can develop a list of options by using the Haddon Matrix (see Chapter 2), reviewing best-practice literature, and collecting input from your population and partners. It is important that your choice of

interventions is clearly linked to your definition of the problem (Step 1). You should be able to explain clearly how the interventions you are considering will address the problem as you have defined it.

Once you have developed your list of intervention options, one way to select an intervention is through the use of a decision tree or matrix (173). A decision matrix is a simple tool designed to identify intervention options and choose between them. It can also identify long-term goals and intervention options that support each other. Here is one example of a decision matrix developed specifically for injury-prevention interventions (173).

- EFFECTIVENESS : *is it likely the intervention will achieve its aim?*
- FEASIBILITY : *is the intervention possible?*
- COST FEASIBILITY : *how affordable is it?*
- SUSTAINABILITY : *what is the potential for continued effect?*
- POLITICAL ACCEPTABILITY : i*s it likely that the intervention will be politically acceptable?*
- SOCIAL WILL : *will there be support for the intervention?*
- POSSIBLE UNINTENDED CONSEQUENCES : *what are the consequences, both positive and negative, that could result from the intervention?*

It is useful to create a table to compare intervention options and rate each intervention on each criteria as low, moderate or high (See Annex Table 1). Suppose four burn prevention interventions have been discussed to address the high incidence of burns from unsafe use of kerosene lamps in your community. Using the decision criteria in the first column, how would you rate each intervention?

Annex Table 1

DECISION MATRIX EXAMPLE

UNSAFE USE OF KEROSENE LAMPS INTERVENTION

DECISION CRITERIA	COMMUNITY- WIDE EDUCATION PROGRAMME ON SAFE USE OF KEROSENE LAMPS	COMMUNITY- WIDE DISTRIBUTION PROGRAMME OF LAMPS WITH SAFER DESIGN FEATURES	A LAW BANNING THE USE OF KEROSENE LAMPS
Effectiveness			
Feasibility			
Cost feasibility			
Sustainability			
Political acceptability			
Social will			
Possible unintended consequences			

CREATE MEASURABLE OBJECTIVES STEP 4

Once you have identified an intervention or interventions that are suitable for the burn problem you are addressing, you are ready to create measurable objectives. A goal statement is broad and reflects the overall mission of your programme (e.g. to improve the community's quality of life by reducing burn injuries), whereas an objective tells you how much of what will change by when (e.g. the rate of burn injuries among a specific population will be reduced by x% in x years). Measurable objectives are critically important because they are the benchmarks against which you will evaluate your programme. Programme evaluation is described in Step 8, although it should be discussed throughout the programme planning process, particularly when creating your measurable objectives and implementation plan.

CREATE IMPLEMENTATION (OR ACTION) PLANS STEP 5

There are many tasks that must be considered when developing an effective programme. An implementation and evaluation plan requires that these tasks be written down in a logical sequence so that when you launch your programme it will go as smoothly as possible. Here are some questions to consider when creating your action plan. Not all of these will apply to every programme or initiative – it depends on what the components of your programme are but in general this step of the planning process encourages you to think about all the administrative and organizational details needed to create, implement and evaluate your intervention.

- What specific services will your programme provide? Will your programme conduct education only, or will it also distribute safety-enhanced products? Will they be sold or distributed free of charge? If you conduct education, will it be done on an individual basis or will group classes be offered?
- What are your programme's hours and days of operation? Will you require an appointment? Will you charge for your services and products? Are prices fixed or will you use a sliding-fee scale? Will you accept cash, cheques and/or credit cards? Who will be responsible for accounting?
- Will clients be expected to meet some type of criteria to use your programme? Must they be from a particular geographical area, have a particular group affiliation or meet certain financial needs criteria?
- Consider the services you plan to offer; what types of staff are required and what kinds of skills should they have? How many staff do you need to provide these services? What are the training needs of your staff? How will you assure quality training and performance?

- Who in your organization needs to be supportive of your endeavour? If you are working with partner agencies, who in their organizations need to be supportive? Do these individuals need to have leadership roles in your programme's organizational structure?
- Who will make long-term decisions affecting your programme? Who will make day- to-day decisions affecting your programme? Do you need an executive committee? An advisory board? How will the members of your priority population be represented in the leadership of your programme?

STEP 6 DETERMINE AND OBTAIN NEEDED RESOURCES

Resources usually include personnel, office space, and funding. Partners can be particularly helpful in finding resources or providing in-kind support. Here are some questions to consider.

- What location is most convenient for your priority population? Will they perceive it as acceptable, accessible and appropriate? Will your location allow you to meet your service goals? Can you afford the space? If not, can you get space donated? How will you design and use the space for maximal educational impact?
- How much money will you need to build/set up your programme? Who will cover these one-off expenses? How much money will you need to staff your programme for a year? How much will supplies, educational materials and other materials cost each year?
- What other operating expenses do you anticipate (e.g. training fees for staff, utilities, participation in conferences, journal subscriptions, rent, insurance, etc.)?
- Will your programme produce any income through sales of products or fees for services rendered? Are you responsible for reporting monthly income tax in your jurisdiction?
- Will you or can you accept donations from clients for services rendered?
- Can any of your costs be covered through in-kind contributions from any of your partner organizations?

STEP 7 CREATE MATERIALS NEEDED FOR IMPLEMENTATION AND EVALUATION

The materials needed to implement and evaluate your intervention will vary by the scope and components of the programme. You may need administrative materials for record-keeping, advertising materials, educational materials, etc. Here are some questions to consider.

- What are the educational needs of your priority population? What are their preferred methods of learning (hands-on, lecture, reading, video etc.)?

- What materials exist that are appropriate for your community? Do you need to create new materials? Who will be responsible for doing so?
- How will you advertise your services to your priority population? Do you have funds to do so? How can your partners help with marketing your services through their networks?
- What information are you required to maintain for legal, reporting, administrative or evaluation purposes? How will you collect, organize and report such information? Who will be responsible? (See Step 8 for evaluation methods)

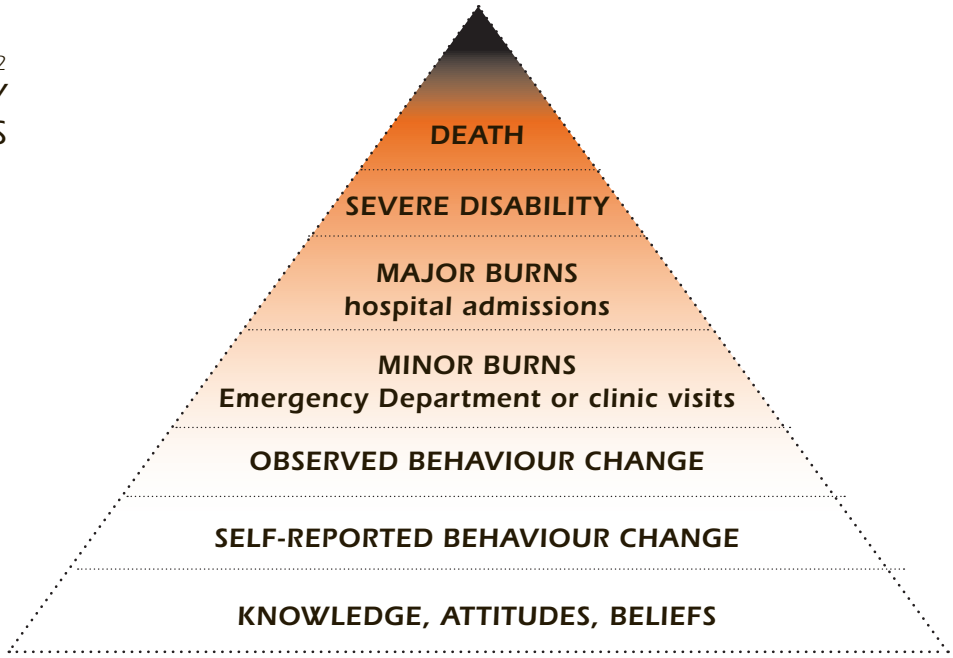
IMPLEMENT, MONITOR AND EVALUATE STEP 8

A critical element of injury-prevention programmes, which is often not given adequate attention, is evaluation of effectiveness. This requires two main activities: evaluation of both process of implementation and outcome.

PROCESS EVALUATION can be regarded, in part, as quality assurance of the programme implementation. For example, are the various items in a public information campaign progressing at the scheduled rate? The main purpose of such evaluation is to make sure that the programme is being delivered as intended and to provide feedback for modification of the intervention. Administrative record-keeping (as described in the previous steps) is essential for process evaluation. Programme leaders should be monitoring the delivery of the intervention in real time, so that adjustments can be made as needed. Only by delivering the intervention as intended will later outcome evaluations be able to provide useful information.

OUTCOME ASSESSMENT evaluates whether the programme achieved its measurable objectives. These can be changes in knowledge, attitude, behaviour or injury. While we all want our programmes to have immediate and direct impact on the most severe consequences of injury, namely fatalities and injuries producing disability, this may not always be possible, given limitations of size of the target population, other factors influencing injury rates, and the generally modest level of programme resources. In these circumstances, measurement of "proxy outcomes" can be suitable, if carefully chosen. These are outcomes which are more frequent and hence more easily measurable, such as changes in safety behaviours. For example, a programme to promote smoke alarm use would reasonably start by measuring changes in the percentage of households that had installed smoke alarms, rather than by measuring rates of death from house fires. Such a programme would be more likely to demonstrate changes in the proxy measure (use of smoke alarms) in a shorter period or in a smaller population, whereas serious burns and deaths are more likely to change only over longer periods. Using such measurable outcomes is critical to "document" the success of a programme, and hence increase or sustain community buy-in and support.

Annex Figure 2
HIERARCHY OF OUTCOMES



Injury outcomes can be thought of as a hierarchy, with the highest level being fatalities (Annex Figure 2). These are the most desirable to prevent, but the hardest for which to reliably evaluate changes because of their relatively infrequent occurrence. The lower levels of the outcome hierarchy are the proxy outcomes and are the easiest in which to assess change, especially in small-scale projects. However, the lower levels have the disadvantage of being less directly and less definitely associated with ultimate decreases in the more serious outcomes.

It is important to focus on proxy measures that have already demonstrated their link to injury outcomes. Smoke alarms are a good example, because they have demonstrated their efficacy in controlled studies already, so we have some confidence that increased use of smoke alarms will result in reductions in house fire deaths and injuries.

Whichever outcome is chosen, it is important to build outcome assessment into the design of the prevention programme. In this way baseline measurements can be obtained, which will subsequently enable comparisons before and after an intervention, and comparisons of groups with and without an intervention. Such outcomes assessment is useful for identifying strategies that have been successful and hence are worth promoting on a wider scale. Outcomes assessment is also useful for identifying those strategies that are not working, and hence should be changed or discontinued (4, 9)

QUESTIONS TO GUIDE YOUR DECISION-MAKING ABOUT PROGRAMME MONITORING AND EVALUATION

- .What evaluation data do your funders, partner organizations or priority populations want you to collect?What evaluation data are of interest to you and your leadership?
- What information would help you in describing your programme's success in fulfilling its mission and in identifying unmet needs?
- What information do you need to collect from clients to determine the appropriateness and effectiveness of the services you offer? What other sources of data would be helpful?
- What information would be helpful in attracting interest (e.g. new partners, new priority populations, new sources of financial support) in your programme's mission?
- How will you collect the information identified above? Do you have evaluation expertise among your existing organizational structure or do you require partnering with another group?
- How will you determine if your programme's mission, objectives and services need to be modified to meet the changing needs of your priority population?
- How will you disseminate evaluation results or annual reports to existing and potential funders?
- How will you respond to the new and emerging burn prevention needs of your community? Do you need to consider partnering with new agencies?

FINAL THOUGHTS ON PROGRAMME PLANNING, IMPLEMENTATION AND EVALUATION

Each programme is unique to the audience, setting and resources available. However, the logic process of building programmes is universal. By following simple planning steps in creating your programme, you will maximize the chances that an effective solution to the burn problem in your community will emerge. While it may seem tempting to "just get started and do something", your community will be well served by taking the time to strategically plan your intervention and engage relevant stakeholders in the process. Evaluation must be a central focus of this work as well. Without evaluating your process and outcomes, you will never know what works and what does not. With careful attention to evaluation, you will be better positioned to advocate for future burn prevention programmes and thus better able to serve your community. Lastly, it is advisable to share your lessons learned with the wider injury-prevention community. Although this is traditionally accomplished through publications and presentations at professional meetings, the internet makes it possible to communicate globally in an instant and numerous list serves offer other important opportunities to share new knowledge.

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