UNIT 4

Implementing specific interventions to prevent road traffic injuries

Overview

Interventions are required to solve the road traffic injury problems discussed in the earlier units. This unit examines the basic principles for road traffic injury control. It goes on to identify and discuss examples of specific interventions that can be implemented in different settings around the world.

Objectives

By the end of this unit, the trainee should be able to:

- describe the basic principles of road traffic injury control;
- describe specific interventions that can be implemented in different settings to prevent road traffic injuries;
- describe a specific road traffic injury problem for which the trainee can design and implement an intervention in the trainee's own setting.

Basic principles of road traffic injury control

Injuries are caused by a transfer of energy between the human body and the environment. The amount of damage and the severity of injuries are directly related to the amount of energy that is available and exchanged during a crash. Reducing or managing the excess energy that may contribute to the occurrence of a crash and the severity of injuries during the crash is therefore one of the main basic principles of road traffic injury control. This approach was first formalized by Haddon in 1973 *(1)* and is referred to as ten strategies (Box 4.1). The emphasis of Haddon's "ten strategies" is on technological modifications to reduce injuries.

What specific interventions can be implemented?

There is no standard package of interventions suitable for all contexts and countries. Interventions proven in one setting may not easily be transferable elsewhere, and will require careful adaptation and evaluation. Where effective interventions are altogether lacking, scientific research is needed to develop and test new measures. Whether in high-income, or low-income and middle-income countries, there are several good practices that can be followed *(2):*

- reducing exposure to risk through transport and land-use policies;
- shaping the road network for road injury prevention;
- improving visibility of road users;
- promoting crash-protective vehicle design;
- setting and securing compliance with road safety rules;
- delivering post-crash care.

BOX 4.1

Haddon's ten strategies for road traffic injury prevention

a) *Prevent the initial aggregation of the particular energy form*. This is usually done by discouraging the use of vehicles and designs that are particularly hazardous and by encouraging alternative travel modes.

b) *Reduce the amount of energy aggregated.* Examples are the setting of speed limits on roads, making engines which are not very powerful, and installing speed limiters on existing vehicles.

c) *Prevent the inappropriate release of energy.* This can be achieved by designing vehicles and the environment such that road users do not make mistakes easily, for example, through the use of better brakes, safer intersections and roundabouts, and skid resistant roads.

BOX 4.1 (continued)

d) *Alter the rate or spatial distribution of release of the energy from its source*. Making pointed and sharp surfaces rounded and flatter distributes the forces over a larger area during an impact and thus reduces stresses on the body. Vehicles with appropriate crashworthiness criteria will transfer less energy to occupants.

e) *Separate susceptible structures from the energy being released by means of space or time*. Separate lanes for bicycles and pedestrians reduce the probability of the riders or walkers being hit by motor vehicles. Daytime curfews for trucks in cities reduce the number of crashes involving pedestrians.

f) *Interpose a material barrier to separate the released energy from susceptible structures*. Examples are physical road dividers on highways, and bollards and fences between pedestrian paths and roads.

g) *Modify contact surfaces or basic structures that can be impacted.* Padded interiors and absence of sharp objects prevent injury. Examples include softer car and bus fronts, breakaway poles on highways, and use of helmets by two-wheeler riders.

h) *Strengthen human beings who are susceptible to damage by the energy transfer.* An example is treatment for osteoporosis of older road users.

i) *Quickly detect and evaluate damage, and prevent its continuation or extension.* Damage can be limited by efficient systems for extraction of victims from vehicles, emergency care, and management of crash sites.

j) *Carry out all necessary measures between the emergency period immediately following damage and ultimate stabilization of the process*. Such measures include intermediate and long-term repair and rehabilitation.

Source: reference *1.*

Apart from the delivery of post-crash care, which is dealt with in Unit 5, examples of the wide range of interventions that are available are presented below.

Managing exposure to risk through transport and land-use policies

Safety-conscious planning and design of the road network and of land use is necessary to minimize the risk of road traffic injuries. Exposure to risk of road traffic injury can be decreased by strategies that include:

- reducing the volume of motor vehicle traffic by means of better land use;
- providing efficient networks where the shortest or quickest routes coincide with the safest routes;
- encouraging people to switch from higher-risk to lower-risk modes of transport;
- placing restrictions on motor vehicle users, on vehicles, or on the road infrastructure;
- promoting safety-centred planning, design and operation of the road network.

Efficient land use

Land-use planning practices and "smart growth" land-use policies – development of high-density, compact buildings with easily-accessible services and amenities – can serve to lessen the risk exposure of road users. The creation of clustered, mixed-use community services, for example, can cut the distances between commonly-used destinations, curtailing the need to travel and reducing dependence on private motor vehicles. The main aspects of land use that influence road safety include:

- the spatial distribution of origins and

destinations of road journeys;
- urban population density and patterns of urban growth;
- the configuration of the road network;
- the size of residential areas;
- alternatives to private motorized transport.

Trip reduction measures

Measures that may reduce the distance travelled include:

- better management of commuter transport, and of transport to and from schools and colleges;
- better management of tourist transport;
- bans on freight transport;
- restrictions on vehicle parking and road use;
- making greater use of electronic means of communication as a substitute for delivering communications by road.

Encouraging use of safer modes of transport

Travel by bus and train is many times safer than any other mode of road travel. Policies that stimulate the use of public transport, and its combination with safe walking and cycling, are thus to be encouraged.

Strategies that may increase the use of public transport include:

- improved mass transit systems (including improvements to routes covered and ticketing procedures, shorter distances between stops, and greater comfort and safety of both the vehicle and the waiting areas);
- providing safe walking and bicycling facilities;
- better coordination between different modes of travel (including the coordination of schedules and the harmonization of tariff schemes);
- secure shelters for bicycles;
- allowing bicycles to be carried on board trains, ferries and buses;
- "park and ride" facilities, where users can park their cars near public transport stops;
- improvements to taxi services;
- higher fuel taxes and other pricing reforms that discourage private car use in favour of public transport.

Shaping the road network for road traffic injury prevention

Examples of road design considerations and strategies that can make a major contribution to road traffic injury prevention are presented below.

Classifying roads and setting speed limits by their function

Many roads have a range of functions, and are used by different types of vehicles and by pedestrians – with large differences in speed, mass of vehicle and degree of protection. In residential areas and on urban roads this often leads to conflicts between the mobility of motor vehicle users on the one hand and the safety of pedestrians and cyclists on the other. Classifying roads functionally – in the form of a "road hierarchy", as it is known in highway engineering – is important for providing safer routes and safer designs. Such a classification takes account of land use, location of crash sites, vehicle and pedestrian flows, and objectives such as speed control.

Improving safety of single-lane carriageways

A range of engineering measures is needed to encourage appropriate speed and make hazards easily perceptible. These measures include:

- provision for slow-moving traffic and for vulnerable road users;
- lanes for overtaking, as well as lanes for vehicles waiting to turn across the path of oncoming traffic;
- median barriers to prevent overtaking and to eliminate head-on crashes;
- better highlighting of hazards through road lighting at junctions and roundabouts;
- improved vertical alignment;
- advisory speed limits at sharp bends;
- regular speed-limit signs;

- rumble strips;
- the systematic removal of roadside hazards – such as trees, utility poles and other solid objects.

Traffic-calming measures

Traffic-calming consists of techniques such as those discouraging traffic from entering certain areas and installing physical speed-reducing measures, that include:

- narrowing of streets;
- giving priority to pedestrians and bicyclists;
- link closure;
- partial street closure;
- speed breakers (road humps);
- raised pedestrian crossings;
- roundabouts;
- rumble devices;
- chicanes ('build outs' or 'kerb extensions');
- speed bumps (Box 4.2).

These measures are often backed up by speed limits of 30 km/h, but they can be designed to achieve various levels of appropriate speed. At speeds below 30 km/h pedestrians can coexist with motor vehicles in relative safety.

Improving visibility of road users

Seeing and being seen are fundamental prerequisites for the safety of all road users. There are various ways of improving the visibility of particular groups of road users. Some commonly used methods are listed below.

For motorized two-wheelers:

- use of daytime running lights on the front of motorized vehicles, which improves visibility while travelling during daylight hours. Some countries have made the use of daytime running lights mandatory (Box 4.3).
- use of reflective and protective clothing (jackets and vests), which increases the visibility of riders during the night and thus reduces the probability of a crash. When these jackets are made with protective padded material, they can also serve to reduce the severity of injuries. However, some of these jackets and vests may be uncomfortable in warmer climates or prohibitively expensive. Brightly coloured clothing, extra reflectors on

BOX 4.2

Speed bumps in Ghana: a low-cost road safety intervention

The use of speed bumps, in the form of rumble strips and speed humps, has been found to be effective on Ghanaian roads. For instance, rumble strips on the main Accra-Kumasi highway at the crash hot spot of Suhum Junction reduced the number of traffic crashes by around 35%. Fatalities fell by some 55% and serious injuries by 76%, between January 2000 and April 2001. This speed-reducing measure succeeded in reducing or even eliminating certain kinds of crashes, as well as improving the safety of pedestrians. Speed control bumps and humps have become increasingly common on Ghanaian roads, particularly in built-up areas where excessive vehicle speeds threaten other road users. A wide range of materials – including vulcanized rubber, hot thermoplastic materials, bituminous mixes, concrete and bricks – have been used in the construction of the speed control areas. Rumble strips are cheap and easy to install. They have been constructed at potentially dangerous places on the Cape Coast-Takoradi highway, the Bunso-Koforidua highway and the Tema-Akosombo highway. Speed humps, in contrast, have been laid to slow down vehicles and improve the safety of pedestrians in the towns of Ejisu and Besease on the Accra-Kumasi highway.

Source: based on reference *2*.

BOX 4.3

Use of daytime running lights by motorcyclists in Malaysia and Singapore

In Malaysia, analysis conducted in 1992 revealed that motorcyclists constituted a majority of the road traffic injuries and fatalities. A nationwide intervention was introduced to encourage the use of daytime running headlights. This consisted of a three-month educational and publicity campaign, followed by a compulsory law introduced in September 1992. The intervention did not have many supporters in the community, and it was thought necessary to evaluate its effect. A preliminary study showed that the number of visibility-related crashes involving motorcycles in the six months after legislation was significantly less than the number of such crashes in the six months before the introduction of the legislation. A subsequent, more extensive study of the long-term effects found that the use of daytime headlights by motorcyclists reduced visibility-related crashes by 29%.

Singapore also has a high rate of motorcycle crashes, and their riders constitute 40%–50% of traffic-related injuries and fatalities. In recognition of this problem, as of November 1995, the Singapore Traffic Police made it compulsory for all motorcyclists to switch on their motorcycle headlights during the daytime. The legislation was accompanied by a publicity campaign and a study of the effectiveness of the programme. All the cases of road collisions reported to the Singapore Traffic Police in the years 1992–1996 were analysed. The results showed that the legislation was effective in reducing the number of fatal and serious injuries.

Source: based on references *3* and *4*.

the vehicle or light reflective vests of thin plastic material may be an alternative.

For four-wheelers:

- adoption and enforcement of laws requiring daytime running lights.
- use of high-mounted brake lights, positioned on the back windscreen of cars, giving greater visibility from the rear.

For cyclists and pedestrians:

- equipping bicycles with lights, and with front, rear, and wheel reflectors.
- using brightly coloured clothing, accessories and vehicles, which can make pedestrians, riders and non-motorized vehicles more visible to all road users. Orange and yellow colours are conspicuous both at night and in the daytime. Bright colours for wheels and rear ends of non-motorized vehicles (e.g. rickshaws) may also have the potential to increase visibility. However, the effectiveness of such measures has yet to be determined.
- illuminating crosswalks, including the floodlighting of pedestrian crossings and increased illumination at crosswalks.

Promoting crash-protective vehicle design

The following design features can make cars more crashworthy:

- a strong passenger compartment with crash-absorbing front and back;
- head-rests to prevent whiplash injury;
- collapsible steering column;
- laminated windscreens fastened to the car to prevent ejection;
- padded instrument panels;
- door locks that prevent doors from opening during a crash;

- crash-resistant roofs;
- side protection bars on doors;
- front end design to prevent injury to pedestrians in crashes, removal of sharp and pointed objects.

Setting and securing compliance with road safety rules

Setting road safety rules is an important aspect of road traffic injury prevention. Attention should be paid to the following:

- Setting rules should not be an end in itself. It is important to ensure compliance through enforcement, information and education.
- Attempts at enforcing road traffic legislation will not have any lasting effect, either on road-user behaviour or on road traffic crashes unless the enforcement is continued for a long time, and is perceived to be so by road users.
- Enforcement levels need to be high, and high levels need to be maintained, so as to ensure that the perceived risk of being caught remains high.
- Imposing very strict penalties (in the form of higher fines or longer prison sentences) does not affect road-user behaviour and tends to reduce the level of enforcement.
- Once offenders are caught, their penalties should be dealt with swiftly and efficiently.
- Using selective enforcement strategies to target particular risk behaviours and choosing specific locations both improve the effectiveness of enforcement.
- Automated means – such as cameras – are cost-effective.
- Publicity supporting enforcement measures increases their effectiveness; but used on its own, publicity has a negligible effect on road user behaviour. It is essential that road users can observe the actual increase in level of enforcement activity.

There are risk factors such as speed and alcohol, discussed in Unit 2, which require enforcement of road safety rules. These are briefly summarized here.

Setting and enforcing speed limits

As indicated in Unit 2, speed is a key risk factor in road traffic injuries, influencing both the risk of a road crash as well as the severity of the injuries that result from crashes. High speeds and large speed differences makes driving situations difficult to predict and control. The greater the speed, the less time available for preventing collisions, and the greater the severity of the consequences when a collision takes place. Controlling vehicle speed can prevent crashes from occurring and can reduce the impact when they do occur, lessening the severity of injuries sustained by the victims (Box 4.4).

Enacting and enforcing laws on alcohol impairment

As indicated in Unit 2, impairment by alcohol is an important factor influencing both the risk of a road crash, as well as the severity of the injuries that result from crashes. The frequency of drinking and driving varies between countries but it is almost universally a major risk factor for road traffic crashes. The scientific literature and national road safety programmes concur that a package of effective measures is necessary to reduce alcohol-related crashes and injuries (Box 4.5).

Enacting and enforcing laws on the use of seat-belts and child restraints

The following can be done to improve seat-belt and child restraint use:

- Make the use of seat-belts and child restraints mandatory by law.
- Strictly enforce these laws, and support enforcement by public information and awareness campaigns.
- Encourage primary enforcement (where a driver is stopped solely for not wearing a seat-belt), which is more effective than secondary enforcement (where a driver can only be stopped if another offence has been committed).
- Set rules requiring use of technological solutions to encourage belt use, for example, seat-belt reminders.
- Use incentive programmes to enhance police enforcement. In these programmes, seat-belt use is monitored and seat-belt wearers are eligible for a reward. The rewards may range from a meal voucher or lottery ticket to

BOX 4.4

Effective management and control of vehicle speed

The following can be done for effective management and control of vehicle speed:

- Set and enforce speed limits;
- Post speed limits so that motorists know what speeds are expected on different roads or sections of roads.

Bear in mind that:

- Introduction of speed limits should be accompanied by sustained, visible enforcement of these limits;
- Speed cameras are a highly cost-effective means of reducing road crashes;
- Speed levels can also be affected by developing a safer infrastructure. This can involve modifying the road environment to reduce traffic flow and vehicle speed, thereby providing protection from crashes and reducing injury rates. Such measures include segregating high-speed and low-speed road users, or discouraging vehicles from entering certain areas;
- Traffic-calming measures can be used;
- The transition from high-speed to low-speed roads can create areas of high risk for crashes – for example, where vehicles exit motorways. Design features can be used to mark transition zones on busy roads approaching towns and villages that can influence drivers' speed. Slower-speed zones are examples of features that are useful in reducing the speed of vehicles;
- Appropriate speed can be imposed on traffic through design features that limit the speed of the vehicle itself.

Source: based on results summarized in reference *2*.

BOX 4.5

What can be done to prevent alcohol-impaired driving?

Below is a summary of things that can be done to prevent alcohol-impaired driving:

- Set blood alcohol limits. The limits should be consistent with current epidemiological information concerning the relationship between alcohol and crash involvement. Upper limits of 0.05 g/dl for the general driving population and 0.02 g/dl for young drivers are generally considered to be the best practice at present;
- Enact laws that establish a lower legal limit for blood alcohol content for younger or inexperienced drivers than for older, more experienced drivers;
- Enforce drink-driving laws;
- Use breath-testing devices that provide objective evidence of blood alcohol content;
- Enact laws that specify minimum legal drinking-age laws, an age below which the purchase or public consumption of alcoholic beverages is illegal;
- Enact laws that require installation of “alcohol ignition interlocks” that require a driver to take a breath test before starting a car;
- Implement a graduated driver-licensing system for new drivers that sets a period during which restrictions are placed on any unsupervised driving. These restrictions should include a prohibition against driving after drinking any alcohol.

Source: based on results summarized in reference *2*.

sizeable prizes such as video recorders or free holidays.

- Encourage the use of the appropriate type of child restraint. Good protection requires that the type of restraint used is appropriate for the age and weight of the child.
- Place child restraints correctly. Child seats should not be placed in front of air bags.

Enacting and enforcing laws making the use of crash-helmets mandatory

There are various strategies that effectively address the problem of head injuries in motorcyclists. They include:

- legislation making helmet wearing compulsory, accompanied by targeted information and enforcement campaigns – with penalties for non-use of crash helmets;
- introduction of standards for motorcycle safety helmets.

In many parts of the world, there are standards setting out performance requirements for crash helmets. These standards are most effective when based on research findings on crash injuries. In low-income and middle-income countries, it would be highly desirable for effective, comfortable and low-cost helmets to be developed, and local manufacturing capacity increased.

Activity

Task

Study the picture below. Explain the steps you would take to promote the use of helmets by two-wheeler riders in such a setting.

Expected results

The purpose of this exercise is to assist the trainees in identifying and discussing some of the practical issues that have to be examined when developing an intervention such as promoting helmet use. This exercise can be done in groups. Trainees can be put into groups of three to four people and asked to discuss what can be done. Each group should then present the main points and outcome of their discussion to the class. Among the key topics that should emerge from the discussions are the need for:

- an assessment to determine helmet-wearing rates, reasons for low use of helmets, numbers of fatalities and injuries occurring to motorcyclists;
- development of a strategy to promote wearing of helmets, including campaigns, making helmets available, distribution of helmets to targeted groups, and enforcement of laws requiring helmets to be worn;
- monitoring and evaluation of helmet use.

The role of education and publicity

Public health sector campaigns in the field of road traffic injury prevention have encompassed a wide range of measures, but education has always featured as one of the key activities of prevention. Ongoing research (Box 4.6) and experience have led to re-examination of the role that education plays in road traffic injury prevention. The following are the key conclusions from research on this issue:

- Informing and educating road users can improve knowledge about the rules of the road and about such matters as purchasing safer vehicles and equipment.
- Basic skills on how to control vehicles can be

BOX 4.6

Re-examination of road safety education and training: conclusions from studies

Concerns regarding the effectiveness (or lack of it) of education in promoting road safety have prompted researchers to do systematic literature reviews on the subject in the past few years. A summary of the conclusions of these reviews is presented below:

- *Education and skill training for children and pedestrians*

  Education and skill training programmes on bicycle handling for children, and on car handling and drunken driving for adolescents, for the most part showed no effects, or even negative effects, on attitude, behaviour, and incidence of injuries. Such training might create unrealistic beliefs in one's own abilities, and parents might overestimate their children's abilities, so that they may be exposed to more dangerous situations *(5)*.

  Pedestrian safety education can result in improvement in children's knowledge and can change observed road crossing behaviour but whether this reduces the risk of pedestrian motor vehicle collision and injury occurrence remains unknown. Changes in safety knowledge and observed behaviour decline with time, suggesting that safety education must be repeated at regular intervals *(6)*.

- *Driver education*

  Driver education (school based) leads to early licensing. Results of systematic literature review provide no evidence that driver education reduces road crash involvement, and suggest that it may lead to a modest but potentially important increase in the proportion of teenagers involved in traffic crashes *(7)*.

  A systematic review that examined the effects of post-licence driver education found no evidence of effect on prevention of road traffic injuries or crashes *(8)*. Although the results are compatible with a small reduction in the occurrence of traffic offences, this may be due to selection biases or bias in the included trials. Because of the large number of participants included in the meta-analysis (close to 300 000 for some outcomes) we can exclude, with reasonable precision, the possibility of even modest benefits.

  Drivers who take a theory test have similar crash rates as drivers who do not undergo a theory test, optional training for motorcycle and moped riders or use of simulators during training *(9)*.

- *Graduated driver licensing systems*

  Young and inexperienced drivers have higher crash rates *(10)*. Over the past decade experiments have been done to provide gradual access to driving privileges to new licensees. These programmes are called graduated driver-licensing systems. Restrictions can include curfews over driving at night, limits on carrying passengers especially at night. Results from studies have shown great promise with reductions in crash rates from 5% to 60% *(11)*.

taught.

- Education can help to bring about a culture of concern and develop sympathetic attitudes towards effective interventions.
- Most programmes providing highway safety education do not work in isolation – they need to be linked or used in combination with other measures.
- There is a need for a balanced approach to the role

of education and publicity, taking into account evidence from research on behaviour change, the interventions that may be promising, those to avoid, and those to encourage, as well as the need to implement proven measures.

- General non-specific road safety campaigns should be avoided. Campaigns should rather be used to put important questions on the agenda, and should preferably support other measures such as new legislation or police enforcement.

The ongoing re-examination of road safety education is an essential aspect of research, and the emerging conclusions need to be considered and examined by researchers and practitioners in the field of road traffic injury prevention. The conclusions draw attention to the need to be cautious and avoid focusing on only road safety education.

Key points

- Injuries are caused by a transfer of energy between the human body and the environment. Therefore reducing or managing the excess energy that may contribute to the occurrence of a crash and the severity of injuries during the crash is one of the main basic principles of road traffic injury control.
- There is no standard package of interventions suitable for all contexts and countries.
- Whether in high-income, or low-income and middle-income countries, there are several good practices that can be followed:
  - reducing exposure to risk through transport and land-use policies;
  - shaping the road network for road traffic injury prevention;
  - improving visibility of road users;
  - promoting crash-protective vehicle design;
  - setting and securing compliance with key road safety rules;
  - delivering post-crash care.

Definitions of key concepts

- Excess speed: exceeding the speed limit set for a specific country, city, town, region or road.
- Inappropriate speed: driving at a speed unsuitable for the prevailing road and traffic conditions.
- Smart growth land-use policies: the development of high-density, compact buildings with easily accessible services and amenities.

Questions to think about

- Choose one of the interventions presented in this unit that has been implemented in the country or city where you live. Discuss the results that have been obtained.
- The local authority of your city is planning interventions to respond to increasing collisions involving children who live on one side of the road but have to cross this road to reach a school on the other side. What interventions would you recommend? What are the reasons for your recommendations?
- The majority of people in a certain community do not wear seat-belts despite the existence of a law requiring the use of seat-belts. Discuss what you would do to address this problem.

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Further reading

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Notes

Trainee's evaluation of Unit 4: Implementing specific interventions to prevent road traffic injuries

This form is to be filled by the trainee at the end of this unit to assess the content and approach used. This evaluation is helpful to the trainee, trainer and developer of this manual.

1. To what extent did you achieve the objectives set for this unit? (Please check once using "X" for each objective)

Objectives	Completely successful	Generally successful	Completely unsuccessful
Describe the basic principles of road traffic injury control.			
Describe specific interventions that can be implemented in different settings to prevent road traffic injuries.			
Describe a specific road traffic injury problem for which the trainee can design and implement an intervention in the trainee's own setting.			

2. What is your overall rating of the content presented in this unit? (Please check one using "X")

Scale	Excellent	Better than expected	Satisfactory	Below average
Rating				

3. How do you rate the balance between theoretical and practical content in this unit? (Please check one using "X")

Scale	Good balance	Too theoretical	Too practical
Rating			

4. a) Did you find the activities presented in the unit helpful? (Please check one)

   Yes_____ No_____

b) If yes, in what ways were they helpful? What improvements do you suggest?

_____

_____

c) If no, what were the shortcomings? What suggestions do you have to make them helpful?

_____

_____

5. What did you like most about the unit?

6. What did you like least about the unit?

7. What did you learn most from this unit?

8. Explain how your organization, community, city and country, and other interested parties will benefit from your having read this unit.

9. What do you think should be added to this unit?

10. What do you think should be dropped from this unit?