CHAPTER 1

The fundamentals

Introduction

Road traffic injuries are a major but neglected global public health problem, requiring concerted efforts for effective and sustainable prevention. Of all the systems that people have to deal with on a daily basis, road transport is the most complex and the most dangerous. Worldwide, the number of people killed in road traffic crashes each year is estimated at almost 1.2 million, while the number injured could be as high as 50 million – the combined population of five of the world's large cities. The tragedy behind these figures regularly attracts less media attention than other, less frequent but more unusual types of tragedy.

What is worse, without increased efforts and new initiatives, the total number of road traffic deaths worldwide and injuries is forecast to rise by some 65% between 2000 and 2020 (*1, 2*), and in low-income and middle-income countries deaths are expected to increase by as much as 80%. The majority of such deaths are currently among "vulnerable road users" – pedestrians, pedal cyclists and motorcyclists. In high-income countries, deaths among car occupants continue to be predominant, but the risks per capita that vulnerable road users face are high.

This is the first major report on road injury prevention jointly issued by the World Health Organization (WHO) and the World Bank, and underscores the concern that the two bodies share about the detrimental impact of an unsafe road transport system on public health and global development. It is the contention of the report, first, that the level of road deaths and injuries is unacceptable, and second, that it is to a large extent avoidable.

There is thus an urgent need to recognize the worsening situation in road deaths and injuries and to take appropriate action. Road traffic injury prevention and mitigation should be given the same attention and scale of resources that is currently paid to other prominent health issues if increasing human loss and injury on the roads, with their devastating human impact and large economic cost to society, are to be averted.

The report has three main aims:

- To create a greater level of awareness, commitment and informed decision-making at all levels – including among governments, professional sectors and international agencies – so that strategies scientifically proven to be effective in preventing road injuries can be implemented. Any effective response to the global challenge of reducing traffic casualties will necessarily require a large mobilization of effort by all those concerned, at the international, national and local levels.
- To provide a sound justification for the change in thinking that has taken place in recent years, especially where significant research has been undertaken, about the nature of the road traffic injury problem and what constitutes successful prevention. The perception that it is the price to be paid for achieving mobility and economic development, needs to be replaced by a more holistic ideology that places the emphasis on the total system of road traffic.
- To help strengthen institutions and create effective partnerships to deliver safer road traffic systems. Such partnerships should exist horizontally between different sectors of government and vertically between different levels of government, as well as between governments and nongovernmental organizations. At governmental level this means establishing a close collaboration between the sectors of transport, public health, finance, the judiciary and others concerned.

The report is thus principally aimed at policy-makers and key professionals in all sectors and at all levels, with an objective to provide a strategic framework for action. Universal principles are set out, rather than a single action plan with worldwide applicability. This is because local conditions must always be taken into account, so that best practices proven elsewhere can be refined and adapted into relevant and successful local interventions.

A public health concern

Road deaths, disability and injury

Every day around the world, almost 16 000 people die from all types of injuries. Injuries represent 12% of the global burden of disease, the third most

important cause of overall mortality and the main cause of death among 1–40-year-olds (*3*). The category of injuries worldwide is dominated by those incurred in road crashes. According to WHO data, deaths from road traffic injuries account for around 25% of all deaths from injury (*4*).

Estimates of the annual number of road deaths vary, as a result of the limitations of injury data collection and analysis, problems of underreporting and differences in interpretation. The figure ranges from around 750 000 (*5*) (probably an underestimate, since it is made on the basis of 1998 data) to 1 183 492 annually – representing over 3000 lives lost daily (see Statistical Annex, Table A.2).

Around 85% of all global road deaths, 90% of the disability-adjusted life years lost due to crashes, and 96% of all children killed worldwide as a result of road traffic injuries occur in low-income and middle-income countries. Over 50% of deaths are among young adults in the age range of 15–44 years (*6*). Among both children aged 5–14 years, and young people aged 15–29 years, road traffic injuries are the second-leading cause of death worldwide (see Table 1.1).

TABLE 1.1

Leading causes of deaths by age group, world, 2002

Rank	0–4 years	5–14 years	15–29 years	30–44 years	45–59 years	≥60 years	All ages
1	Lower respiratory infections 1 890 008	Childhood cluster diseases 219 434	HIV/AIDS 707 277	HIV/AIDS 1 178 856	Ischaemic heart disease 1 043 978	Ischaemic heart disease 5 812 863	Ischaemic heart disease 7 153 056
2	Diarrhoeal diseases 1 577 891	Road traffic injuries 130 835	Road traffic injuries 302 208	Tuberculosis 390 004	Cerebrovascular disease 623 099	Cerebrovascular disease 4 685 722	Cerebrovascular disease 5 489 591
3	Low birth weight 1 149 168	Lower respiratory infections 127 782	Self-inflicted injuries 251 806	Road traffic injuries 285 457	Tuberculosis 400 704	Chronic obstructive pulmonary diseases 2 396 739	Lower respiratory infections 3 764 415
4	Malaria 1 098 446	HIV/AIDS 108 090	Tuberculosis 245 818	Ischaemic heart disease 231 340	HIV/AIDS 390 267	Lower respiratory infections 1 395 611	HIV/AIDS 2 818 762
5	Childhood cluster diseases 1 046 177	Drowning 86 327	Interpersonal violence 216 169	Self-inflicted injuries 230 490	Chronic obstructive pulmonary diseases 309 726	Trachea, bronchus, lung cancers 927 889	Chronic obstructive pulmonary diseases 2 743 509
6	Birth asphyxia and birth trauma 729 066	Malaria 76 257	Lower respiratory infections 92 522	Interpersonal violence 165 796	Trachea, bronchus, lung cancers 261 860	Diabetes mellitus 749 977	Diarrhoeal diseases 1 766 447
7	HIV/AIDS 370 706	Tropical cluster diseases 35 454	Fires 90 845	Cerebrovascular disease 124 417	Cirrhosis of the liver 250 208	Hypertensive heart disease 732 262	Childhood-cluster diseases 1 359 548
8	Congenital heart anomalies 223 569	Fires 33 046	Drowning 87 499	Cirrhosis of the liver 100 101	Road traffic injuries 221 776	Stomach cancer 605 395	Tuberculosis 1 605 063
9	Protein–energy malnutrition 138 197	Tuberculosis 32 762	War 71 680	Lower respiratory infections 98 232	Self-inflicted injuries 189 215	Tuberculosis 495 199	Trachea, bronchus, lung cancers 1 238 417
10	STDs excluding HIV 67 871	Protein–energy malnutrition 30 763	Hypertensive disorders 61 711	Poisonings 81 930	Stomach cancer 185 188	Colon and rectum cancers 476 902	Malaria 1 221 432
11	Meningitis 64 255	Meningitis 30 694	Maternal haemorrhage 56 233	Fires 67 511	Liver cancer 180 117	Nephritis and nephrosis 440 708	Road traffic injuries 1 183 492
12	Drowning 57 287	Leukaemia 21 097	Ischaemic heart disease 53 870	Maternal haemorrhage 63 191	Diabetes mellitus 175 423	Alzheimer and other dementias 382 339	Low birth weight 1 149 172
13	Road traffic injuries 49 736	Falls 20 084	Poisoning 52 956	War 61 018	Lower respiratory infections 160 259	Liver cancer 367 503	Diabetes mellitus 982 175
14	Endocrine disorders 42 619	Violence 18 551	Childhood cluster diseases 48 101	Drowning 56 744	Breast cancer 147 489	Cirrhosis of the liver 366 417	Hypertensive heart disease 903 612
15	Tuberculosis 40 574	Poisonings 18 529	Abortion 43 782	Liver cancer 55 486	Hypertensive heart disease 129 634	Oesophagus cancer 318 112	Self-inflicted injuries 874 955

Source: WHO Global Burden of Disease project, 2002, Version 1 (see Statistical Annex).

In low-income countries and regions – in Africa, Asia, the Caribbean and Latin America – the majority of road deaths are among pedestrians, passengers, cyclists, users of motorized two-wheelers, and occupants of buses and minibuses (*7, 8*). The leading casualties in most high-income countries, on the other hand, are among the occupants of cars.

However, when it comes to comparative fatality rates (deaths for any measure of exposure) for all users in the traffic system, these regional differences disappear. Nearly everywhere, the risk of dying in a road crash is far higher for vulnerable road users – pedestrians, cyclists and motorcyclists – than for car occupants (*8, 9*).

TABLE 1.2

Change in rank order of DALYs for the 10 leading causes of the global burden of disease

	1990		2020
Rank	Disease or injury	Rank	Disease or injury
1	Lower respiratory infections	1	Ischaemic heart disease
2	Diarrhoeal diseases	2	Unipolar major depression
3	Perinatal conditions	3	Road traffic injuries
4	Unipolar major depression	4	Cerebrovascular disease
5	Ischaemic heart disease	5	Chronic obstructive pulmonary disease
6	Cerebrovascular disease	6	Lower respiratory infections
7	Tuberculosis	7	Tuberculosis
8	Measles	8	War
9	Road traffic injuries	9	Diarrhoeal diseases
10	Congenital abnormalities	10	HIV

DALY: Disability-adjusted life year. A health-gap measure that combines information on the number of years lost from premature death with the loss of health from disability.
Source: reference *2*.

The road traffic death toll represents only the "tip of the iceberg" of the total waste of human and societal resources from road injuries. WHO estimates that, worldwide, between 20 million and 50 million people are injured or disabled each year in road traffic crashes (the reason for the wide range of this estimate being the considerable, known underreporting of casualties) (*10*).

Using epidemiological evidence from national studies, a conservative estimate can be obtained of the ratios between road deaths, injuries requiring hospital treatment, and minor injuries, as being 1:15:70 in most countries (*11–18*).

In many low-income and middle-income countries, the burden of traffic-related injuries is such that they represent between 30% and 86% of all trauma admissions (*19, 20*).

While a decrease in deaths due to road traffic crashes of some 30% is forecast in high-income countries, current and projected trends in low-income and middle-income countries foreshadow a huge escalation in global road crash mortality between 2000 and 2020. Furthermore, on current trends, by 2020, road crash injury is likely to be the third leading cause of disability-adjusted life years lost (see Table 1.2).

The social and economic costs of road traffic injuries

In economic terms, the cost of road crash injuries is estimated at roughly 1% of gross national product (GNP) in low-income countries, 1.5% in middle-income countries and 2% in high-income countries (*5*).

The direct economic costs of global road crashes have been estimated at US$ 518 billion, with the costs in low-income countries – estimated at US$ 65 billion – exceeding the total annual amount received in development assistance (*5*). Furthermore, the costs estimated for low-income and middle-income countries are probably significant underestimates. Using more comprehensive data and measurement techniques, the estimated annual costs (both direct and indirect) of road crash injury in European Union (EU) countries alone, which contribute 5% to the global death toll, exceed €180 billion (US$ 207 billion) (*9, 21*). For the United States of America, the human capital costs of road traffic crashes in 2000 were estimated at US$ 230 billion (*22*). If comparable estimates were made of the direct and indirect economic costs of road crashes in low-income and middle-income countries, the total economic cost globally of road crashes would be likely to exceed the current estimate of US$ 518 billion.

Road crashes not only place a heavy burden on national and regional economies but also on

households (see Box 1.1). In Kenya, for example, more than 75% of road traffic casualties are among economically productive young adults (*23*).

Despite the large social and economic costs, though, there has been a relatively small amount of investment in road safety research and development, compared with other types of health loss (see Table 1.3).

There exist, however, well-tested, cost-effective and publicly-acceptable solutions to the problem. Funding for interventions, though, even in many countries most active in road safety – all of whom have targets for further reductions in casualties – has been scarce (*25–28*).

In short, current road safety efforts fail to match the severity of the problem. Road travel brings society benefits, but the price society is paying for it is very high.

BOX 1.1

The human tragedies behind road crash statistics

On a spring weekend in 2000, in the rural English setting of Suffolk, Ruth, 22 years old and her brother Paul, 20, joined their parents to celebrate their 25th wedding anniversary. After the family celebrations, on the Sunday evening, Paul went to a film, driven by a friend in his amateurly-repaired and rebuilt old Fiat Uno.

At midnight they heard the heavy knocking of a policeman, who announced that there had been a car crash and asked the shocked parents to attend the local hospital. The prognosis was terrible. Paul had suffered massive brain injury and was not expected to live. Strangely, he did not look so bad – many scratches and bruises, deep glass cuts to his left cheek, and broken fingers and femur – but the brain scan told a far worse story.

Paul was transferred to intensive care and, within hours, to the regional Neurosciences Critical Care Unit. Mercifully, they had a bed and knew how to provide the best care. However, his life hung by a thread. He had suffered severe injuries to his brain and lungs. The doctors kept Paul in a coma until he had stabilized. When he was allowed to come round, though, the family's worst fears were confirmed as the doctors talked about nerves severed from the brain stem.

Paul survived and now, over three years later, continues to progress, but painfully slowly, from a minimally-responsive, vegetative state. He still cannot walk or talk or write, so communication with him is very difficult. But he can now smile, and show pleasure or frustration. He can swallow and eat and, with the coordination in his right hand improving and with prompting, he can sometimes help himself to eat. He remains doubly-incontinent.

After a few months in a general hospital, Paul had six months of rehabilitation therapy and is now in a high-dependency home, 50 km from his parents. Additional therapy, support workers and equipment are paid for from interim compensation claims against the driver's insurance. Without these funds, and the tireless lobbying and much other work by his parents, his sister and others, Paul would not have progressed as far as he has.

Mum and Dad go to see Paul once a week, often timing the visit to coincide with discussions with doctors, managers or therapists. They bring Paul home most Saturdays and once a month overnight. Dad can only work three days a week now because of the load of duties related to Paul. Their house has been adapted to accommodate the wheelchair and provide for Paul's care needs.

The family has learnt to cope with the stress caused by the memory of the crash and its consequences. However, their trust and their attitude of "it won't happen to me or my close ones" has disappeared. Instead, there is agonized concern about road safety, the attitudes of drivers and the injustices of the legal system.

In this case, the young driver had driven so fast that, trying to take a corner, he caught the kerb, crossed the road, climbed a low bank and crashed the rear of the car into a tree. Paul was in the back and took the brunt of the impact. The back of the car broke off, due to the poor-quality "renovation" job on the rusted vehicle, which should never have been allowed to pass the compulsory annual vehicle test (the "MOT" test).

The system failed Paul's family by doing nothing about the dishonest MOT pass, and by bringing only a minor driving charge against the driver, with the offence of excess speed – and not of ruining Paul's life. On top of their suffering, Paul's parents have had to live with the injustices of the law, which they feel does not deal properly with crashes such as those of Paul, and pays inadequate attention to serious injury.

There can be a very fine dividing line between death and injury. For many months, the family grieved over the loss of Paul, who had before him all the hopes of a bright and promising young man – hopes that have long vanished.

TABLE 1.3

Estimated global research and development funding for selected topics

Disease or injury	US$ millions	1990 DALYs ranking	2020 DALYs ranking
HIV/AIDS	919–985	2	10
Malaria	60	8	—
Diarrhoeal diseases	32	4	9
Road traffic crashes	24–33	9	3
Tuberculosis	19–33	—	7

DALYs: disability-adjusted life years.
Source: reference *24*.

Changing fundamental perceptions

A key purpose of this report is to communicate current knowledge and thinking about road injury prevention to a wider audience involved in managing road safety. Since the last major WHO world report on road safety issued over 40 years ago (*29*), there has been a major change in the perception, understanding and practice of road injury prevention – a shift of paradigms – among traffic safety professionals around the world.

Figure 1.1 sets out the guiding principles of this paradigm. Some governments, some organizations, and some individuals will more easily and readily than others take on board their implications. The principles involved will not all be adopted at once but will take time to become firmly established, even in those countries where road safety is energetically pursued.

The following sections provide examples of how this new way of perceiving and dealing with road traffic safety is already affecting capacity building and policy. Also discussed are the types of measures found to be successful and the starting points for institutional and programme development. Chapter 4 examines further some of the programmes and interventions for road traffic safety that are suitable for local adoption and adaptation.

The predictability and preventability of road crash injury

One reason for the historical neglect of "injury" in public health is the traditional view of accidents and injuries as random events that happen to others (*6, 30*). Such events are looked upon as an inevitable outcome of road transport.

While the risk of a crash is relatively low for most individual journeys, people travel many times each day, every week and every year. The sum of these small risks is considerable. The term "accident", which is widely used, can give the impression, probably unintended, of inevitability and unpredictability – an event that cannot be managed. This document prefers to use the term "crash" instead, to denote something that is an event, or series of events, amenable to rational analysis and remedial action.

Many highly-motorized countries, in response to rising road trauma levels during the 1960s and early 1970s, achieved large reductions in casualties through outcome-oriented and science-based approaches. This response was stimulated by campaigners including Ralph Nader in the United States (*31*), and given intellectual strength by scientists such as William Haddon Jr (*32, 33*).

FIGURE 1.1

The road safety paradigm shift

ROAD INJURY PREVENTION AND CONTROL – THE NEW UNDERSTANDING

- Road crash injury is largely preventable and predictable; it is a human-made problem amenable to rational analysis and countermeasure
- Road safety is a multisectoral issue and a public health issue – all sectors, including health, need to be fully engaged in responsibility, activity and advocacy for road crash injury prevention
- Common driving errors and common pedestrian behaviour should not lead to death and serious injury – the traffic system should help users to cope with increasingly demanding conditions
- The vulnerability of the human body should be a limiting design parameter for the traffic system and speed management is central
- Road crash injury is a social equity issue – equal protection to all road users should be aimed for since non-motor vehicle users bear a disproportionate share of road injury and risk
- Technology transfer from high-income to low-income countries needs to fit local conditions and should address research-based local needs
- Local knowledge needs to inform the implementation of local solutions

Experience shows that with political will and a commitment to achieve effective safety management, a rapid and significant reduction in road injuries can be achieved. The efforts required, as will be outlined in this report, include (*25, 34*):

- a scientific approach to the topic;
- the provision, careful analysis and interpretation of good data;
- the setting-up of targets and plans;
- the creation of national and regional research capacity;
- institutional cooperation across sectors.

The need for good data and a scientific approach

Road traffic injury prevention is a highly politicized issue. Most people have their own opinions on what could make the roads safer. Anecdotal information and its reporting by the media all too often allow issues to be understood as major traffic safety problems requiring priority action, which in turn puts pressure on policy-makers to respond. Policy decisions for effective road injury prevention need to be based on data and objective information, not on anecdotal evidence.

First, data on the incidence and types of crashes are needed. After that, a detailed understanding of the circumstances that lead to crashes is required to guide safety policy. Furthermore, knowledge of how injuries are caused and of what type they are is a valuable instrument for identifying interventions and for monitoring the effectiveness of interventions.

In many low-income and middle-income countries, systematic efforts to collect road traffic data are not well developed and underreporting of deaths and serious injuries is common. The health sector has an important responsibility to ensure that the necessary data systems are established and that data on the main injury problems and on the effectiveness of interventions are communicated to a wider audience.

Only by systematic and data-led management of the leading road injury problems will significant reductions in exposure to crash risk and in the severity of crashes be achieved.

Road safety as a public health issue

Traditionally, road traffic safety has been assumed to be the responsibility of the transport sector, with the main focus within this sector limited to building infrastructure and managing traffic growth.

Road safety agencies and research institutes

With the sharp increases in motorization in the 1960s in many developed countries, traffic safety agencies were often set up, usually located within a government's transport department. Often, though, there was little coordination between these bodies and other government departments with responsibilities relating to road safety, either nationally or locally. In some cases, for example, vehicle safety standards had been developed by departments dealing with trade and industry, while traffic law enforcement was dealt with at the local or regional level, controlled by the justice department. In general, the public health sector was slow to become involved (*34–38*).

A second development was the creation of national technical and scientific support bodies on road traffic, in which road safety decision-making formed a part. Examples included the Swedish National Road and Traffic Research Institute created in 1971, the United Kingdom Road Research Laboratory (now TRL Ltd), and the Accident Research Units in Adelaide and Sydney, Australia, as well as the Australian Road Research Board. In the United States, such research units were embedded within the national traffic safety agency so as to feed more directly into policy-making. Formal advisory bodies, such as the National Transportation Safety Board and the Transportation Research Board (part of the United States National Academy of Sciences), were also set up to provide independent advice and guidance.

The combination of new, dedicated institutes on road safety and greater scientific research has in many cases produced major changes in thinking about traffic safety and in interventions (*34*). However, at the same time, there is often a real conflict between the aims of traffic safety lobbies and those of campaigners for increased mobility or for environmental concerns. In such cases, the lobby for mobility has frequently been the dominant one. In the long term, increases in mobility, without the

corresponding necessary increases in safety levels, will have a negative effect on public health (*39*).

The focus on mobility has meant investment in constructing and maintaining infrastructure – that is, cars and roads – for private and commercial motorized transport, to the relative neglect of public transport and of the safety of non-motorized road users such as pedestrians and cyclists. This has placed a heavy burden on the health sector.

Road crash injuries are indeed a major public health issue, and not just an offshoot of vehicular mobility. The health sector would greatly benefit from better road injury prevention in terms of fewer hospital admissions and a reduced severity of injuries. It would also be to the health sector's gain if – with safer conditions on the roads guaranteed for pedestrians and cyclists – more people were to adopt the healthier lifestyle of walking or cycling, without fearing for their safety.

The public health approach

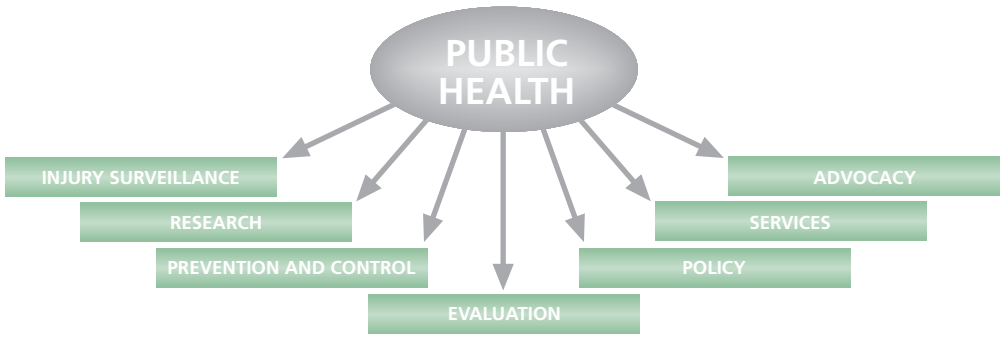
The public health approach to road traffic injury prevention is based on science. The approach draws on knowledge from medicine, biomechanics, epidemiology, sociology, behavioural science, criminology, education, economics, engineering and other disciplines.

While the health sector is only one of many bodies involved in road safety – and usually not even the leading one – it nonetheless has important roles to play (see Figure 1.2). These include:

- discovering, through injury surveillance and surveys, as much as possible about all aspects of road crash injury – by systematically collecting data on the magnitude, scope, characteristics and consequences of road traffic crashes;
- researching the *causes* of traffic crashes and injuries, and in doing so trying to determine:
  - causes and correlates of road crash injury,
  - factors that increase or decrease risk,
  - factors that might be modifiable through interventions;
- exploring ways to prevent and reduce the severity of injuries in road crashes – by designing, implementing, monitoring and evaluating appropriate interventions;
- helping to implement, across a range of settings, interventions that appear promising, especially in the area of human behaviour, disseminating information on the outcomes, and evaluating the cost-effectiveness of these programmes;
- working to persuade policy-makers and decision-makers of the necessity to address injuries in general as a major issue, and of the importance of adopting improved approaches to road traffic safety;
- translating effective science-based information into policies and practices that protect pedestrians, cyclists and the occupants of vehicles;
- promoting capacity building in all these areas, particularly in the gathering of information and in research.

FIGURE 1.2

Road traffic injury as a public health problem



Cross-sectoral collaboration is essential here, and this is something the public health sector is in a good position to promote.

Road safety as a social equity issue

Studies show that motor vehicle crashes have a disproportionate impact on the poor and vulnerable in society. These are also the people with usually little influence over policy decisions (*40, 41*). Even in high-income countries, poor children are at greater risk than children from more prosperous families (*41–43*).

Poorer people comprise the majority of casualties and lack ongoing support in the event of long-term injury. Lower socioeconomic groups have limited access to post-crash emergency health care (*44*). In addition, in many developing countries, the costs of prolonged medical care, the loss of the family breadwinner, the cost of a funeral, and the loss of income due to disability can push families into poverty (*45*). In Mexico, the second commonest cause of children being orphaned is traffic crashes (*45*).

In developing countries, the population groups exposed to the highest risks of injury and death from road crashes – for example, pedestrians and users of motorized two-wheelers – are from lower socioeconomic groups (*40, 46*). They face a greater likelihood of injury, since affordable transport poses higher risks in these places than private car use.

A large proportion of the road crash victims in low-income and middle-income countries are pedestrians and cyclists. They benefit the least from policies designed for motorized travel, but bear a disproportionate share of the disadvantages of motorization in terms of injury, pollution and the separation of communities.

In high-income countries, the risks associated with walking, cycling and motorcycling remain very high in relation to those of car travel – the principal focus of urban and rural highway provision since motorization levels rose sharply in the 1960s (*47, 48*).

In many countries, the absence of a voice for the most vulnerable groups has meant that the safety of pedestrians and cyclists is often disregarded in favour of motorized travel.

Equal protection for all road users should be a guiding rule, to avoid an unfair burden of injury and death for poorer people and vulnerable road users (*40, 49*). This issue of equity is a central one for reducing the global burden of road crash death and injury.

Systems that accommodate human error

The traditional view in road safety has been that when crashes occur, they are usually the sole responsibility of individual road users, despite the fact that other factors beyond their control may have come into play, such as the poor design of roads or vehicles. It is still widely held today that since human error is a factor in some 90% of road crashes, the leading response should be to persuade road users to adopt "error-free" behaviour. According to this policy, information and publicity should form the backbone of road traffic injury prevention, rather than being one element of a much more comprehensive programme (*50, 51*).

Human error on the roads does not always lead to disastrous consequences. Error by a road user, though, may indeed trigger a crash, but not necessarily be its underlying cause. In addition, human behaviour is governed not only by individual knowledge and skills, but also by the environment in which the behaviour takes place (*52*). Indirect influences, such as the design and layout of the road, the nature of the vehicle, and traffic laws and their enforcement – or lack of enforcement – affect behaviour in important ways. For this reason, the use of information and publicity on their own is generally unsuccessful in reducing road traffic collisions (*26, 34, 35, 53*).

Error is part of the human condition. Aspects of human behaviour in the context of road traffic safety can certainly be altered. Nonetheless, errors can also be effectively reduced by changing the immediate environment, rather than focusing solely on changing the human condition (*54*).

In the field of road safety, it has proved difficult to overcome the traditional overreliance on single approaches (*26, 34, 39, 55, 56*). Road safety policymakers in north-western Europe are increasingly acknowledging, though, that the road traffic system

needs to ensure, through its design and operation, that it does not lead to significant public health loss (*57, 58*).

None of the above contradicts the strict need for individuals to comply with key safety rules and to avoid dangerous situations (*52, 55*). However, as the Swedish Committee of Inquiry into Road Traffic Responsibility concluded (*59*):

> *In order to achieve a safe transport system, there must be a change in our views concerning responsibility, to the extent that system designers are given clearly defined responsibility for designing the road system on the basis of actual human capabilities, thereby preventing the occurrence of those cases of death and serious injury that are possible to predict and prevent.*

Systems that account for the vulnerability of the human body

The uncertainty of human behaviour in a complex traffic environment means that it is unrealistic to expect that all crashes can be prevented. However, if greater attention in designing the transport system were given to the tolerance of the human body to injury, there could be substantial benefits. It is certainly within the bounds of possibility to try to ensure that if crashes do occur, they do not, as a matter of course, lead to serious public health loss.

In the majority of serious and fatal crashes, injuries are caused because loads and accelerations, exceeding those the body can tolerate, are applied by some part of the car (*60*). Pedestrians, for example, incur a risk of about 80% of being killed at a collision speed of 50 kilometres/hour (km/h), as opposed to a 10% risk at speeds of 30 km/h. At speeds of over 30 km/h, motorists, pedestrians and cyclists increasingly make mistakes, the consequences of which are often fatal. The human tolerance to injury for a pedestrian hit by a car will be exceeded if the vehicle is travelling at over 30 km/h (*61*).

Most traffic systems, however, whether in developing or developed countries, go beyond these limits on a regular basis. Separating cars and pedestrians on the road by providing pavements is very often not done. Speed limits of 30 km/h in shared-space residential areas are commonly not implemented. Car and bus fronts, as generally designed, do not provide protection for pedestrians against injury at collision speeds of 30 km/h or greater.

For car occupants, wearing seat-belts in well-designed cars can provide protection to a maximum of 70 km/h in frontal impacts and 50 km/h in side impacts (*61*). Higher speeds could be tolerated if the interface between the road infrastructure and vehicle were to be well-designed and crash-protective – for example, by the provision of crash cushions on sharp ends of roadside barriers. However, most infrastructure and speed limits in existence today allow much higher speeds without the presence of crash-protective interfaces between vehicle and roadside objects, and without significant use of seat-belts. This is particularly the case in many low-income and middle-income countries.

In all regions of the world, to prevent road death and disabling injury, a traffic system better adapted to the physical vulnerabilities of its users needs to be created – with the use of more crash-protective vehicles and roadsides.

Technology transfer from high-income countries

Transport systems developed in high-income countries may not fit well with the safety needs of low-income and middle-income countries for a variety of reasons, including the differences in traffic mix (*50, 62, 63*).

In low-income countries, walking, cycling, motorcycling and use of public transport are the predominant transport modes. In North America and Europe, there are between two and three people per car. In China and India, on the other hand, there are 280 and 220 people per car, respectively (*64*), and while it is predicted that car ownership will increase in these countries, it will still remain low in terms of cars per capita for another 20–30 years (*49*).

In developing countries, roads often carry a wide range of users – from heavy good vehicles to bicycles and pedestrians without any separation. Among the pedestrians, the most vulnerable are children and older people. The motorized traffic on these roads is capable of high acceleration and

speed, both key factors in the causes of road crash injury.

Technology transfer, therefore, needs to be appropriate for the mix of different vehicle types and the patterns of road use in a particular place (*65*).

Road safety in countries that are in the process of becoming motorized is further hindered by the perception that current levels of walking, cycling and motorcycling are temporary. Such a view may have arisen through imported expertise from developed countries as much as from domestic sources (*66*). This tends to lead to models of infrastructure from developed countries being adopted to cater to the *longer-term* transport needs. However, in most low-income countries, safety should be promoted within *existing* conditions, and these include: low per capita incomes, the presence of mixed traffic, a low capacity for capital intensive infrastructure, and a different situation as regards law enforcement (*50*).

In high-income settings, new strategies and programmes for traffic injury prevention generally require considerable analysis and planning before implementation. In developing countries, though, because of the scarcity of resources, the priority should be the import and adaptation of proven and promising methods from developed nations, and a pooling of information as to their effectiveness in the imported settings among other low-income countries (*67*).

The new model

In all parts of the world, whatever the level of motorization, there is a need to improve the safety of the traffic system for all its users, and to reduce current inequalities in the risk of incurring road crash injuries.

To achieve this, advances in road safety will require an approach that includes various key elements absent from previous efforts. This will entail policy-makers, decision-makers, professionals and practitioners recognizing that the traffic injury problem is an urgent one, but one for which solutions are already largely known. It will require that road safety strategies be integrated with other strategic, and sometimes competing goals, such as those relating to the environment and to accessibility and mobility.

A key factor in tackling the growing road traffic injury burden is the creation of institutional capacity across a range of interlinking sectors, backed by both strong political commitment and adequate and sustainable resources.

A systems approach

An essential tool for effective road crash injury prevention is the adoption of a *systems approach* (*68*) to:

— identify problems;
— formulate strategy;
— set targets;
— monitor performance.

Road safety efforts must be evidence-based, fully costed, properly resourced and sustainable.

In the United States some 30 years ago, William Haddon Jr inspired safety professionals when he talked about road transport as an ill-designed, "man-machine" system needing comprehensive systemic treatment. He defined three phases of the time sequence of a crash event – pre-crash, crash and post-crash – as well as the epidemiological triad of human, machine and environment that can interact during each phase of a crash. The resulting nine-cell Haddon Matrix models a dynamic system, with each cell of the matrix allowing opportunities for intervention to reduce road crash injury (*32*) (see Figure 1.3).

This work led to substantial advances in the understanding of the behavioural, road-related and vehicle-related factors that affect the number and severity of casualties in road traffic. The "systems" approach seeks to identify and rectify the major sources of error or design weakness that contribute to fatal and severe injury crashes, as well as to mitigate the severity and consequences of injury.

Building on Haddon's insights, a wide range of strategies and techniques for casualty reduction have since been tested internationally, through scientific research and empirical observation. The strategies (discussed further in Chapter 4) include interventions:

FIGURE 1.3

The Haddon Matrix

PHASE		FACTORS: HUMAN	FACTORS: VEHICLES AND EQUIPMENT	FACTORS: ENVIRONMENT
Pre-crash	Crash prevention	Information Attitudes Impairment Police enforcement	Roadworthiness Lighting Braking Handling Speed management	Road design and road layout Speed limits Pedestrian facilities
Crash	Injury prevention during the crash	Use of restraints Impairment	Occupant restraints Other safety devices Crash-protective design	Crash-protective roadside objects
Post-crash	Life sustaining	First-aid skill Access to medics	Ease of access Fire risk	Rescue facilities Congestion

— to reduce exposure to risk;
— to prevent road traffic crashes from occurring;
— to reduce the severity of injury in the event of a crash;
— to reduce the consequences of injury through improved post-collision care.

This systemic approach to interventions is targeted and carried out within a broader system of managing safety.

Building capacity for systemic safety management is a long-term process that in high-income countries has developed over an extended period of motorization and the growth and reform of institutions. In low-income and middle-income countries, systemic safety management is generally weaker, and needs to be strengthened.

Evidence from North America, Australia and Europe shows that integrated strategic programmes produce a marked decline in road deaths and serious injuries (*34, 69, 70*). A recent review of countries with the lowest death rates – the Netherlands, Sweden and the United Kingdom – concluded that while it was accepted that there was scope for improvement, their progress had been due to continuing planned systemic improvements over recent decades aimed at vehicles, roads and users (*25*). Chapter 4 discusses the measures that have contributed to the relative successes of these programmes.

While progress has been made in many highly-motorized countries, the practical realization of the systems approach remains the most important challenge for road safety policy-makers and professionals.

At the same time, there are plenty of examples of the mistakes that highly-motorized nations have made in attempts to improve safety. If newly-motorizing nations could avoid such mistakes, a large proportion of road crash injuries could be avoided (*26, 56, 64*). Such mistakes include:

— the failure to adopt strategies or interventions based on evidence;
— expenditure on ineffective but easy policy options;
— a focus on the mobility of vehicle users at the expense of the safety of vulnerable road users;
— insufficient attention to the design of traffic systems and insufficient professional scrutiny of the detail of traffic safety policy.

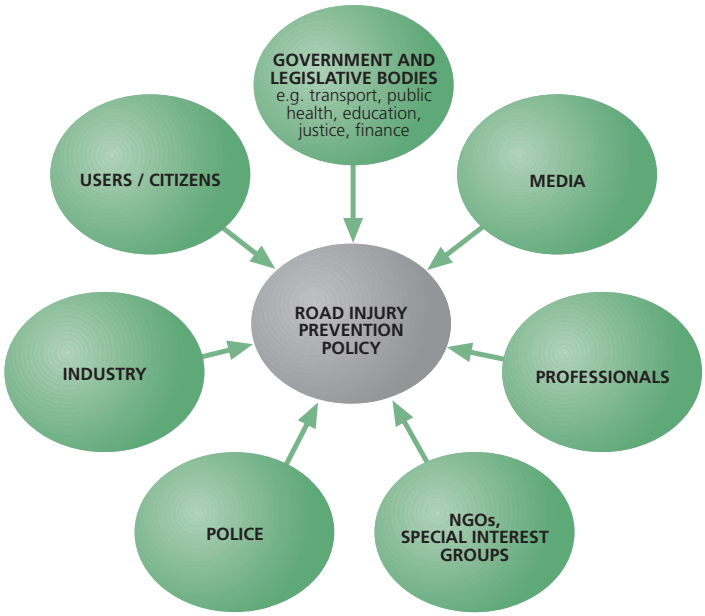
The errors also included those of omission, as opportunities to prevent deaths and injuries by measures such as the design of better vehicles and less hazardous roadsides, and improving trauma care systems, were in many cases missed (*56*).

Developing institutional capacity

The development of traffic safety policy involves a wide range of participants representing a diverse group of interests (see Figure 1.4). In many countries, responsibilities for road safety are spread over different levels of government with policy being decided at local, national and international levels. In the United States, for example, responsibilities are split between the federal government and the individual states. In EU countries, much of the regulation affecting vehicle safety is initiated centrally in Brussels, Belgium.

FIGURE 1.4

The key organizations influencing policy development



The construction of multisectoral institutional capacity, both in the governmental and non-governmental spheres, is a key to developing road safety, and can only be delivered by a national, political commitment (see Box 1.2). As Wesemann observes, there is sufficient evidence to show that free-market mechanisms are no substitute for government intervention when it comes to providing greater safety (*71*).

The role of government

Historically, in most highly-motorized countries, governmental responsibilities for traffic safety policy fall within the transport ministry or the police department. Other government departments such as those of justice, health, planning and education may also have responsibilities for key areas. In some instances, vehicle safety standards are handled by the department (or ministry) of industry.

Trinca et al. – in their historical analysis of how governments have dealt with road safety – conclude that in many cases the institutional arrangements for traffic safety have been fragmentary and lacking a strong lead, and that road safety interests have been submerged by other competing interests (*34*).

The experience of several countries indicates that effective strategies for reducing traffic injury have a greater chance of being applied if there is a separate government agency with the power and the budget to plan and implement its programme (*34*). Examples of "stand-alone" traffic safety agencies are limited. However, in the 1960s, Sweden and the United States created traffic safety bodies, separate from the main transport departments, that oversaw the implementation, in a relatively short period of time, of a range of new road safety interventions.

The Swedish Road Safety Office (SRSO) was established in the late 1960s, with responsibility for road safety. Though it lacked significant powers or resources, the number of road deaths between 1970 and the mid-1980s was reduced each year. In 1993, the SRSO merged with the more powerful and better-resourced Swedish National Road Administration (SNRA), to which the ministry of transport and communications delegated full responsibility for road safety policy.

In the United States – against a background of sharply rising road casualties – the Highway Safety Act of 1970 created a traffic safety agency, the National Highway Traffic Safety Administration (NHTSA). NHTSA delivered the first set of vehicle safety standards and encouraged a new way of thinking about traffic safety strategy. The agency is responsible for reducing deaths, injuries and economic losses resulting from motor vehicle crashes. It aims to accomplish this by setting and enforcing safety performance standards for motor vehicles and motor vehicle equipment, and by providing grants to state and local governments to enable them to conduct effective local road safety programmes. NHTSA investigates safety defects in

BOX 1.2

Reducing traffic fatalities in Bogotá, Colombia

Over an eight-year period from 1995 to 2002, the Colombian capital, Bogotá, with a population of seven million, implemented a range of policies to reduce fatal and non-fatal injuries from external causes. As a result, the number of traffic-related deaths fell over the period by almost a half – from 1387 in 1995 to 697 in 2002.

The first measure was to set up a unified data system on violence and crime, designed by the Institute of Forensic Medicine and Science to gather data on deaths from violence, and in particular from traffic crashes. Using the statistics on road traffic crashes in Bogotá, the interagency Committee for Epidemiological Surveillance of Injuries from External Causes then produced a set of public policies aimed at reducing the number of accidents, improving mobility around the city and increasing the safety of road users.

Improving the performance and image of traffic police

The following year, 2000 traffic police who had failed to enforce traffic regulations and, in many cases, were guilty of corruption were replaced. Responsibility for regulating traffic and enforcing rules was transferred to the Metropolitan Police, which assigned more than 1000 officers and 500 auxiliaries to traffic duties. This police force now has a positive public image and concentrates exclusively on enforcing traffic discipline. Officers found acting corruptly are dismissed.

Since 1996, spot checks have been carried out for drunken driving. Drivers failing the test have their vehicles impounded and are fined around US$ 150. The media are closely involved with these checks, conducted on weekends at crash black spots. Speed cameras have also been set up on the city's main roads.

In 1998, the Colombian National University was commissioned to carry out research into traffic crashes. Based on their findings, further decisions to increase road safety were taken, including the construction of highways, pavements and pedestrian bridges. The study also identified individual behaviour that increased the risk of traffic injuries, and from this drew up civic education programmes on traffic safety.

Attempts to change behaviour

One of these programmes, launched by the city's mayor, was aimed at changing people's behaviour on the roads. Measures promoted included the wearing of safety belts and observing pedestrian crossings. While the Highway Code already included these rules and people were generally aware of them, most people had failed to observe them and the authorities had generally failed to enforce them.

In the programme, mime was used on numerous sites throughout Bogotá. The mime actors working for the programme used sign language to point out to drivers that they were not wearing seat-belts, or that they had failed to give way at pedestrian crossings. At first, drivers were simply warned and told to change their behaviour. If this failed, a traffic policeman stepped in and handed out a fine, to the applause of onlookers. Nowadays, over 95% of drivers have been found to observe these rules.

Converting space into pedestrian areas

Since 1996, radical steps have been taken to win back areas from street traders and seasonal vendors. Large public spaces that had been taken over by vendors or vehicles have been converted into pedestrian areas, with new pavements and pedestrian bridges constructed.

In addition to the traffic police, the administration employs some 500 guides in its Bogotá Mission programme – young people trained in traffic regulations, first aid, preventive safety measures and the detailed layout of the city. Their task is to encourage safe behaviour on public roads.

Mass transport system

A new mass transport system, known as the TransMilenio, has not only improved urban transport and mobility, but has also reduced the number of traffic injuries along its routes, with the construction of infrastructure to ensure the safety of pedestrians and other road users. Surrounding areas have also been improved with better lighting and other equipment to make the system safer, more user-friendly and more efficient.

motor vehicles, helps states and local communities deal with the threat posed by drunken drivers, promotes the use of safety belts, child safety seats and air bags, and provides consumer information on motor vehicle safety topics. NHTSA also conducts research on traffic safety and driver behaviour.

While giving responsibility for road safety to a stand-alone agency is likely to increase the priority given to road safety, strong political support and actions from other agencies are essential to bring about major changes (*72*). If the establishment of a stand-alone agency to coordinate activity is not possible, then an alternative is to strengthen the existing road safety unit, giving it greater powers within the government transport ministry (*34*).

The experience from a wide range of countries is that, whatever the organizational structure, it is important that the lead governmental organization for road safety should be clearly defined, with its specific responsibilities and coordinating roles set out (*66, 72*).

Parliamentary committees

Experience worldwide demonstrates that effective road safety policies can also arise out of the efforts of informed and committed members of parliament.

In the Australian state of New South Wales in the early 1980s, the Parliamentary Standing Committee on Road Safety was responsible for the introduction and full implementation of random breath testing, which led to a 20% reduction in deaths and – according to surveys – was supported by over 90% of people. Earlier, in the neighbouring state of Victoria, political action and a report by a parliamentary committee had led to the world's first legislation on the compulsory use of front seat-belts. The law in Victoria came into effect at the beginning of 1971; by the end of that year car occupant deaths had fallen by 18%, and by 1975 by 26% (*73*).

Joint groups comprising legislators and professionals can also make a valuable contribution. In the United Kingdom in the 1980s, for example, a cross-party coalition of members of parliament came together with concerned professionals and nongovernmental organizations to form the Parliamentary Advisory Council for Transport Safety (PACTS). The first success of the Council – which campaigned strongly for road safety policy to be based on evidence – was in having legislation passed for front seat-belt use. PACTS went on to argue for, and eventually see, the introduction of further measures, including speed humps and the use of rear seat-belts.

A sympathetic institutional climate needs to be built up where the mutual encouragement of road injury prevention professionals and policy-makers – both in the executive and the legislature – can provide a stimulus and effective response. It is important that legislative bodies provide both authorization and funding support to the relevant government agencies to carry out road safety initiatives.

Research

Rational decision-making in public policy is dependent on impartial research and information. Developing research capacity nationally is a central feature of the new model of road safety (*74, 75*) (see Box 1.3). Without research capacity, there exist few means to overcome misconceptions and prejudices about road crash injuries.

National and community research – as opposed to relying solely on international research – is important for identifying local problems and localized groups at increased risk of road injury. It also helps to ensure a cadre of national and local professionals who can use research findings to calculate the implications for policy and programmes. Furthermore, the national evaluation effort needs to be led by research professionals, since it is only through implementation and thorough evaluation that effective programmes evolve.

The independence of research and its separation from the executive function in developing public policy is necessary for ensuring quality and to protect the research body against short-term political pressures, but at the same time interaction between the two is essential (*34*).

There are many examples of the role of independent research effort carried out by universities and national research laboratories in developing national and international policy. The Transportation Research and Injury Prevention Programme at

BOX 1.3

Research capacity development

"Capacity development" is a broad concept covering the planning, development, implementation, evaluation and sustainability of a complex phenomenon. Efforts at capacity development in the field of health research have been conducted for several decades by international, bilateral and private organizations. Traditionally, such programmes provided funds to train scientists from the developing world in centres of excellence in developed countries. In the field of road traffic injury prevention, there are several types of initiative that can provide models for capacity development.

Network development at the institutional level allows for exchange of information, the sharing of experiences, and the fostering of collaborative projects and research studies. The WHO Collaborating Centres for Violence and Injury Prevention are one global example of this model. Another, at regional level, is the Injury Prevention Initiative for Africa.

Another model is to support schemes that allow scientists and professionals to exchange research ideas and findings, develop proposals, mentor younger researchers and carry out research directed at policy-making. The global Road Traffic Injury Research Network is an example of such a framework that focuses on researchers from low-income and middle-income countries.

A third model for capacity development is to strengthen university departments and research institutes in the developing world so as to generate a critical mass of appropriately trained professionals. The Indian Institute of Technology and Universiti Putra Malaysia are examples of centres with regular training programmes on road safety.

A fourth model is to strengthen career development pathways of trained professionals and to prevent their drain from low-income and middle-income countries. Both of these are important for attracting and retaining valuable human resources. Part of such a strategy includes establishing positions for road traffic injury prevention in appropriate ministries – such as those of health and transport – and finding incentives to encourage professionals in such posts to perform at a high level.

In recent years, there have been growing concerns about the impact of training programmes and attempts have been made to devise methods to evaluate them. Recent efforts initiated by the World Health Organization to assess national health research systems may provide useful tools to evaluate research capacity development as well.

the Institute of Technology in New Delhi, India, has contributed much to a better understanding of the road injury problems of vulnerable road users and to identifying possible interventions in low-income and middle-income countries – as has equally the Centre for Industrial and Scientific Research in South Africa.

There are Accident Research Units at universities in Adelaide and Melbourne, Australia; Loughborough, England; and Hanover, Germany. Among other work, these units gather crash injury information which feeds into the development of international vehicle safety standards. The former Transport Research Laboratory (now known as TRL Ltd) in the United Kingdom is known for its research and development work on European vehicle safety standards, which have helped reduce casualties among a large population. The Dutch Institute for Road Safety Research (SWOV), which is independent of government, has made a significant contribution in the Netherlands (*58*). In the United States, academic institutes such as the North Carolina Highway Safety Research Center and the University of Michigan Transportation Research Institute, as well as government bodies such as NHTSA and the National Center for Injury Prevention and Control at the Centers for Disease Control and Prevention, have advanced research over several decades (*76*).

The involvement of industry

Industry shares responsibility for road injury prevention, in the design and use of its products and as an employer whose staff and transport services are often major road users. It also supports work on road traffic crashes and injuries. As one example,

organizations funded by the insurance industry make a valuable contribution to road safety. Folksam in Sweden and the Insurance Institute for Highway Safety in the United States provide objective information about the crash performance of new cars and other safety issues. Data collection by the Finnish insurers' fund, which investigates every fatal crash occurring nationally and carries out safety studies, feeds directly into public information and policy.

Nongovernmental organizations

The nongovernmental sector can play a major role in road casualty reduction (*34*). Nongovernmental organizations (NGOs) serve road safety most effectively when they:

- publicize the true scale of the road injury problem;
- provide impartial information for use by policy-makers;
- identify and promote demonstrably-effective and publicly-acceptable solutions, with consideration as well of their cost;
- challenge ineffective policy options;
- form effective coalitions of organizations with a strong interest in casualty reduction;
- measure their success by their ability to influence the implementation of effective road casualty reduction measures (*77*).

An example of a road safety NGO is the Trauma Committee of the Royal Australasian College of Surgeons, set up in 1970. Its objectives include: establishing and maintaining the highest possible level of post-impact care for those injured in crashes; developing undergraduate and postgraduate training programmes; gathering and disseminating hard clinical data that can be used to identify traffic injury problems; actively promoting injury prevention measures; and supporting community awareness programmes (*34*).

In the 20 years since its inception, the advocacy efforts of Mothers Against Drunk Driving (MADD) have had remarkable success. The United States-based organization has witnessed the enactment of over 300 excess-alcohol laws between 1980 and 1986, the introduction of random sobriety checkpoints, the elimination of plea bargaining for excess alcohol, mandatory prison sentences, and in many states, a minimum drinking age now set at 21 years.

The Brussels-based European Transport Safety Council (ETSC) provides an international example of successful coalition-building to achieve specific aims. Successful campaigns include a European Union-wide road fatality reduction target and new vehicle safety standard legislation. Since its inception in 1993, ETSC has pushed road safety to the centre of European Union transport policy-making and has had a remarkable influence on the work of the Road Safety and Technology Unit of the European Commission's Directorate-General for Energy and Transport and on the European Parliament's scrutiny of transport safety matters (*27*).

In developing countries, it is often difficult for organizations that want to campaign on road safety to obtain funding (*72*). However, there are several new victims' organizations and advocacy groups that have been set up in developing countries. Examples include: Asociación Familiares y Víctimas de Accidentes del Tránsito (Argentina) [Association of Families and Victims of Traffic Accidents]; Friends for Life (India); the Association for Safe International Road Travel (Kenya and Turkey); the Youth Association for Social Awareness (Lebanon); and Drive Alive (South Africa).

Achieving better performance

In the past 30 years, a new body of knowledge has been accumulated regarding effective road safety management and ways of measuring it. This section outlines examples of some of the most recent methods in traffic safety management. These include:

- management based on outcome or results, using objective information;
- targets to motivate professionals;
- acceptance of the idea of shared responsibility;
- partnerships between central and local government;
- partnerships involving other concerned bodies.

Shared responsibility

The approach for deciding how responsibility for safety on the roads should be shared is a pragmatic

and ethical one, but with scientific foundations, particularly in the science of ergonomics. It recognizes that road deaths and serious injuries can be avoided by adopting a culture of safety involving all the key participants and by implementing important safety measures more widely and systematically (*55, 70*).

In the new paradigm, the principle of social responsibility involves the vehicle manufacturer providing crash protection inside and outside the vehicle. The vehicle uses a road system where conflict is minimized by design and energy transfer is controlled as far as possible. That system is then used by a community that complies with risk-avoiding behavioural norms created by education, legislation and enforcement (*55*).

In this model, designers and builders are an integral part of the systems approach to road safety (*55*). For the model to be effective, though, there must also be accountability and a means to measure performance objectively.

Two countries in particular have formally adopted the systems approach to road safety. Both Sweden and the Netherlands, as described in the following sections, have put into legislation models in which effective partnerships are the key method of delivering road safety plans, setting targets and introducing other safety performance indicators.

Safety performance indicators, related to crashes or injuries, provide a test for ensuring that actions are as effective as possible and represent the best use of public resources (*78*).

Sweden's "Vision Zero"

Vision Zero – so called because its ultimate goal is no fatalities or severe injuries through road traffic crashes – has public health as its underlying premise (*61*) (see Box 1.4). It is a road safety policy that puts the protection of the most vulnerable road users at its centre.

BOX 1.4

Vision Zero

Vision Zero is a traffic safety policy, developed in Sweden in the late 1990s and based on four elements: ethics, responsibility, a philosophy of safety, and creating mechanisms for change. The Swedish parliament voted in October 1997 to adopt this policy and since then several other countries have followed suit.

Ethics

Human life and health are paramount. According to Vision Zero, life and health should not be allowed in the long run to be traded off against the benefits of the road transport system, such as mobility. Mobility and accessibility are therefore functions of the inherent safety of the system, not vice versa as it is generally today.

Responsibility

Until recently, responsibility for crashes and injuries was placed principally on the individual road user. In Vision Zero, responsibility is *shared* between the providers of the system and the road users. The system designers and enforcers – such as those providing the road infrastructure, the car-making industry and the police – are responsible for the functioning of the system. At the same time, the road user is responsible for following basic rules, such as obeying speed limits and not driving while under the influence of alcohol. If the road users fail to follow such rules, the responsibility falls on the system designers to redesign the system, including rules and regulations.

Safety philosophy

In the past, the approach to road safety was generally to put the onus on the road user. In Vision Zero, this is replaced by an outlook that has been used with success in other fields. Its two premises are that:

human beings make errors;

there is a critical limit beyond which survival and recovery from an injury are not possible.

It is clear that a system that combines human beings with fast-moving, heavy machines will be very unstable.

BOX 1.4 (continued)

It is sufficient for a driver of a vehicle to lose control for just a fraction of a second for a human tragedy to occur. The road transport system should therefore be able to take account of human failings and absorb errors in such a way as to avoid deaths and serious injuries. Crashes and even minor injuries, on the other hand, need to be accepted. The important point is that the chain of events that leads to a death or disability must be broken, and in a way that is sustainable, so that over the longer time period loss of health is eliminated.

The limiting factor of this system is the human tolerance to mechanical force. The chain of events leading to a death or serious injury can be broken at any point. However, the *inherent* safety of the system – and that of the road user – is determined by people not being exposed to forces that go beyond human tolerance. The components of the road transport system – including road infrastructure, vehicles and systems of restraint – must therefore be designed in such a way that they are linked to each other. The amount of energy in the system must be kept below critical limits by ensuring that speed is restricted.

Driving mechanisms for change

To change the system involves following the first three elements of the policy. While society as a whole benefits from a safe road transport system in economic terms, Vision Zero relates to the citizen as an individual and his or her right to survive in a complex system. It is therefore the demand from the citizen for survival and health that is the main driving force. In Vision Zero, the providers and enforcers of the road transport system are responsible to citizens and must guarantee their safety in the long term. In so doing, they are necessarily required to cooperate with each other, for simply looking after their own individual components will not produce a safe system. At the same time, the road user has an obligation to comply with the basic rules of road safety.

In Sweden, the main measures undertaken to date include:

- setting safety performance goals for various parts of the road traffic system;
- a focus on vehicle crash protection, and support for the consumer information programme of the European New Car Assessment Programme (EuroNCAP);
- securing higher levels of seat-belt use and fitting smart, audible seat-belt reminders in new cars;
- installing crash-protective central barriers on single-carriageway rural roads;
- encouraging local authorities to implement 30 km/h zones;
- wider use of speed camera technology;
- an increase in the number of random breath tests;
- the promotion of safety as a competitive variable in road transport contracts.

While the Vision Zero does not say that the ambitions on road safety historically have been wrong, the actions that would have to be taken are partly different. The main differences probably can be found within how safety is being promoted; there are also some innovations that will come out as a result of the vision, especially in infrastructure and speed management.

A tool for all

Vision Zero is relevant to any country that aims to create a sustainable road transport system, and not just for the excessively ambitious or wealthy ones. Its basic principles can be applied to any type of road transport system, at any stage of development. Adopting Vision Zero means avoiding the usual costly process of trial and error, and using from the start a proven and effective method.

Vision Zero is a long-term strategy in which improvements are delivered in gradual increments, and where, over time, the responsibility for safety becomes shared by the designers and users of the road traffic system. The idea is that a system more tolerant of human limitations will lead eventually to a changed division of responsibility between the car industry, the health sector, road safety engineering and traffic planning (*61*).

According to the policy, if the inherent safety of the system cannot be changed, then the only radical way to reduce the road toll is to lower travel speeds. On the other hand, if a substantial reduction in vehicle speed is unacceptable, the alternative has to be investment to improve the inherent safety of the system, at a given level of desired mobility (*61*).

Investment in Sweden has been mainly directed at managing speed where there is a potential for conflict with other vehicles and providing better links between vehicle crash protection and the infrastructure. Other investments are being directed towards more protective roadsides and a greater separation of road users where speeds exceed 60–70 km/h. For pedestrian safety, the aim is to restrict vehicle speeds to 30 km/h where there are potential dangers between vehicles and pedestrians, or else physically to separate cars and pedestrians.

Setting an example, the Swedish National Road Administration has already instigated quality assurance for its own road transport operations and work-related road travel.

"Sustainable safety" in the Netherlands

Conceived by the Institute for Road Safety Research and the Dutch Ministry of Transport, and developed in cooperation with local authorities, a three-year programme on "sustainable safety" was launched in 1998 (see Box 1.5).

BOX 1.5

Sustainable safety: the example of the Netherlands

The increasing demands for mobility have unwanted and adverse consequences. Future generations, though, should not have to bear the heavy burden resulting from the demands of the present generation. The means exist now to reduce significantly the costly and largely avoidable tragedy of road casualties.

Aim

By 2010 in the Netherlands, road deaths should be reduced by at least 50% and injuries by 40%, compared with the 1986 baseline figures.

What is a safe and sustainable traffic system?

A road traffic system that is safe and sustainable will have the following features:

its infrastructure will have been adapted to take into account human limitations, using proper road design;

its vehicles will be equipped to make the task of driving easier and to provide a high standard of protection in crashes;

its road users will be provided with adequate information and education and, where appropriate, will be deterred from undesirable or dangerous behaviour.

Strategic principles

There are three guiding principles in the strategy for a safe and sustainable road system. These are as follows:

The road network should be reclassified according to *road function*, with a single and unambiguous function established for as many roads as possible. The three types of road function are:

- the *flow function* – enabling high speeds for long-distance traffic, frequently also involving large volumes of traffic;
- the *distributor function* – helping to distribute traffic to scattered destinations and serving regions and districts;
- the *access function* – enabling direct access to properties alongside a road.

Speed limits should be set according to road function.

Using appropriate design, the function of roads, their layout and their use should be made compatible, by:

- preventing the unintended use of roads;
- preventing large discrepancies in speed, direction and volume at moderate and high speeds;
- preventing confusion among road users by making the nature of roads more predictable.

Necessary actions

The actions needed to achieve the safe and sustainable road systems include:

the creation of partnerships at national, regional and local levels to re-engineer the road network, with a greater emphasis on safety;

a programme to be implemented in two phases, with a start-up period of two years, to reclassify the road network;

a 30 km/h speed limit introduced as a general rule for all built-up areas, with powers given to local authorities to make exceptions.

As with the Swedish programme, the sustainable safety programme in the Netherlands takes, as its underlying premise, that "man is the measure of all things". Its key aim is to re-engineer and manage the road network so as to provide a safer system (*58*).

Speed management is a central theme. One of the goals is to convert as many urban roads as possible to a "residential" function, with a maximum speed limit of 30 km/h. Previous experience in the Netherlands with 30 km/h zones had shown that a casualty reduction of 22% could be achieved (*58*). Once it had been established that two thirds of the Dutch urban road network could be converted to 30 km/h zones, the programme – a joint operation between central and local government – reclassified the road network and by 2001 had converted as much as 50% of it into 30 km/h zones. A second phase of the programme will extend to 2010.

The Institute for Road Safety Research has estimated that an annual return on investment for the scheme of 9% will be forthcoming, which represents around twice the usual return of 4% from other large infrastructure projects.

TABLE 1.4

Examples of current fatality reduction targets in use[a]

Country or area	Base year for target	Year in which target is to be realized	Target reduction in the number of road traffic fatalities
Australia	1997	2005	–10%
Austria	1998–2000	2010	–50%
Canada	1991–1996	2008–2010	–30%
Denmark	1998	2012	–40%
European Union	2000	2010	–50%
Finland	2000	2010	–37%
		2025	–75%
France	1997	2002	–50%
Greece	2000	2005	–20%
		2015	–40%
Ireland	1997	2002	–20%
Italy	1998–2000	2010	–40%
Malaysia	2001	2010	< 3 deaths/10 000 vehicles
Netherlands	1998	2010	–30%
New Zealand	1999	2010	–42%
Poland	1997–1999	2010	–43%
Saudi Arabia	2000	2015	–30%
Sweden	1996	2007	–50%
United Kingdom	1994–1998	2010	–40%
United States	1996	2008	–20%

[a] It should be noted that some of these targets also include reductions in serious injury and are supplemented by other targets, e.g. to reduce the numbers of casualties among children.

Sources: references *48, 79*.

Setting targets

Since the late 1980s, several countries have recognized that targets in road safety plans can be a useful tool for promoting proven casualty reduction measures higher up the list of political priorities, and for helping to attract appropriate resources for them. Many countries have set targets to reduce road casualties, and some of these are shown in Table 1.4.

International experience with numerical targets in road safety programmes, documented by the Organisation for Economic Co-operation and Development (OECD) (*80*) and more recently by Elvik (*81*) and ETSC (*48*), indicates that setting quantitative targets can lead to better programmes, more effective use of resources and an improvement in road safety performance. A prerequisite for target setting is the availability of data on deaths and injuries, as well as information on traffic trends.

Elvik concluded that ambitious, long-term targets set by national governments appear to be the most effective in improving road safety performance (*81*).

Targets must be quantitative, time-dependent, easily intelligible and possible to evaluate. Among their main purposes are:

— to provide a rational means for identifying and carrying out interventions;

— to motivate those working in road safety;

— to raise the level of commitment to safety in the wider community;
— to encourage the ranking of safety measures (and their implementation) according to their value in reducing casualties;
— to encourage authorities with responsibilities for road safety to set their own targets;
— to allow assessments at different stages of a programme and to identify the scope for further activity.

Setting challenging but achievable road safety targets – something being done by an increasing number of countries – is a sign of responsible management. All the same, there is no guarantee that simply by setting targets, road safety performance will improve (*81*). In addition to a target, realistic safety programmes must be developed, properly implemented and well monitored. A survey undertaken of national road safety plans showed that planners need to consider (*82*):

— how to balance the objectives of safety, mobility and environmental concern;
— what barriers exist to implementing interventions, and how these could be overcome;
— how meaningful accountability for the achievement of goals could be obtained.

Policy-makers setting targets for higher safety levels need to concern themselves with a wide range of factors that influence safety (*78, 83*).

In New Zealand, the road traffic strategy sets four levels of target.

- The overall target is to reduce the socioeconomic costs of road crashes (including direct and indirect costs).
- This should be achieved by meeting the second level of targets, requiring specific reductions in the numbers of fatalities and serious injuries.
- A third level of targets consists of performance indicators (including those related to speed, drink driving and rates of seat-belt wearing) that are consistent with the targeted reductions in final outcomes.
- A fourth level of targets is concerned with institutional delivery outputs (such as the number of police patrol hours and the kilometres of high-risk crash sites treated) that are required to achieve the third-level targets (*25, 83, 84*).

Partnerships in the public and private sectors

Significant progress has been made in establishing different types of partnerships within tiers of government and between the private and public sector. Some examples of effective partnerships are set out below.

The model of Victoria, Australia

The Australian state of Victoria has developed a strong partnership between traffic law enforcement and traffic injury compensation schemes, underpinned by the use of research to provide evidence for new policies and practices. In this scheme, the Transport Accidents Commission (TAC), set up in 1986, compensates victims of road crashes through a no-fault system (in which the insurer pays for any damages incurred in a crash, regardless of which party was considered at fault), funded by premiums that are levied as part of the annual vehicle registration charge.

The TAC determined that a substantial investment in road injury prevention would be more than offset by reduced payments in compensation. It invested heavily in the road agency's remedial programme for high-risk crash sites. It also helped the police purchase enforcement technology so as to raise levels of enforcement, and it embarked on an intense series of public education campaigns. The three separate ministries of the state government – those of transport, insurance and justice – jointly set policy and coordinated the programme.

A series of controlled enforcement and education programmes was undertaken, each subject to scientific evaluation. Victoria has a tradition of scientific evaluation of road safety interventions and enforcement practice, in particular, has in the past been shaped by research findings (*85*). An example is Victoria's approach to the enforcement of speed limits using speed cameras. In most other places, speed cameras are generally sited at crash "black spots", with signs and other overt signals maximizing the focus on the specific site. In Victoria,

the objective, at least in urban areas, is to cover the whole road network. The strategy is thus covert and random – and, to the motorist, unpredictable. The link here between research and road safety policy-making is strong – making the intervention more effective. Since the potential benefits of the programme are scientifically researched and publicized, there is public support for the programme. This support may not otherwise have been forthcoming, as the seemingly draconian levels of enforcement might have led to public opposition.

The Victorian model has been adapted and implemented in South Africa's KwaZulu-Natal province – an example of a successful transfer of technology from a high-income country (*86*).

Safety partnerships in the United Kingdom

In 1998, the United Kingdom's Department for Transport, together with other government departments, created a policy of allowing local multisectoral partnerships, subject to strict financial criteria, to recover the costs of speed enforcement. The national project brought in representatives from a wide range of government and professional sectors.

In April 2000, pilot studies were launched in eight areas. The core membership of the partnerships included local authorities, the local law courts, the Highways Agency and the police. Some pilot areas also actively involved their local health sector organizations.

In those pilot studies where comparisons could be made, there was a 35% reduction in road crashes compared with the long-term trend during the first two years of the schemes, and a 56% reduction in fatal and serious pedestrian casualties (*87*).

The introduction of the cost recovery system has been a good example of "joined-up" government – seamless partnerships across a range of sectors – at both a national and local level. The process has enabled a more consistent and rigorous approach to enforcement, and it has freed up resources to focus on locally-targeted routes. In total, the system has released around £20 million of additional funds for local partnerships to spend on speed and traffic signal enforcement and on raising public awareness of the dangers of speeding. The benefits to society, in terms of casualties saved, have been estimated at around £112 million in the first two years of operation (*87*).

New car assessment programmes

People buying cars are becoming increasingly aware of the importance of safe car design and they frequently seek reliable information about the safety performance of individual car models. New Car Assessment Programmes (NCAPs) in which new car models are subjected to a range of crash tests and their performance rated with a "star" system have been developed around the world. Such programmes provide a resource for consumers, promote safety and also give credit to the efforts of car manufacturers that focus on safety. The first NCAP was set up in 1978 in the United States, followed by the Australian NCAP in 1992 and the European version (EuroNCAP) in 1996.

The EuroNCAP illustrates how a partnership between government, and motoring and consumer organizations can deliver an important source of impartial information about the performance of new cars in realistic crash tests. EuroNCAP's contributing organizations include the departments of transport of France, Germany, the Netherlands, Spain (Catalonia), Sweden and the United Kingdom. Also participating are the Allgemeiner Deutscher Automobil-Club (ADAC), the European Commission, the FIA Foundation, and – on behalf of European consumer organizations – the International Consumer Research and Testing (ICRT).

Types of whole vehicle tests (such as frontal impact, side impact and pedestrian-friendliness) and test procedures (including velocity, ground clearance height and percentage overlap tests) vary across the various NCAPs, making the comparison of systems based on crash tests more difficult.

Such information on the crash-worthiness of vehicles has helped consumers realize the value of safety and take the information into account when they purchase new vehicles. The car industry has consequently responded by making substantial improvements in car design over and above

legislative requirements. However, there has been little response to date to the pedestrian protection tests undertaken in the Australian and European programmes. Research has shown that cars with three or four stars are approximately 30% safer, compared with two-star cars or cars without a Euro-NCAP score, in car-to-car collisions (*88*).

A promising similar development, led by the automobile clubs in Europe, is seeking to devise a star rating system for specific types of roads, so that road builders are also encouraged to improve the safety of their roads beyond the basic standards.

Conclusion

Road traffic injuries and deaths are a major public health issue worldwide. Unless appropriate action is taken urgently, the problem will worsen globally. This will particularly be the case in those developing countries where rapid motorization is likely to occur over the next two decades. A sizeable portion of the burden of injury will continue to be borne by vulnerable road users – pedestrians, cyclists and motorcyclists.

There is hope, though, that the devastating loss of life and health entailed in such a worsening scenario can be avoided. Over the last forty years the science of traffic safety has developed to a point where the effective strategies for preventing or reducing crashes and injuries are well known.

A scientific, systems approach to the problem of road safety is essential, though it is not yet fully accepted in many places. The new model of understanding road safety can be summarized as follows:

- Crash injury is largely predictable and largely preventable. It is a problem amenable to rational analysis and remedy.
- Road safety policy must be based on a sound analysis and interpretation of data, rather than on anecdote.
- Road safety is a public health issue that intimately involves a range of sectors, including that of health. All have their responsibilities and all need to be fully engaged in injury prevention.
- Since human error in complex traffic systems cannot be eliminated entirely, environmental solutions (including the design of roads and of vehicles) must help in making road traffic systems safer.
- The vulnerability of the human body should be a limiting design factor for traffic systems, i.e. for vehicle and road design, and for setting speed limits.
- Road crash injury is a social equity issue, with vulnerable road users bearing a disproportionate share of road injury and risk. The objective must be equal protection.
- Technology transfer from high-income to low-income countries must be appropriate and should address local needs, as determined by research.
- Local knowledge needs to feed in to the implementation of local solutions.

In addition, the formidable challenge of reducing the level of human loss on the roads requires the following to be developed:

— increased capacity for policy-making, research and interventions, in both the public and private sectors;
— national strategic plans, incorporating targets where data allow;
— good data systems for identifying problems and evaluating responses;
— collaboration across a range of sectors, including the health sector;
— partnerships between public and private sectors;
— accountability, adequate resources and a strong political will.

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