Injury prevention and control: The public health approach

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Abstract

Injuries are among the leading causes of death and disability throughout the world, and injury rates are highest among middle- and low-income countries. Efforts in injury prevention have high potential gain for society because they disproportionately reduce death and disability to the young. Many opportunities to implement injury prevention strategies exist, and a systematic approach to injury prevention can help identify the most effective and efficient approaches. Building capacity for injury prevention activities in low- and middle-income countries is an important public health priority.

Introduction

Injuries are a leading contributor to the disease burden worldwide. They contribute significantly to premature life lost and years lived with disability for all countries, all regions of the world, and all age groups. Injuries cause over 5 million deaths per year, with approximately 1.2 million of these due to road traffic injuries (Krug *et al.* 2000; Peden *et al.* 2002; World Health Organization 2004). For children under 14 years of age, road traffic crashes, drowning, fires, poisoning, interpersonal violence, and war are all in the leading 10 causes of death. Deaths represent just a small proportion of the many injuries that cause serious injury and potentially life-long disability, and injuries also cause significant psychological trauma and financial loss. The burden of traumatic injuries necessitates that injury prevention be considered an international public health priority.

Because the majority of us will suffer multiple minor injuries throughout our lives, most of which cause only minor discomfort or inconvenience, we may be lulled into believing that injuries are just part of life. However, a serious injury or the traumatic death of a loved one can completely change the course of the lives of those affected. Many of these severe and fatal injuries can be prevented, and global investment in traumatic injury prevention will have significant long-term health and financial benefits.

For developed countries, progress has been made in reducing the toll of traumatic injuries. In the United States, for example, road traffic crashes per million vehicle miles travelled decreased nearly 90 per cent from the 1930s into the twenty-first century (Institute of Medicine 1999). Mortality rates have decreased for deaths from drowning, residential fires, homicide, poisoning, among others. However, these rates remain unacceptably high knowing that many effective prevention strategies have not yet been widely implemented.

The burden of traumatic injury worldwide is disproportionately concentrated in lower-income countries (Hofman *et al.* 2005; Ameratunga *et al.* 2006). The World Health Organization (WHO) anticipates that, if current trends continue, road traffic injuries, interpersonal violence, war, and self-inflicted injuries will all be among the leading 15 causes of disability-adjusted life years lost by the year 2020. Road traffic crashes, which in 1990 ranked as the ninth leading cause of disability-adjusted life years lost, is predicted to reach the rank of three in 2020 (Peden *et al.* 2002). Operations of war will rise from the rank of 16 in 1990 to 8 by 2020, and interpersonal violence will rise from rank 19 to 12. Despite some successes in many areas of injury prevention, new risks, changing environments, and increasing population size constantly challenge injury control efforts.

Effective injury prevention strategies will require organization of the public health response and increased integration of professionals from many backgrounds. Modern injury control research combines ideas and skills from public health, biomechanics, engineering, behavioural sciences, law, law enforcement, medicine, and urban planning, among others. Research that identifies how effective interventions in high-income countries can be translated in low- and middle-income settings is a priority, but injury prevention strategies will need to be appropriate for local environments. Injury prevention activities that integrate multiple approaches within an organized public health response have a stronger chance of success.

This chapter will present the current state of knowledge regarding the burden of injuries and will introduce the basic concepts of building injury prevention infrastructure and capacity.

Causal model of injuries

Injuries are generally divided into the two broad categories of intentional and unintentional. Intentional injuries are those in which there was an intent to commit harm, either to oneself or someone else. Unintentional injuries occur without a direct intent to commit harm, even if gross negligence was involved. For example, a motor vehicle occupant death caused by a drunk driver would

be considered an unintentional injury even though in many countries the driver could be prosecuted for a crime.

Injuries are further classified by their cause, such as motor vehicle occupant injuries, drowning, suicide/attempted suicide, homicide/assault, or residential fire injuries. Until the late 1990s, cause and intent were coded together, so that, for example, a poisoning death would not be distinguished as intentional or unintentional. In the 1990s, a collaboration between the US Centers for Disease Control and Prevention and the American Public Health Association recommended that cause and intent be considered as separate components of describing an injury, and most data are now coded accordingly (Centers for Disease Control and Prevention 1997). Through this collaboration, a matrix to code injuries by intent and cause using the International Classification of Diseases, 9th revision, was developed. This matrix served as a template to create codes for injury cause and intent that are now included in the 10th revision of this coding system.

Injury causes are very broad and represent a diverse range of physical harm. What, therefore, is the uniting feature that defines an injury? The traditional epidemiologic model for infectious diseases provides a framework for the epidemiologic study of traumatic injury (Fig. 10.4.1). At the centre of the causal pathway for injuries is the agent-host interaction. The agent, which in the case of injuries is energy, is absorbed by the host to cause injury. Energy can take many forms, such as mechanical, electrical, chemical, radiation, and thermal. An example of an agent-host relationship is a motor vehicle crash, in which the energy exerted on the individual is mechanical. The reservoir is the place in the environment where the agent is found. The potential for energy transfer exists everywhere, but its potential to cause injury is limited to specific conditions. For instance, the potential energy in a motor vehicle exists only when the car is being driven, and causes injury only when the vehicle crashes.

Vehicles and vectors are mechanisms which transport energy from the reservoir to the host. A vehicle is an inanimate object, such as a motor vehicle; a vector is animate, such as a dog biting a child. For many injury causes, vehicles and vectors are both involved in energy transfer, such as when one individual (vector) stabs another with a knife (vehicle). The injury outcome is the trauma or injury sustained by the individual, and is influenced by host responses to the energy. Only energy transmitted beyond a host's tolerance causes an injury, and therefore not all exposures to energy result in noticeable injury. A human has some resistance to energy which can be increased through exercise or protective devices, or reduced through changes in intrinsic factors such as existing medical conditions or age and through extrinsic factors such as fatigue and alcohol.

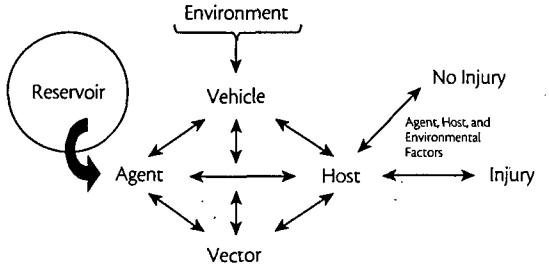

Fig.10.4.1 Causal model of injury.

This causal model is important when considering injury prevention strategies. Injury prevention aims to prevent energy transfer or to reduce the amount of energy that is transferred. Prevention activities can focus on the host, on the environment, on vehicles or vectors, or combine all of these components. A theoretical approach to injury prevention based on this model is presented later in this chapter.

Data sources

Data that describe injury events and that provide information related to injuries can be found from a wide variety of sources, both within and outside of the health sector (Hyder & Morrow 2006). Data sources within the health sector include some that capture a wide range of health conditions, such as health information systems, vital registration systems and hospital discharge data. Other sources are specific to injuries, such as emergency medical services data and trauma registries. Sources outside the health sector cover a wide spectrum, including data from police, the transportation sector, legal records, and insurance company claims. Sources such as newspaper articles and consumer reports have also been used to describe injury incidence and risk. This diversity of data sources makes the field of injuries and violence unique in terms of the inter-sectoral nature of the information (Norton *et al.* 2006).

In many instances, data sources need to be linked together to provide a complete description of the injury. Motor vehicle crash injuries, for example, often require data from traffic enforcement to describe the cause and nature of the crash and data from the health sector to describe the injuries and their severity. Linking these data sources can be impeded by issues of privacy and access to identifying information for linkage, as well as data quality issues. In low- and middle-income countries these data systems, if they exist at all, are often not computerized and have never been evaluated for quality, making such linkages even more challenging. However, information from multiple sources is often necessary to examine causal hypotheses about injuries.

The Global Burden of Disease study attempted to collect consistent and internationally comparable data (Murray & Lopez 1996; WHO 2002). This global data has several limitations in regard to injuries. For example, burn data include deaths from fire-related burns only, and exclude scalds, and drowning deaths exclude drowning deaths due to floods. However, this data is the most comprehensive source for describing the global burden of injuries, especially in relation to other health conditions, and it is thus very useful for public health purposes.

Generally, mortality data has the highest quality, and most high- and middle-income countries have some vital statistics systems that capture the majority of deaths and their causes. Population-based data that describe the causes and types of non-fatal injuries and their outcomes are more challenging to collect and far less available, especially in the developing world. The public health infrastructure and routine collection of health information in the developing world has been fragile, especially in regions such as sub-Saharan Africa and South Asia. It is thus not surprising that there has been little tradition of developing specific information sources for injuries. Population-based studies from low- and middle-income countries, though, consistently conclude that the injury burden is higher than reported in national official statistics and that injuries are significantly underreported in these regions.

One of the important developments over the past decades in the field of health information systems has been the development of summary measures of population health (Hyder & Morrow 2006). The sentinel work of the Ghana Health Assessment Team in the development of the days of life lost indicator evolved into the launch of the disability adjusted life year (DALY) by the World Bank and WHO (WDR 1993; Hyder *et al.* 1998). The DALY combines the loss of healthy life from premature mortality and that lost from life lived with disability in the uni-dimensional measure of time (Murray & Lopez 1996). This allows deaths, morbidity, disability—both fatal and non fatal health outcomes—from a disease to be measured (Fig. 10.4.2). The combination of years of life lost (premature deaths) and years lived with disability in summary measures of population health (like DALY) is important for injuries which cause both types of health outcomes. Technical details of the DALY and other measures are available elsewhere (Murray and Lopez 1996; www.who.int).

Global burden of injury

Over 5 million deaths occur from all injuries worldwide each year (Table 10.4.1), of which nearly 85 per cent are in low–middle income countries (LMIC) (World Health Organization 2002). Nearly 25 per cent of these deaths are caused by road traffic injuries, with self-inflicted injuries and violence comprising a further 17 and 11 per cent of deaths respectively (Fig. 10.4.3). Injury death rates are highest for road traffic injuries, followed by 'other' unintentional injuries, self-inflicted injuries and violence; similar patterns are observed for non-fatal health outcomes using DALY rates (Table 10.4.2).

Road traffic injuries (RTIs) alone kill over 1 million people every year, qualifying these types of injuries as the tenth leading cause of death worldwide (World Health Organization 1999). According to the Global Burden of Disease study, death and disability from road traffic injuries are projected to rise substantially in future years to become the third leading cause of disability-adjusted life years lost worldwide by 2020 (Murray & Lopez 1996). Globally, the majority of those killed are from low- or middle-income countries. The absolute number of fatalities and the mortality rate resulting from road traffic injuries vary considerably across countries, and although all age groups are affected young adults, particularly males, are most at risk of loss of life. Since this age group corresponds to the most economically productive segment of the population, road traffic injuries have serious implications for national economies.

The WHO estimates that there are over 3 million cases of acute poisoning resulting in over 300 000 deaths each year. More males die from poisoning and over 90 per cent of these events occur in LMIC. Non-fatal, unintentional poisoning resulted in a loss of over 7.5 million DALYs globally. Falls cause more than 350 000 deaths worldwide with a mortality rate of 6 per 100 000 globally. They result in more than 15 million DALYs lost per year (2 DALYs per 1000 population)—signifying the important contribution of morbidity and disability from falls. The global burden from falls is also disproportionately high in low- and middle-income countries. Over 300 000 deaths are caused by fire burns resulting in more than 10 million DALYs lost; however, unlike other injuries, more females than males died from fires (male to female ratio of 0.6:1.00). Causing an estimated 400 000 deaths each year, drowning is the second leading cause of unintentional injury death globally, with 97 per cent of these deaths in low- and middle-income countries. (These data include only 'accidental drowning and submersion and exclude drowning due to floods [cataclysms], boating and water transport'.) One-third of drowning occurs in the Western Pacific Region, though Africa has the highest drowning fatality rate. Overall, the male rate of drowning is more than twice that for females.

Self-inflicted injuries, including suicides, attempted suicide, self-destructive behaviours and self-mutilation, cause the deaths of over 850 000 people globally, resulting in more than 20 million DALYs lost. Interpersonal violence disproportionately affects low- and middle-income countries with an estimated rate of 32 per 100 000 people, compared to 14.4 per 100 000 in high-income countries

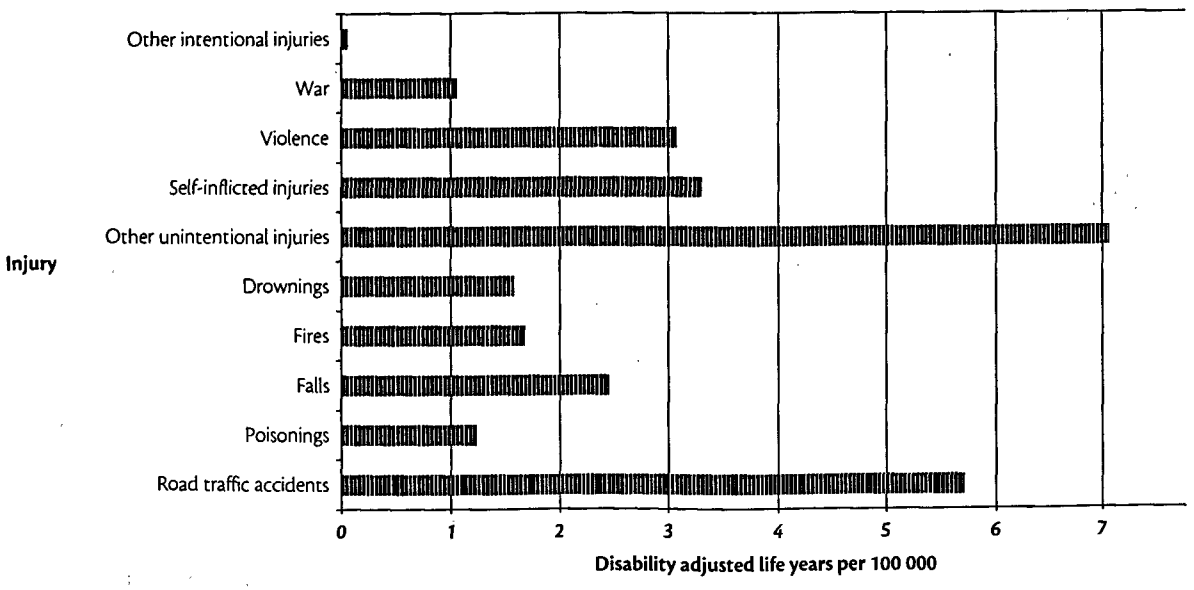

Fig. 10.4.2 Worldwide burden of injury by cause (2001).

Table 10.4.1 Deaths from injuries worldwide, 2001

	Total	Males	Females
All injuries	5 185 745	3 482 854	1 702 891
Unintentional injuries	3 534 562	2 296 318	1 238 244
Road traffic accidents	1 189 417	866 871	322 547
Poisonings	349 460	225 797	123 664
Falls	387 477	233 661	153 816
Fires	309 740	118 583	191 157
Drowning	384 666	263 145	121 521
Other unintentional injuries	913 802	588 262	325 539
Intentional injuries	1 651 183	1 186 536	464 647
Self-inflicted injuries	874 533	547 017	327 516
Violence	556 272	442 137	114 136
War	207 589	187 128	20 461
Other intentional injuries	12 788	10 253	2 534

(Krug *et al.* 2002). Surveys indicate that up to 8 per cent of women (over 16 years) report experiencing sexual violence within the past 5 years, while up to 27 per cent report experiencing sexual violence from an intimate partner in the past year (Krug *et al.* 2002). An estimated 200 000 youth homicides are committed globally varying from 1 in high-income countries to 36 per 100 000 in Latin America. It is estimated that for every youth homicide, there are up to 40 victims of non-fatal youth violence receiving hospital treatment (Krug *et al.* 2002).

Surprisingly, the burden of homicide is found in children under 5 years of age as well; the rate of homicides are 2.2 per 100 000 for boys and 1.8 per 100 000 for girls in high-, and 6.1 and 5.1 per 100 000 for boys and girls, respectively, in low-income countries (Krug *et al.* 2002). Abuse of the elderly occurs in the home and institutions and there is a lack of global data on this issue; however, surveys in the developed world indicate a prevalence of 4–6 per cent of abuse of older persons (Krug *et al.* 2002). War is also an important form of collective violence and was estimated by WHO to cause more than 200 000 direct deaths worldwide in 2001.

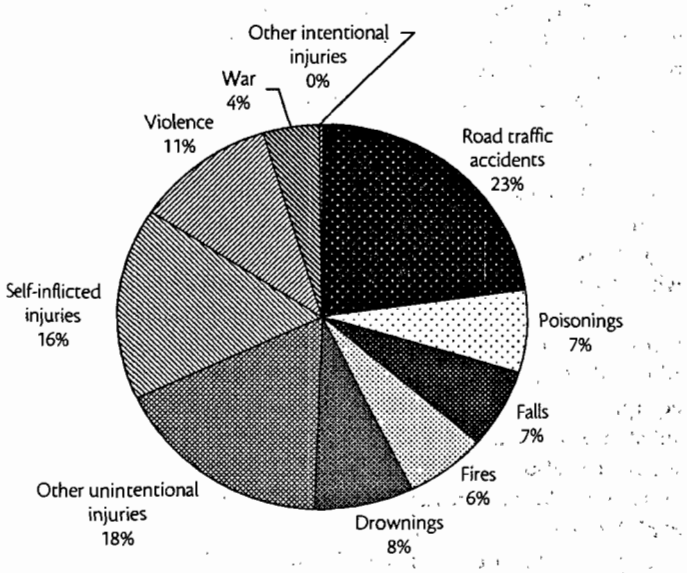

Fig. 10.4.3 Distribution of injury deaths in low- and middle-income countries, 2001.

Disparity in injury morbidity and mortality

South Africa reported drowning as the 2nd leading cause of injury mortality for children less than 15 years (Kibel *et al.* 1990) and demonstrated an increasing trend in drowning deaths for all ethnic groups in the 1980s and 1990s (Cywes *et al.* 1990; Kibel *et al.* 1990). A review of more than 300 paediatric deaths (0–14 years) in the United Arab Emirates revealed that drowning was the 2nd leading cause of death for both genders (Bener *et al.* 1998). Drowning is also the second leading cause of death for the 10–19 year age group in Taiwan; while it remains the number one cause for males aged 10–14 years (Lu *et al.* 1998). China and India—the world's most populous nations—contribute 43 per cent of the world drowning deaths and 41 per cent of the total DALYS attributed to drowning globally (World Health Organization 2003).

Recent work from South Asia explores police data in Pakistan, and provides a unique picture of trends in suicides over 15 years (1985–1999). During this period, there were 2568 reported suicides, 71 per cent in men and 39 per cent in women. While firearms are the leading method of suicide in the United States, in Pakistan, the leading method was organophosphates followed by hanging (Khan & Hyder 2006).

The true extent of intimate partner violence is largely unknown but surveys in Paraguay and the Philippines reveal that 10 per cent of women surveyed reported being assaulted by an intimate partner compared to 22 per cent in the United States, 29 per cent in Canada, and 34 per cent in Egypt (Krug *et al.* 2002). Other studies show that 3 per cent of women in Australia, the United States and Canada had been assaulted by a partner in the previous 12 months, compared to 27 per cent in Nicaragua, 38 per cent in South Korea, and 53 per cent in West Bank and Gaza (Krug *et al.* 2002). Country comparisons are difficult because data is sparse and because of varying definitions of what constitutes abuse. Furthermore, cultural norms may lead to very different reporting tendencies. Women in countries who have conducted programmes to screen and respond to intimate partner violence, including victim's assistance programmes and social marketing campaigns against intimate partner violence, may be less inhibited to divulge their experiences with violence.

Economic and societal burden

The average annual cost of road crashes has been estimated at about 1 per cent of the gross national product in developing countries, 1.5 per cent in countries in economic transition, and 2 per cent in highly motorized countries. The annual economic cost of road traffic injuries globally is about US$518 billion. In low- and middle-income countries, the annual cost of road traffic crashes is about US$65 billion, exceeding the total annual amount received by these countries in development assistance (Jacobs 2000). Studies exploring the economic and social costs of road traffic injuries in low-income countries show that males who provided the majority of the household income in India and Bangladesh were the most common victims of road traffic fatalities; and the consequences included reduced household income and reduced food consumption for the victim's family

Table 10.4.2 The Haddon matrix for motor vehicle safety (illustrative)

Phases	Factors			
	Human	**Vehicle**	**Physical environment**	**Sociocultural environment**
Pre-injury	Reduce alcohol intoxication, programmes to increase defensive driving and decrease road rage	Increase vehicle stability, increased visibility	Improvements in road structure and traffic controls, traffic calming measures	Support safety programmes and increase consumer awareness of safety issues
Injury	Use of seat belts and car seats, proper placement of car seats, booster seats	Increase energy absorbed by the vehicle frame, safety features such as air bags, head rests, shatterproof windshields, and collapsible steering columns	Install energy-absorbing guard rails	Programmes to provide car seats, educational programmes about car seat installation and placement
Post-injury	Stabilize serious injuries, reduce bleeding and other complications	Design for easier extrication	Enhanced emergency medical systems and field care	Support infrastructure of trauma care, including 911 system, emergency and trauma care, and rehabilitation services

(Aeron-Thomas *et al.* 2004). In addition, the poor were found to spend a much greater proportion of their income on funeral and/or medical costs than the non-poor (Aeron-Thomas *et al.* 2004).

Estimates of the cost of violence the United States reach over 3 per cent of the gross domestic product. In England and Wales, the total costs from violence amount to an estimated US$40 billion annually. The economic effects of interpersonal violence are expected to be more severe in poorer countries, and yet, there is a scarcity of studies on the costs of violence in low- and middle-income countries (Waters *et al.* 2004). However, estimates from low- and middle-income countries indicate that the overall costs of violence are substantial, ranging up to 25 per cent of annual gross domestic product. Comparisons with high-income countries are complicated by the fact that economic losses related to productivity tend to be undervalued in lower-income countries. Child abuse results in US$94 billion in annual costs to the US economy (1 per cent of GDP) and intimate partner violence costs the US economy nearly US$13 billion (0.1 per cent of GDP); this can be compared to 1.6 per cent of GDP in Nicaragua and 2 per cent of GDP in Chile. The cost of gun violence also has been calculated at US$155 billion annually in the United States.

Risk factors for injuries

Motorization rates rise with income (Kopits & Cropper 2003), and in a growing number of LMIC where economies are experiencing growth, there has been a corresponding increase in the numbers of motor vehicles (Ghaffar *et al.* 1999). Data obtained from routinely collected police reports in a number of LMIC show that speed is a leading causal factor in road traffic crashes (Afukaar 2003; Odero 2003; Wang *et al.* 2003), accounting for up to 50 per cent of all crashes. Alcohol is associated with an increased risk of road crashes (Peden *et al.* 2004) and in studies conducted in LMIC alcohol has been shown to be present in up to 69 per cent of fatally-injured drivers (Odero & Zwi 1995). A study from China showed a two-fold increased risk of car crash associated with driver chronic sleepiness (Liu *et al.* 2003); while surveys of commercial road transport in African countries have shown that drivers often work unduly long hours and go to work when exhausted (Mock *et al.* 1999; Nafukho & Khayesi 2002). A significant risk factor for increased injury severity is non-use or inappropriate use of safety devices such as motorcycle helmets (Kulanthayan *et al.* 2000; Liu *et al.* 2004), and seat belts (Peden *et al.* 2004).

Risk factors for falls in older people include: Low bone density; poor nutritional status; low body mass index; low calcium intake; co-morbid conditions (hypertension, diabetes); poor performance in activities of daily living; poor cognitive function; poor vision; environmental factors affecting balance; family history of hip fracture; and alcohol consumption (Cummings *et al.* 1995; Dargent-Molina *et al.* 1996; Clark *et al.* 1998; Boonyaratavej *et al.* 2001). A study in Thailand suggested that features associated with poor socioeconomic status may also be risk factors, for example, lack of electricity in the house and living in Thai huts (Jitapunkul *et al.* 2001). In younger ages, falls from balconies, apartment windows, beds, nursery equipment, and playground equipment are commonly reported in high-income nations. In addition, falls from roof tops and trees are reported from developing countries (Bangdiwala & Anzola-Perez 1990; Adesunkanmi *et al.* 1999; Kozik *et al.* 1999; MacGregor 2000; Raja *et al.* 2001; Istre *et al.* 2003; Dedoukou *et al.* 2004).

Women appear to be at greater risk of fire-related burn injuries compared with men, and burn-related injuries account for a much higher proportion of injuries in young children when compared with other age groups (Jie & Ren 1992; Liu *et al.* 1998). In addition, place of residence, smoking, alcohol use, lack of water supply, low-income, crowding, presence of a pre-existing impairment in a child, sibling death from a burn, clothing of manmade fabrics, cooking equipment within reach of children, storage of a flammable substance in the home, and lack of temperature controls for hot water have also been identified as risk factors for burns (Forjuoh *et al.* 1995; Werneck & Reichenheim 1997; Warda *et al.* 1999; Jaye *et al.* 2001).

The majority of drowning incidents in high-income countries are associated with recreational or occupational activities, while in most LMIC they are associated with everyday activities near

natural bodies of water (Celis 1997; Kobusingye *et al.* 2001; Brenner 2003; Hyder *et al.* 2003). Children aged 1–4 years, males, those living in rural areas, alcohol use, number of children in the family, presence of a well in the home, and lack of child supervision are additional risk factors for drowning (Kibel *et al.* 1990; Celis 1997; Ahmed *et al.* 1999; Kozik *et al.* 1999; Carlini-Cotrim & da Matta Chasin 2000; Kobusingye *et al.* 2001; Brenner 2003; Driscoll *et al.* 2004). Several studies have shown that young age, residential mobility, limited adult supervision of children, previous poisoning, the use of non-standard containers for storage (e.g. Coca-Cola bottles); and the storage of poisons at ground level are risk factors for childhood poisoning (Azizi *et al.* 1993; Chatsantiprapa *et al.* 2001; Soori 2001). Access to prescription drugs is also a frequent cause of poisoning.

A number of factors have been associated with an increased risk of suicide. Depression, schizophrenia, anxiety disorders and alcohol and drug abuse play a significant role in increasing risk (Krug *et al.* 2002). In addition, a previous suicidal attempt, family history of suicide, painful current illness, personal loss, interpersonal conflict, social isolation, place of residence (rural), unemployment, immigration status, religious affiliation, and poor economic conditions have been shown to pose a higher risk for suicide (Krug *et al.* 2002; Khan & Hyder 2006). Risk factors for violence, in general, have been identified in various studies including being male and young, abuse of alcohol and drugs, being a victim of child abuse, low socio-economic status, marital discord, parental conflict, and low access to medical care (Krug *et al.* 2002). In addition, macro-risk factors for violence in the literature include rapid social change, economic inequality, poverty, weak economic safety nets, corruption, gender inequalities, and high firearm availability. Previous victimization, having many sexual partners, and involvement in sex work have also been shown to be associated with increased levels of sexual violence in particular.

Theoretical basis for injury prevention

The causal model for injuries allows the injury process to be categorized into distinct phases which are important for prevention (Haddon 1970, 1972). The *pre-injury* phase is the period prior to the energy transfer, the *injury* phase is the often millisecond period in which the energy is transferred to the host, and the *post-injury* phase is the period of recovery and rehabilitation. Prevention approaches affect the injury process in one of these three injury phases.

Primary injury prevention includes prevention strategies that aim to prevent the transfer of injury to the host, and thus act in the pre-injury phase. Examples of successful primary prevention strategies include roadway designs that reduce motor vehicle collisions (Graham 1993), child-resistant caps on medication bottles to prevent ingestion and poisoning (Poison Prevention Technical Advisory Committee 1971), and pool fences to prevent submersion and drowning (Thompson & Rivara 2007).

Secondary injury prevention includes strategies that reduce the amount of energy that is transferred to the host. While these strategies are often put in place long before the injury event, their function acts to reduce energy transferred during the injury phase. Examples of secondary prevention strategies include seat belts and air bags (Evans 1995), motorcycle and bicycle helmets (US General Accounting Office 1991; Thomas *et al.* 1994). Seat belts and helmets do not prevent the crash itself, but they reduce the amount of energy transmitted to the host during the crash. Secondary prevention strategies might not prevent injury completely. For example, lower extremity injuries are not prevented by either seat belts or helmets. However, studies have consistently shown that when these devices are present, the risk for mortal injury is much less and injury severity is reduced.

Tertiary prevention strategies act in the post-injury phase to help with recovery and rehabilitation once an injury has occurred. One example is the development of trauma systems, which help with triage and transport of an injured individual to reduce the time between injury and definitive medical care (Mann *et al.* 1999; Nathens *et al.* 2000). Optimizing resources to enable recovery and rehabilitation does not prevent the injury or reduce the amount of energy transfer, but tertiary prevention strategies can have enormous impact on improving survival, function and quality of life following an injury.

The Haddon Matrix is a framework that combines these injury phases with the major components of the injury causal model to help identify prevention approaches (Fig. 10.4.1). This matrix, developed by Dr. William Haddon in the United States, was the foundation for the study of motor vehicle crashes and countermeasures for highway safety and continues to be an applicable theoretical framework for injury prevention (Haddon 1972). Using the three injury phases, Haddon categorized prevention approaches into those that affect the host, vehicles and vectors, the physical environment, and the socio-cultural environment. An example of the Haddon Matrix with examples from motor vehicle occupant protection is included in Table 10.4.2.

The Haddon Matrix provides a framework for identifying individual approaches to injury prevention. However, one single intervention strategy is unlikely to be highly effective. Multiple collaborative approaches need to be combined to maximize success. For example, the success of seat belt use in reducing motor vehicle occupant fatalities in the United States required a combination of engineering, education, policy, and enforcement that led to the current use rate of 80 per cent (National Highway Traffic Safety Administration 2007). Although seat belts were developed and available from the early 1900s, they were not required to be a standard feature on passenger cars in the United States until 1968. The steps to getting seat belts installed as a regular feature in passenger cars required considerable advocacy and policy initiatives. However, once the seat belts were installed, use rates without any occupant incentive or education were about 11 per cent. Efforts in the areas of legislation, enforcement, and public education were necessary to achieve the high use rates currently observed. Stricter legislation, for example, is associated with higher use, as evidenced by the higher use rates consistently observed among states with primary (not wearing a seat belt is by itself a citable offence) compared with secondary (not wearing a seat belt can be cited only along with another citation) laws in the United States (National Highway Traffic Safety Administration 2007).

Successful injury prevention strategies

It cannot be emphasized strongly enough that success in reducing injuries will depend on multi-faceted and comprehensive efforts. As demonstrated through the Haddon Matrix, injuries occur as a complex interplay between individuals and their physical and

socio-cultural environments. Injury rates have very clear patterns within both individuals and geographic areas. Understanding these patterns within the context of the environment is essential to reducing the global burden of injuries. Below are some examples of successful injury prevention efforts.

Trends in road traffic injuries throughout the world provide a case study of how an integrated approach can lead to successful prevention. Over the last several decades, developed countries have experienced decreases in motor vehicle occupant death rates, even while the total miles driven, and thus exposure to the roadway, have dramatically increased. In contrast, developing countries have experienced large increases in the rate of road traffic fatality rates. For example, developed countries experienced a cumulative decrease in the number of road traffic fatalities of nearly 40 per cent between 1968 and 1985, while Asian countries experienced an increase of over 150 per cent and African countries an increase of over 300 per cent (Transport and Road Research Laboratory 1991; WHO 2004). Nearly 90 per cent of road traffic deaths now occur in low- or middle-income countries (WHO 2004).

The main reason for success in developed countries has been a comprehensive approach to intervention which has included environmental, engineering, legislative, and educational approaches. In the United States, The National Highway Traffic Safety Administration and the Federal Highway Safety Administration estimate that 243 000 lives were saved between 1966 and 1990 as a result of highway, traffic, and motor vehicle safety programmes (Institute of Medicine 1999). Road modifications mandated by the Federal Highway Traffic Safety Act of 1966 led to a shift from two-lane rural roads to interstate freeways. Although vehicle volume and speed are highest on interstate highways, the number of crashes per mile travelled on interstate highways is the lowest of all roadway types. Safety features built into interstate roads are numerous, and include: Divided highways that separate traffic flow in different directions, avoiding lane crossings and decreasing the risk for head-on crashes; graded curves; crash-absorbing barriers that reduce the risk of cars running off the road, especially in areas where roadside hazards exist; skid-resistant surfaces that reduce loss of traction while braking; and, lighted signage to increase visibility and reduce distraction (Graham 1993).

At the same time, changes to the motor vehicle itself increased the likelihood of survival in a crash. In addition to the implementation of seat belts and then air bags, legislation required modifications that improved vehicle crash worthiness. Some examples of these modifications include shatter-resistant windshields, collapsible steering columns, crash-friendly dashboard surfaces, frames that are resistant to passenger space intrusion, increased strength of the vehicle frame, seat, and doors, lap and shoulder belts, and air-bags (Haddon & Baker 1981). Studies have found that these safety improvements to the motor vehicle led to a 24–40 per cent decrease in fatal crashes and saved over 9000 lives each year (Robertson 1981; Institute of Medicine 1999).

Most of these changes were due in part to legislative efforts, and these efforts were themselves collaborative in nature. For example, the successful modification of the roadway and vehicle environments was facilitated by the establishment of the National Highway Traffic Safety Administration (NHTSA) through the Federal Highway Act of 1966. NHTSA was established as the lead United States federal agency to identify and respond to road traffic hazards, and its establishment was due largely to advocacy efforts that educated the general public and legislators about the scope and potential to prevent roadway fatalities.

Additional legislative approaches that have contributed to motor vehicle occupant safety include laws to require seat belt use, driver training, speed limits, and laws that aim to reduce drunk driving. These laws were all introduced because of successful education of legislators. However, their effectiveness varies dramatically. For example, most countries have laws against drinking and driving, yet countries have wide variation in the rate of alcohol-involved crashes as well as the number of drinking drivers, drivers cited for drinking and driving, and punished for drinking and driving. While this variation has much to do with factors associated with patterns of alcohol consumption, access to transportation, and the driving culture, this variation is also due to factors associated with the laws themselves. The effectiveness of legislative approaches depends on the level of enforcement that accompanies them and on the perception that the legislated consequences will actually occur (Mann *et al.* 2003). The effectiveness of drinking and driving laws is influenced by the level of enforcement, the ability of courts to impose penalties, and that the nature of the penalties serves as a deterrent.

Historically, many developed countries have focused much of their efforts on protecting vehicle occupants, and these efforts have shown many successes. However, the focus on motor vehicle occupants without concomitant integration of urban planning, sustainable transportation, and pedestrian and bicycle safety may be problematic in the long run. More recently, countries throughout Europe as well as Australia and the United States have introduced an approach called 'traffic calming' that aims to control motor vehicle traffic and speed in neighbourhoods, and thus increase safety and walkability in communities (Ewing 1999; Richter *et al.* 2006). The concept of traffic calming dates back to the Dutch city of Delft in the 1960s, when residents angry with fast-moving cars cutting through their local streets blocked them with gardens, social areas, and play grounds (Ewing 1999). Modern traffic calming involves a variety of approaches to reduce traffic volume and speed in residential areas using visually appealing strategies.

Success in reducing road traffic deaths has depended on the development of an infrastructure that can identify and respond to road hazards, and a wide variety of approaches to address these hazards. In some developed and many developing countries, the car culture is growing without concomitant safety efforts (Bishai *et al.* 2003). Highway design standards are often outdated or translated too directly from an industrialized country, and insufficient resources for roadway maintenance are available (Transport and Road Research Laboratory 1991). Poorly designed and maintained roadways are even further stressed by an ever-increased number and variety of vehicles. In addition to a growing number of passenger cars and a high proportion of commercial vehicles and buses, developing countries' roadways include animal-powered vehicles, small engine vehicles (such as scooters and motorcycles) that carry multiple people, bicycles, human-powered transport vehicles (such as a rickshaw), and pedestrians. This complex mix of vehicles contributes to increased deaths on the road.

In order to avert the growing toll of road traffic deaths, the WHO has called for a 'systems approach' in which the interaction between vehicles, roads, road users and their physical, social, and economic

environments form the basis for a multi-sectoral response (WHO 2004).

Road traffic crashes provide one example of the potential for injury prevention success, the necessity for an integrated approach, and the need for building capacity for injury prevention. Throughout the world, general capacity for conducted injury prevention activities is limited. Growing awareness of the burden of traumatic injury coupled with a growing evidence base of successful injury prevention approaches bode well for increasing injury prevention activities in many countries.

Resources to identify successful injury prevention programmes

In addition to information to measure the scope, burden, and cost of injuries, several good resources are available to identify evidence-based injury prevention approaches. Two international collaborative efforts provide structured and systematic reviews of existing literature.

The Cochrane Collaboration provides scientific evidence-based reviews of health care interventions through the Cochrane Library (Bero & Rennie 1995; Alderson *et al.* 2004). The library has more than 100 reviews on the prevention, treatment, and rehabilitation of traumatic injuries, including topics such as fall-related injuries to older persons, pool fencing to prevent drowning in children, and interventions for promoting smoke alarm ownership and function. Abstracts are available free of charge (http://www.cochrane.org/reviews/index.htm) and full reviews are available by subscription, with most major libraries holding subscriptions. Cochrane reviews are highly weighted towards evidence from randomized controlled trials, which excludes many of the observational evaluations conducted for injury interventions. The search strategy protocol requires inclusion of international findings as well as unpublished data, and when sufficient data are present meta-analyses are conducted. Thus, these reviews are meant to be applicable to an international audience.

The Campbell Collaboration, begun in 1999, includes systematic reviews of social service programmes, divided into the categories of education, crime and justice, and social welfare (Davies & Boruch 2001). The goal of the collaboration is to provide evidence for policy decisions regarding social issues. While the majority of injury prevention-related reviews are found within the crime and justice reviews, many reviews in the other categories are strongly related to injury and violence prevention. The Campbell Collaboration includes evidence from all types of study designs, and has methods groups to ensure systematic interpretation of findings. Methods groups include experimental methods, quasi-experimental methods, and process and quantitative methods. Campbell reviews can be accessed free of charge (http://www.campbellcollaboration.org/frontend.asp).

Another source of recommendations for injury prevention strategies is *The Guide to Community Preventive Services: Systematic Reviews and Evidence–Based Recommendations* (the *Guide*). This system was developed by the Task Force on Community Preventive Services, established by the United States Centers for Disease Control and Prevention (Pappaioanou & Evans 1998). The *Guide's* recommendations are primarily based on evidence of effectiveness, including the suitability of the study design, but they also assess the applicability of the intervention to other populations or settings, the economic impact, barriers observed in implementing the interventions, and if the intervention had other beneficial or harmful effects (Briss *et al.* 2000). The *Guide* then provides a recommendation as to whether the approach is 'strongly recommended', 'recommended', has 'insufficient evidence' or is 'discouraged'. The Guide has injury-related reviews in the categories of alcohol, motor vehicle, physical activity, substance abuse, worksite, mental health, social environment, and violence. Reviews are available free of charge at http://www.thecommunityguide.org/default.htm.

In addition there are more global sources of information that provide help and guidance on a variety of injury issues. The Department of Violence and Injuries Prevention of the WHO (www.who.int) offers a diversity of guidelines and manuals that provide assistance in implementing programmes or conducting research. Examples include guidelines for establishing injury surveillance systems, conducting community based surveys and evaluating prehospital care. International non-governmental organizations also offer a variety of assistance and expert members on specific issues. Examples include the International Society for Child and Adolescent Injury Prevention (www.iscaip.net), the Road Traffic Injuries Research Network (www.rtirn.net), and the International Society for Violence and Injury Prevention (www.isvip.org).

Another source of recent estimates of the burden of injuries and cost-effectiveness of interventions is the Disease Control Priorities for Developing Countries Project (www.dcp2.org). This project worked on both intentional and unintentional injuries as well as emergency care to present a consistent set of estimates for the global burden of injuries and their impact in low- and middle-income countries. In addition, using a consistent set of guidelines, the project worked out the cost-effectiveness of interventions to reduce the burden of injuries across the world.

Building capacity for injury prevention

In order to implement the comprehensive strategies for injury prevention that are most effective, countries, states, and local communities need to develop the infrastructure and capacity to conduct the essential activities needed for an injury prevention programme. Infrastructure includes the identification of agencies to oversee essential injury control activities and the integration of these activities. Capacity includes the availability of human, financial, relational, and structural resources.

Most important of these is the development of a critical mass of trained injury professionals in a country to understand the local environment, develop, implement, and evaluate prevention programmes. Because there is a lack of trained injury prevention professionals in low- and middle-income countries, capacity development should focus on the developing world. In order to facilitate training of injury prevention professionals, the WHO developed a training programme called Teach Violence and Injury Prevention—TeachVIP (http://www.who.int/violence_injury_prevention/capacitybuilding/teachvip/en/print.html)This programme provides teaching materials to introduce the major topics of the field of injury and violence prevention, and is an important tool for trainers. The WHO has also identified priorities for global reduction in the two leading causes of injury death: Motor vehicle injuries and violence. These priorities are listed in Box 10.4.1. Capacity-building efforts are best organized around the public health framework of surveillance, prevention/evaluation, and treatment.

Box 10.4.1 WHO's priorities for the future of injury prevention

Continued success in the prevention and control of injuries will depend on systematic and organized efforts. Worldwide, much progress has been made, and it is important to find efficient methods to share and adapt successful approaches. The World Health Organization has developed reports on two of the leading causes of injury mortality and morbidity: Road traffic injuries and violence. Below, the priorities that were identified in these reports are summarized.

Priorities from the World Report on Road Traffic Injury Prevention:[a]

1. Identify a lead agency in government to guide national road traffic safety efforts
2. Assess the problems, policies, institutional settings and capacity relating to road traffic injury
3. Prepare a national road traffic safety strategy and plan for action
4. Allocate financial and human resources to address the problem
5. Implement specific actions to prevent road traffic crashes, minimize injuries and their consequences, and evaluate these efforts
6. Support the development of national capacity and international collaboration

Priorities from the World Report on Violence and Health:[b]

1. Create, implement, and monitor a national action plan for violence prevention
2. Enhance capacity for collection of data on violence
3. Define priorities for, and support research on, the causes, consequences, costs and prevention of violence
4. Promote primary prevention responses
5. Strengthen responses for victims of violence
6. Integrate violence prevention into social and educational policies, and thereby promote gender and social equality
7. Increase collaboration and exchange of information on violence prevention
8. Promote and monitor adherence to international treaties, laws, and other mechanisms to protect human rights
9. Seek practical, internationally agreed responses to the global drug trade and the global arms trade

Sources:

[a] World Health Organization. *World Report on Road Traffic Injury Prevention.* (http://www.who.int/violence_injury_prevention/publications/road_traffic/world_report/en/index.html)

[b] World Health Organization. *World Report on Violence and Health.* (http://www.who.int/violence_injury_prevention/violence/world_report/en/index.html)

Surveillance

One of the most important priorities for injury prevention worldwide is the development of dependable local injury surveillance systems. These systems are necessary to identify and explain the nature of the injury problem, and also to track changes over time as interventions are implemented and new risks emerge. Surveillance efforts need to focus on two priorities: Enhanced data quality and the establishment of registry systems to track injury trends.

Several efforts to collect international injury mortality data have found that differences in death certification systems, methods of data collection, and definitions of variables severely challenge international comparisons (Krug *et al.* 2000; Fingerhut 2004; Hofman *et al.* 2005; Polinder *et al.* 2007). As mentioned in the previous section on data sources, many countries have an insufficient infrastructure to accurately enumerate and code traumatic injury deaths. The International Collaborative Effort on Injury Statistics, undertaken by the US National Center for Health Statistics as a multi-country exercise, was the first effort to compare international mortality rates (Fingerhut 2004). This collaboration has undertaken several projects to improve data compatibility between countries, such as the Barell injury diagnosis matrix that provides guidance for coding injury diagnoses by body region and nature of injury. Other efforts have been undertaken by the WHO and the European Union, among others (Krug *et al.* 2000; Polinder *et al.* 2007). These efforts consistently identify data quality as a major impediment.

The burden of traumatic injury is disproportionately born by low- and middle-income countries, and these countries are also the least likely to have established surveillance systems to monitor injury trends (Hofman *et al.* 2005). Surveillance systems are needed to identify and track trends in injuries for research and prevention efforts, and are also necessary to attract the attention of policymakers and community leaders. Data registries need to be developed using methods that are not highly resource-intensive, such as adding injuries to existing medical reporting systems for conditions such as infectious diseases. In order to be effective, minimum data elements with standard definitions need to be employed. If possible, surveillance should be developed to provide some benefit to the agencies responsible for collecting the data. One method of accomplishing this is to integrate measurable quality indicators into the data collection so that agencies can use the data systems to monitor their own performance.

Investment in data infrastructures will be critical to the long-term sustainability of injury prevention efforts. Data will be necessary to monitor changes over time, to evaluate new efforts, and to continue to engage new partners in injury control efforts. Guidelines for injury surveillance and surveys have been released by the WHO (www.who.int).

Prevention and evaluation

Effective and cost-beneficial injury prevention programmes are needed worldwide. In developed countries, a growing number of programmes are emerging, but far too many are not evaluated. Among approaches that are evaluated and found to be effective and adaptable to wider populations, few are the subject of wide-spread dissemination.

The wide-spread dissemination of injury prevention programmes takes concerted effort. For example, smoke alarms have been shown to reduce the risk of dying in a house fire by half (Hall 1994). When smoke alarms were first introduced, few homes had them, and currently, the majority of homes do not install them effectively (Harvey *et al.* 1998; Peek-Asa *et al.* 2005). In order to increase the number of homes with operational smoke alarms, several agencies

in the United States, such as the National Fire Protection Agency and the Centers for Disease Control and Prevention, initiated national campaigns to educate consumers about smoke alarms, to change building codes to require smoke alarms, and to engage public health agencies in the dissemination and installation of alarms (Ballesteros *et al.* 2005). These efforts appear to be effective, and currently, nearly 90 per cent of US homes have at least one operational smoke alarm (Harvey *et al.* 1998).

Although a number of successful strategies for injury prevention have been identified, these have primarily been developed in high-income countries. Existing strategies will have varying success in different environments. For example, random breath alcohol screening for drivers has been an effective policy/enforcement method to reduce drinking and driving in Australia, especially when combined with social marketing campaigns raising awareness of the risks of drinking and driving, and bringing attention to the likelihood and penalties of being caught. However, random driver screening is not adaptable to the United States because law enforcement lacks the authority to randomly stop drivers without cause (Peek-Asa *et al.* 1999). Policy efforts need to work within the authorities of the local agencies as well as the local economic, political, and cultural environments. Without an understanding of the local environment, it is unlikely that translation of existing strategies will be effective.

Thus, injury prevention efforts can occur at multiple levels (national, regional, and local), but are most effective when integrated within the local environments. When developing a new approach to an injury problem, it is important to identify the scope of the problem, the populations that are at highest risk, the causal mechanisms of the injury, and the environment in which the injuries occur. For example, one could propose to address a high incidence of dog bites to children through an educational campaign focused on dog owners and veterinarians. However, if most of the bites are caused by feral dogs that have no owner and are unlikely to see a veterinarian, this educational campaign is unlikely to make any difference.

Priority should be placed on adapting proven interventions from high-income countries to low- and middle-income countries (Peden *et al.* 2004). Growing evidence supports this approach. Data from a controlled study undertaken in South Africa has shown that the free distribution of child resistant containers appears to be a highly effective means of preventing poisoning in children (Krug *et al.* 1994). Increased supervision of children around bodies of water, and use of barriers have also been proposed as measures that might reduce drowning in developing countries (Hyder *et al.* 2003).

There are many factors to consider when either developing a new strategy or adapting an existing strategy to a new community. Some of these factors are obvious, such as the cost of the programme, the existence of an agency or group of individuals to conduct the work, and good evidence that the strategy is effective when implemented correctly. Other considerations are equally important but less obvious. These include issues such as acceptance of the strategy by the community, equity or perceived equity, and the potential to stigmatize the affected community (Runyan 1998).

An international panel assembled by the Fogarty Center of the US National Institutes of Health recognized that, in addition to lack of data, the trained workforce to develop injury prevention programmes was lacking in most low- and middle-income countries (Hofman *et al.* 2005). In particular, the proportion of the trained public health workforce that focuses on injury prevention and safety issues is relatively small when compared to health conditions of equal magnitude. And, ironically, many health care professionals cannot mobilize to conduct prevention activities because they are overwhelmed in treating the injuries and illnesses of the individuals who are in need of the prevention services. In addition to a paucity of trained injury prevention professionals, funding to conduct injury prevention activities is scarce, if existent at all. Although resources are scarce, the potential of pooling resources among multiple agencies offers promise. Building sufficient infrastructure to bring the necessary stakeholders together will help identify better uses of existing resources, while also increasing the number of individuals who can move programmes forward. This, in turn, will help leverage increased resources to sustain efforts that can be proven effective.

Treatment

Many injuries lead to death because of inadequate emergency and trauma care, although an organized trauma response system can dramatically reduce deaths from injuries (Mann *et al.* 1999; Hofman *et al.* 2005). For example, one study reported up to 58 per cent pre-hospital mortality for intentional injuries in Pakistan (Chotani 2002), while in a comparative study trauma mortality was 65 per cent in resource poor settings compared with 55 per cent and 35 per cent in moderate and good resource settings (Mock 1998).

However, many countries lack trained medical personnel, equipment, and infrastructure (Kobusingye 2005). An evaluation of trauma care capabilities in Mexico, Vietnam, India, and Ghana indicated that even when a sufficient number of health care professionals were trained, 'brain drain' from rural to urban and from low- to higher-income communities led to widespread provider shortages (Mock *et al.* 2006). In order to develop a stronger trauma response system, improvements must be made in the areas of increased human resources, physical resources, security for health care personnel, transportation systems to get patients to definitive treatment, and administrative infrastructure (Kobusingye 2005; Mock *et al.* 2006).

Although many of these improvements require new resources, system-wide changes are possible through effective planning even in the absence of significantly increased resources. For example, several low-cost trauma training programmes have been developed and used effectively in low-income countries, and these have contributed to decreased injury mortality (Kobusingye 2005). Administrative changes, such as making necessary diagnostic equipment available for critical trauma cases, are also low-cost. However, identifying and implementing low-cost strategies cycles back to the need for data. Finding the low-cost strategies that will work in a health care facility will be enhanced by data systems that can track trends in patient treatment and be used for quality assurance. These systems are lacking in many health care organizations throughout the world.

Improving emergency medical systems and trauma treatment capacity could greatly reduce injury mortality worldwide, and also reduce the physical, emotional, and financial consequences of severe injuries. These efforts need to be in collaboration with general worldwide efforts to improve access to public health and medical services. Over the past few years, WHO has released guidelines for pre-hospital and trauma care with a special focus on low- and

middle-income countries (www.who.int). In addition, an evaluation of interventions for emergency care has been evaluated and checklists developed to identify potentially useful approaches in the developing world (Kobusingye *et al.* 2006).

Necessary elements to sustainable injury programmes

Resources are the biggest challenge to implementing needed surveillance, prevention, and treatment components; although these needed resources come in a variety of forms. A review of the Swedish Safe Communities programme concluded that no single type of resource or programme component is sufficient to sustain injury prevention efforts (Nilsen *et al.* 2005). The Swedish Safe Communities model, adopted in many variations throughout the world, encourages communities to establish grassroots efforts to address local safety and injury prevention issues. Each local community identifies its own priorities, methods to address the priorities, and methods to integrate with regional and national safety efforts. The evaluation identified financial resources as necessary but not sufficient for sustainability, and, furthermore, that reliance on several key individuals was not predictive of sustainability. Sustainable efforts required financial, human, relational, and structural resources that bring together people with many different skills and capabilities to work together. This is a challenge in any community, but particularly challenging in a community with already limited public health and medical resources.

Conclusion

Despite the high burden of injuries throughout the world, investment in safety and injury prevention infrastructure has been low. In low-income countries such as Pakistan and Uganda, approximately US$0.07 per capita was devoted to safety. In every country, the amount invested in prevention is far surpassed by the amount spent on the treatment of traumatic injuries, and thus studies that focus on cost-benefits are badly needed. International assistance has also not prioritized safety or injury prevention. External assistance to the health sectors of low income countries was US$2–3 per DALY lost to infectious diseases, but only US$0.06 per DALY lost to injuries (Mock *et al.* 2004).

Since 90 per cent of the world's population lives in low- and middle-income countries, and the burden of injuries is predicted to increase in these countries, it is imperative that future research and development activities focus especially on their needs. Basic research to describe the existing burden, causes, and distribution of injuries is still needed in LMIC. Trials of injury interventions have largely not been conducted in LMIC, and there is a great need to modify, adapt and test existing, as well as new interventions in these specific settings (Peden *et al.* 2004). More work is also required to assess barriers to implementation of such interventions globally.

The role of international organizations (such as WHO and the World Bank) and national agencies (such as ministries of health or medical research councils) needs to be emphasized in moving ahead the injury prevention agenda. The international movements currently underway for violence prevention and road traffic injuries prevention as promulgated through the two World Reports are examples of how joint global-national partnerships are needed for making change.

Progress will also be supported if a growing number of professionals become advocates for safety. Professionals from public health, medicine, engineering, social services, urban planning, law and law enforcement, among others, can all have a strong voice in raising awareness for safety programmes and to encourage individuals to make safe choices.

Key points

- Injuries and violence are a leading cause of mortality and morbidity worldwide.
- Injuries disproportionately affect young and vulnerable populations, and injury rates are disproportionately high among low- and middle-income countries.
- Prevention of injuries is very feasible and works best with a multidisciplinary and integrated approach.
- Building capacity for injury prevention should be a priority for all countries, but is an urgent need for low- and middle-income countries.
- Improvement in global injury prevention efforts would be aided by increased capacity in data systems, building an evidence base for successful approaches, trauma care delivery, and trained injury prevention professionals.

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Oxford Textbook of Public Health

FIFTH EDITION

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Great Clarendon Street, Oxford OX2 6DP
Oxford University Press is a department of the University of Oxford.
It furthers the University's objective of excellence in research, scholarship,
and education by publishing worldwide in
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Auckland Cape Town Dar es Salaam Hong Kong Karachi
Kuala Lumpur Madrid Melbourne Mexico City Nairobi
New Delhi Shanghai Taipei Toronto
With offices in
Argentina Austria Brazil Chile Czech Republic France Greece
Guatemala Hungary Italy Japan Poland Portugal Singapore
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Oxford is a registered trademark of Oxford University Press
in the United Kingdom and in certain other countries.
Published in the United States
by Oxford University Press Inc., New York

First edition 1984
Second edition 1991
Third edition 1997
Fourth edition 2002 (reprinted in paperback 2004, 2005 twice)
Fifth edition 2009

British Library Cataloguing in Publication Data
Data available
Library of Congress Cataloguing in Publication Data
Data available
Typeset by Cepha Imaging Pvt. Ltd., Bangalore, India
Printed by L.E.G.O.S.p.A.

ISBN 978–0–19–921870–7 (Set)
ISBN 978–0–19–957943–3 (Vol. 1)
ISBN 978–0–19–957944–0 (Vol. 2)
ISBN 978–0–19–957945–7 (Vol. 3)

1 3 5 7 9 10 8 6 4 2

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Preface to the fifth edition

Much has happened in the world and in the field of public health since the publication of the 4th edition of the *Oxford Textbook of Public Health*. Sudden acute respiratory syndrome (SARS) has come and gone, H5N1, H1N1 and the probability of new variant influenzas are the emerging infectious diseases of greatest concern, the health gap between rich and poor countries and within many countries has widened, HIV continues to be a major problem despite the development of effective treatments and strategies to prevent mother-to-child transmission, wars continue to be waged causing massive loss and disruption of human life and displacement of people, violence and terrorism have increased, and the epidemics of obesity and asthma have intensified. Our inability to effectively meet disasters has been demonstrated with the tsunami devastating northern Indonesia, Sri Lanka, and southern Thailand (2004), although the rapid, effective response by the Chinese to the Sichuan earthquake (2008) gives evidence that our ability to respond to natural disasters is improving.

On the positive side, the World Health Organization and member states are in the process of developing international reporting systems for emerging diseases, we have made strides in preventing chronic diseases such as cancer and heart disease (although these diseases are already a major cause of morbidity and mortality in low- and middle-income countries), polio has been eliminated in much of the world through effective new immunization strategies, and environmental pollution and global warming are now recognized as major problems and have attracted political concern—a major step in implementing effective solutions. Further, the burgeoning field of genomics holds promise of transforming both medicine and public health, but we must be concerned that it is applied to the improvement of the health of individuals and society and not used to discriminate against genetically vulnerable persons. Although private organizations have long contributed to public health, there has been a recent surge in private support of public health, particularly in the field of HIV/AIDS. While these contributions have had very positive effects on the health of people, particularly in low- and middle-income countries, they have also had unexpected impacts.

Public health continues to be a dynamic, exciting field which challenges creative thinking and demands implementation of innovative strategies. For the 5th edition of the Textbook, we have outlined these continuing and new public health problems and have recruited authors who are leaders in recognizing and addressing them. Although we have continued dividing the basic structure of the Textbook into three major topic areas, the scope of public health, the methods of public health, and the practice of public health, we have added chapters to reflect the growth and changes in the field since 2002 and the emergence of new public health strategies. Thus, we have added new chapters on management of public health disasters, collective violence including war, applications of genomics to the field of public health, gene–environment interactions, clinical epidemiology, private support of public health, and the global health agenda for the twenty-first century, among others. All other chapters have been updated, most of them by new leaders in their respective fields. Further, we have recruited public health professionals from all the major regions of the world, reflecting the global scope of public health and the textbook.

We hope that this 5th edition will contribute to the advancement of the field of public health through its presentation of the scope, concerns, strategies, and applications of the field. The Textbook is intended for public health researchers, practitioners, students of the field, and other health professionals who wish to understand the field and their opportunities for contributing to the health and well-being of the people of the world.

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