CHAPTER 2

Drowning and injury prevention

A number of injury-related health outcomes may arise through the recreational use of water and adjacent areas. Prominent among them are:

- drowning and near-drowning;
- major impact injuries (including spinal injuries resulting in various degrees of paraplegia and quadriplegia; and head injuries resulting in concussion, brain injury and loss of memory and motor skills);
- slip, trip and fall injuries (including bone fractures/breaks/dislocations resulting in temporary or permanent disability; facial injuries resulting in nose and jaw dislocations and scarring; and abrasions); and
- cuts, lesions and punctures

This chapter discusses these adverse health outcomes and their contributory factors, along with possible preventive measures. Bites, stings and so on from aquatic organisms are addressed in chapter 11.

2.1 Drowning

Drowning, which can be defined as death arising from impairment of respiratory function as a result of immersion in liquid, is a major cause of death worldwide. It has been estimated that, in 2000, 449 000 people drowned worldwide, with 97% of drownings occurring in low- and middle-income countries (Peden & McGee, 2003). It is the third leading cause of death in children aged 1–5 and the leading cause of mortality due to injury, with the mortality rates in male children being almost twice as high as those in female children (Peden & McGee, 2003). Not all drownings are related to recreational water use and the percentage that is attributable to recreational water is likely to vary from country to country. A study in the USA found that 50–75% of all drownings there occurred in natural waters (oceans, lakes, rivers, etc.), with both children and adults being victims (Dietz & Baker, 1974). Brenner et al. (2001) examined the location of drownings in children in the USA. They reported that for children aged between 1 and 4, 56% of drownings were in artificial pools and 26% were in other bodies of freshwater, while among older children 63% of drownings were in natural bodies of freshwater. In Australia, between 1992 and 1997, 17% of drownings occurred in non-tidal lagoons and lakes and 10% occurred at surf beaches (Mackie, 1999). In Uganda, drowning has been shown to be responsible for 27% of all injury fatality. Most of the drowning victims were young males who drowned in lakes and rivers during transportation or on fishing trips (Kobusingye,

2003). Data on drowning in many countries is inadequate, especially in terms of the location of the incident, and this can hamper the evaluation of interventions and prevention and rescue techniques.

Death by drowning is not the sole outcome of distress in the water. Near-drowning is also a serious problem. One study (Wintemute et al., 1988) found that for every 10 children who die by drowning, 140 are treated in emergency rooms and 36 are admitted to hospitals for further treatment (see also Spyker, 1985; Liller et al., 1993), although some never recover. In the Netherlands, it has been reported that on average there are about 300 drowning fatalities a year and an additional 450 cases who survive the drowning incident, of these 390 are admitted to hospital for further treatment (Bierens, 1996; Branche & Beeck, 2003).

It is possible to survive prolonged submersion in cold water (e.g., less than 21 °C). In rare cases, people have been submerged for significant periods (e.g., up to 40 min) with normal neurological recovery (Spyker, 1985; Winegard, 1997; Chochinov et al., 1998; Hughes et al., 2002; Perk et al., 2002).

The recovery rate from near-drowning may be lower among young children than among teenagers and adults. Some survivors suffer subsequent anoxic encephalopathy (Pearn et al., 1976; Pearn, 1977; Patrick et al., 1979), leading to long-term neurological deficits (Quan et al., 1989). Studies show that the prognosis depends more on the effectiveness of the initial rescue and resuscitation than on the quality of subsequent hospital care (Fenner et al., 1995; Cummings & Quan, 1999). Development of effective rescue resources, with on-scene resuscitation capabilities, may be important in reducing the frequency of drowning and consequences of near-drowning.

2.1.1 Contributory factors

Both drowning and near-drowning have been associated with many contributory factors (see, for example, Poyner, 1979). Data suggest, for example, that males are more likely to drown than females (Peden & McGee, 2003). This is generally associated with higher exposure to the aquatic environment (through both occupational and recreational uses), greater consumption of alcohol (leading to decreased ability to cope and impaired judgement) and their inclination towards higher risk-taking activity (Dietz & Baker, 1974; Mackie, 1978; Plueckhahn, 1979, 1984; Nichter & Everett, 1989; Quan et al., 1989; Howland et al., 1996).

Alcohol consumption is one of the most frequently reported contributory factors associated with the greatest proportion of adolescent and adult drownings in many countries (Howland & Hingson, 1988; Levin et al., 1993; Petridou, 2003). For children, lapses in parental supervision are the most frequently cited contributory factor in drownings (Quan et al., 1989), although alcohol consumption by the parent or guardian may also play a role in the lapse of supervision (Petridou, 2003).

Drowning and near-drowning may be associated with recreational water uses involving minimal water contact. Recreational use of watercraft (yachts, boats, canoes) and fishing (from watercraft, water's edge, rocks or solid structures) have been associated with drownings (Plueckhahn, 1972; Nichter & Everett, 1989; Steensberg, 1998). Such recreational water uses may occur during cold weather, and immersion

cooling may be a significant contributory factor (see section 3.2; Bierens et al., 1990, 1995; Beyda, 1998; Lindholm & Steensberg, 2000). Non-use of lifejackets, even when readily available, is frequently cited as a significant contributory factor in these cases (Plueckhahn, 1979; Patetta & Biddinger, 1988; Steensberg 1998; Quan et al., 1998). In one study in North Carolina, USA, the activities most frequently associated with drownings were (in descending order) swimming, wading and fishing (Patetta & Biddinger, 1988).

Attempted rescue represents a significant risk to the rescuer. For example, a study in North Carolina reported the death by drowning of the would-be rescuer in a significant number of cases (Patetta & Biddinger, 1988). In Australia, Mackie (1999) reported that between 1992 and 1997 there were 1551 non boating-related drownings, of which over 2% were sustained while attempting a rescue.

Hyperventilation before breath-hold swimming and diving has been associated with a number of drownings among individuals, almost exclusively males, with excellent swimming skills. Although hyperventilation makes it possible for a person to extend their time under water, it may result in a loss of consciousness by lowering the carbon dioxide level in the blood (Craig, 1976; Spyker, 1985).

At beaches with surf, rip currents can be a major cause of distress. These currents, which pull swimmers away from shore, have been found to be a factor in as many as 80% of rescues by surf lifeguards (USLA, 2002). In Australia, 35% of rescues and 18.5% of resuscitation cases, over a ten year period, from surf beaches were due to rip currents (Fenner, 1999).

The presence of pre-existing disease is a risk factor for drowning and near-drowning, and higher rates of drowning are reported among those with seizure disorders (Greensher, 1984; CDC, 1986; Patetta & Biddinger, 1988; Quan et al., 1989). Further documented contributory factors include water depth and poor water clarity (Quan et al., 1989).

2.1.2 Preventive and management actions

It has been suggested that over 80% of all drownings can be prevented and prevention is the key management intervention (World Congress on Drowning, 2002; Mackie, 2003). Surprisingly, there is no clear evidence that drowning rates are greater in poor swimmers (Brenner, 2003) and the value of swimming lessons and water safety instruction as drowning preventive measures has not been demonstrated (Patetta & Biddinger, 1988; Mackie, 2003). There is also a significant debate regarding the age at which swimming skills may be safely acquired. Although the need for adult supervision is not decreased when young children acquire increased skills, the possibility that training decreases parental vigilance has not been assessed (Asher et al., 1995).

The availability of cardiopulmonary resuscitation (CPR) (including infant and child CPR) skills (Patetta & Biddinger, 1988; Orlowski, 1989; Liller et al., 1993; Kyriacou et al., 1994; Pepe and Bierens, 2003a) and of rescue skills among witnesses (Patetta & Biddinger, 1988) have been reported to be important in determining the outcome of unintentional immersions. It has been recommended that resuscitation

skills should be learned by all professionals who frequent aquatic areas (Pepe & Bierens, 2003b) as early first aid and resuscitation are important factors in survival after a drowning incident.

The Centers for Disease Control and Prevention, USA (CDC) have suggested that legal limits for blood alcohol levels during water recreation activities should be mandated and enforced, and that the availability of alcohol at water recreation facilities should be restricted (CDC, 1998). Cummings & Quan (1999) report data that supports the theory that decreasing alcohol use around water is an effective safety intervention.

Education, aimed at making both locals and tourists knowledgeable about water-based hazards (such as rip currents), can play an important role in reducing drowning. Whittaker (2003) noted that an education package, started in 1998, apparently reduced the drowning rate on beaches in Victoria (Australia) by 31% over a 4 year period.

The principal contributory factors and preventive and management actions for drowning and near-drowning are similar and are summarized in Table 2.1.

2.2 Spinal injury

Data concerning the number of spinal injuries sustained as a result of swimming or water recreation incidents are not widely available or systematically collected. In the USA, it has been found that some 10% of all spinal cord injuries (an incidence of approximately 1000 per year) are related to diving into water (Think First Foundation, 2002).

Blanksby et al. (1997) tabulated data from a series of studies concerning diving incidents as the cause of acute spinal injury in various regions of the world. In one study (Steinbruck & Paeslack, 1980), 212 of 2587 spinal cord injuries were caused by sports or diving incidents, of which 139 were associated with water sports, the majority (62%) with diving. Diving incidents were found to be responsible for 3.8–14% of traumatic spinal cord injuries in a comparison of French, Australian, English and US studies (Minaire et al., 1979), for 2.3% of spinal injuries in a South African study and for 21% in a Polish study (Blanksby et al., 1997).

In diving incidents of all types, injuries are almost exclusively located in the cervical vertebrae (Minaire et al., 1979; Blanksby et al., 1997; Watson et al., 2001). Statistics such as those cited above therefore underestimate the importance of these injuries, which typically cause quadriplegia (paralysis affecting all four limbs) or, less commonly, paraplegia (paralysis of both legs). In Australia, for example, diving incidents account for approximately 20% of all cases of quadriplegia (Hill, 1984). The financial cost of these injuries to society is high, because those affected are frequently healthy younger persons—principally males under 25 years (Blanksby et al., 1997)—and treatment of persons with spinal injuries can be very expensive.

2.2.1 Contributory factors

Data from the USA suggest that body surfing at a beach and striking the bottom was the most common cause of aquatic spinal injury. Ten per cent of spinal injuries occurred when people dived into water, particularly from high platforms, including

TABLE 2.1. DROWNING AND NEAR-DROWNING: PRINCIPAL CONTRIBUTORY FACTORS AND PREVENTIVE AND MANAGEMENT ACTIONS

Contributory factors
• Alcohol consumption
• Cold
• Current (including rip currents, river currents, and tidal currents)
• Offshore winds (especially with flotation devices)
• Ice cover
• Pre-existing disease
• Underwater entanglement
• Bottom surface gradient and stability
• Waves (coastal, boat, chop)
• Water transparency
• Impeded visibility (including coastal configuration, structures and overcrowding)
• Lack of parental supervision (infants)
• Poor or inadequate equipment (e.g. boats or lifejackets)
• Overloading of boats
• Overestimation of skills
• Lack of local knowledge
Preventive and management actions
• Public education regarding hazards and safe behaviours
• Regulations that discourage unsafe behaviours (e.g., exceeding recommended boat loadings)
• Continual adult supervision (infants)
• Restriction of alcohol provision
• Provision of properly trained and equipped lifeguards
• Provision of rescue services
• Access to emergency response (e.g., telephones with emergency numbers)
• Local hazard warning notices
• Availability of resuscitation skills/facilities
• Development of rescue and resuscitation skills among general public and user groups
• Coordination with user group associations concerning hazard awareness and safe behaviours
• Wearing of adequate lifejackets when boating

trees, balconies and other structures. Special dives such as the swan or swallow dive are particularly dangerous, because the arms are not outstretched above the head but to the side (Steinbruck & Paeslack, 1980). There is no evidence to suggest that impact upon the water surface gives rise to serious (spinal) injury (Steinbruck & Paeslack, 1980). Alcohol consumption may contribute significantly to the frequency of injury through diminished awareness and information processing (Blanksby et al., 1997).

Minimum depths for safe diving are greater than frequently perceived, but the role played by water depth has not been conclusively ascertained. Inexperienced or unskilled swimmers require greater depths for safe diving. The velocities reached from ordinary dives are such that sight of the bottom even in clear water may provide an inadequate time for deceleration response (Yanai & Hay, 1995). Most diving injuries occur in relatively shallow water (1.5 m or less) and few in very shallow water (e.g., less than 0.6 m), where the hazard may be more obvious (Gabrielsen, 1988; Branche et al., 1991). Familiarity with the water body is not necessarily protective. In a study from South Africa (Mennen, 1981), it was noted that the typical injurious dive is into a water body known to the individual.

Data from the Czech Republic suggest that spinal injuries are more frequently sustained in open freshwater recreational water areas than in supervised swimming areas, although the number of injuries sustained in freshwater areas in this country appears to be declining (EEA/WHO, 1999).

A proportion of spinal injuries will lead to death by drowning. While data on this are scarce, it does not appear to be a common occurrence (see, for example, EEA/WHO 1999 regarding Portugal). In other cases, the act of rescue from drowning may give rise to spinal cord trauma after the initial impact (Mennen, 1981; Blanksby et al., 1997).

2.2.2 Preventive and management actions

Technique and education appear to be important in injury prevention (Perrine et al., 1994; Blanksby et al., 1997), as are preventive programmes. In Ontario, Canada, for example, preventive programmes established by Sportsmart Canada and widespread education decreased the incidence of water-related injuries substantially between 1989 and 1992 (Tator et al., 1993).

Because of the young age of many injured persons, awareness raising and education regarding safe behaviours are required early in life. Many countries have school-age swimming instruction that may inadequately stress safe diving, but which may also provide a forum for increasing public safety (Damjan & Turk, 1995). Education and awareness raising appear to offer the best potential for diving injury prevention, in part because people have been found to take little notice of signs and regulations (Hill, 1984). This is not to suggest that signs should not be utilized, but that both education and signage may provide significant benefits.

The principal contributory factors and preventive and management actions for spinal cord injury are summarized in Table 2.2.

TABLE 2.2. SPINAL CORD INJURY: PRINCIPAL CONTRIBUTORY FACTORS AND PREVENTIVE AND MANAGEMENT ACTIONS

Contributory factors
• Alcohol consumption
• Diving into water of unknown depth
• Bottom surface type
• Water depth
• Lack of adult supervision
• Conflicting uses in one area
• Diving into water from trees/balconies/structures
• Poor underwater visibility
Preventive and management actions
• Local hazard warnings and public education
• General public (user) awareness of hazards and safe behaviours, including use of signs
• Early education in diving hazards and safe behaviours
• Restriction of alcohol provision
• Use separation
• Lifeguard supervision
• Emergency services, access

2.3 Brain and head injuries

Concussions, brain injury and skull/scalp abrasions have occurred through beach and aquatic recreational activities such as diving into shallow water. The contributory factors and preventive and management actions are similar to those for spinal injuries and for limb and minor impact injuries and are summarized in Table 2.2 and Table 2.3.

TABLE 2.3. FRACTURES, DISLOCATIONS AND OTHER IMPACT INJURIES: CONTRIBUTORY FACTORS AND PRINCIPAL MANAGEMENT ACTIONS

Contributory factors
• Diving into shallow water • Underwater objects (walls, piers) • Poor underwater visibility • Adjacent surface type (e.g., of water fronts and jetties) • Conflicting uses in one area
Preventive and management actions
• General user awareness of hazards and safe behaviours • Appropriate surface type selection • Adjacent fencing (e.g., of docks and piers) • Use separation • Lifeguard supervision • Warning signs

2.4 Fractures, dislocations and other impact injuries

Recreational water users have experienced injuries to the nose and jaw areas when swimming underwater, shallow diving or hitting underwater objects such as walls and piers or even other water users (depending upon the nature of the activity). These and other injuries have also been reported as a result of slipping, tripping or falling while entering or leaving the water. Injuries involving limb fractures or breaks of different types have many causes and may occur in a variety of settings in or around water. Broken bones (along with scarring, significant blood loss and amputation) have been reported as a result of injuries sustained from boat propellers (CDC, 2002), although it is not clear whether these were sustained from the boat or while in the water. The principal contributory factors and preventive and management actions associated with fractures, dislocations and other impact injuries are summarized in Table 2.3.

2.5 Cuts, lesions and punctures

There are many reports of injuries sustained as a result of stepping on glass, broken bottles and cans. Discarded syringes and hypodermic needles may present more serious risks (Philipp et al., 1995). Cuts and related injuries can also result from

contact with shells, corals and so on. In the case of injury from such objects, wound infection from, for example, *Vibrio* spp. or *Aeromonas* spp. may be an additional problem (see chapter 5). The use of footwear on beaches should be encouraged. Adequate litter bins and beach cleaning operations contribute to prevention. In some areas, syringe/sharp objects disposal bins may be appropriate. Education policies to encourage users to take their litter home are a key remedial measure (see Table 2.4). Banning the possession of glass containers (bottles, jars, etc.) in some beach areas has been found to reduce the likelihood of injuries from broken glass.

2.6 Interventions and control measures

The majority of injuries can be prevented by appropriate measures especially at a local level. A relatively low cost way of promoting aquatic safety is through public education before the visitor even sets foot on the beach. Once the visitor arrives at the beach, additional public education efforts can further enhance public safety. A variety of measures to increase public awareness can be employed and these are reviewed in Chapter 13 (see 13.5).

At the beach, physical hazards should be removed or mitigated if possible, or measures should be taken to prevent or reduce human exposure. Physical hazards that cannot be completely dealt with in this way should be the subject of additional preventive or remedial measures—for example, open or rough water, rough waves, rip currents and bottom debris could all be the subject of general education, general warning notices or special warnings, especially at times of increased risk. It may be possible to rate recreational water areas according to certain characteristics, in order to provide objective, easily understandable information to the public. For example, a beach with a small tidal range, no sudden changes in water depth and so on might be rated as 'family friendly'. A river that is used for white water canoeing might be rated as 'suitable for beginners' under certain conditions or for 'experienced canoeists'

TABLE 2.4. CUTS, LESIONS AND PUNCTURES: PRINCIPAL CONTRIBUTORY FACTORS AND PREVENTIVE AND MANAGEMENT ACTIONS

Contributory factors
• Presence of broken glass, bottles, cans, medical wastes • Walking and entering water barefoot
Preventive and management actions
• Beach cleaning • Solid waste management • Provision of litter bins • Regulation (and enforcement) prohibiting glass containers • General public awareness regarding safe behaviours (including use of footwear) • General public awareness regarding litter control • Local first aid availability

in spate (flood) conditions. Such as system could complement the hazard ranking system outlined in section 2.7.1.

The term hazard is generally used in relation to the capacity of a substance or event to adversely affect human health (see 1.5). In this context, the absence of appropriate control measures may be treated as a component in the chain of causation. For example, the lack of lifeguards, rescue equipment, signs and other remedial actions can contribute to a variety of negative health outcomes.

2.6.1 Lifeguarding

At many coastal and fresh water beaches, people known as lifeguards or lifesavers protect recreational water users from injury and drowning. Depending upon local practice they may be volunteers or paid, or both. Here, the term "lifeguard" is used to refer to people trained and positioned at recreational water sites to protect the water user. Lifeguards, when adequately staffed, qualified, trained and equipped, seem to be an effective measure to prevent drowning. The report of a working group convened by the Centers for Disease Control and Prevention, USA states that "One effective drowning prevention intervention is to provide trained, professional lifeguards to conduct patron surveillance and supervision at aquatic facilities and beach areas" (Branche & Stewart, 2001).

Lifeguards can also assist in injury prevention (e.g., advising users not to enter dangerous areas, such as where a rip current is forming) and by playing a more general educational role (concerning water quality hazards and exposure to heat, cold or sunlight, for example). It has been estimated that lifeguards take 49 preventive actions for every rescue from drowning that they effect (USLA, 2002). According to Branche & Stewart (2001), "the presence of lifeguards may deter behaviours that could put swimmers at risk for drowning, such as horseplay or venturing into rough or deep water, much like increased police presence can deter crime". Further details on lifeguarding can be found in Appendix A.

2.6.2 Use separation

The waterfront may be used for diverse purposes, such as transit (pedestrian, vehicular), sunbathing, swimming, surfing, paddling, watercraft (yachts, powerboats, canoes, personal watercraft) and as a route of access, and the water itself may be used by both swimmers and non-swimmers. As a result of multiple and often dense use, conflicts may emerge, and in many cases zoning or other restrictions on certain uses may become necessary.

Use separation is a measure for minimizing risk where different user groups use the water in different ways within a confined area. Different zones are established for incompatible activities, including for example swimming, diving, sailboarding or powerboating, as well as for conservation and naturalist activities. Specific regulations may be identified for the use of surfboards or similar apparatus. For example, these may be banned within a distance of 70 m of any fishing pier or within 50 m of any swimmer, although this may be difficult to enforce.

At flat water beaches, lines, buoys and markers may be useful in limiting the water recreation area and separating different activities. Lines can also be used to prevent swimmers from entering dangerous areas, to warn of changing conditions or to indicate separation of shallow and deep areas, underwater obstructions, radical changes in slope, etc. The anchoring rope for buoys and markers should not create any risk of entanglement. The buoys are not intended as rest areas.

At coastal beaches where tide, current and wave action typically prevent the use of perimeter devices such as these, lifeguards may patrol and issue warnings or visual reference points onshore may help to keep activities in their proper areas.

It is of particular importance to separate boats from other water users, especially motorboats. If boat launching is to be permitted, special areas should be established that effectively separate it from zones for other uses. At the beachside warning signs and/or buoys should be provided. Boat lanes are generally perpendicular to the shoreline and delimited by floating lines. Boats should launch through this lane at a specified low speed—for example, not more than 3 knots. If boating areas are not delimited for all kind of boats (sailboats, powercraft and jet skis included), an exclusion zone may be defined—for example, in the 200-m zone.

2.6.3 Infrastructure and planning

Waterfront areas are accessed for a variety of purposes, some of which affect safety. Routes used for emergency access—for instance, during launching of rescue craft or to provide access to ambulances—should be suitably maintained, and continuous accessibility should be assured.

Ready access to telephones or other means of communication with emergency services may contribute to speed of rescue or resuscitation. Telephones should ideally be readily accessible and clearly visible, marked on local maps and posted with numbers of key emergency services.

In many recreational water use areas, certain locations or subareas may present significant continuous hazards to human health—for example, due to currents, weirs or rocks. Access to such areas may be discouraged or prevented by a combination of one or more interventions, such as signing, fencing and lifeguard supervision. In some instances, caution lines are used to discourage access, intentional or otherwise, by water users.

In areas with or without lifeguards, rescue equipment may be provided that is accessible for public use. All such safety equipment should be clearly visible from a distance and kept in good repair. Location intervals should be determined according to the response required for a given water recreation area. Public rescue equipment should normally be kept in place year-round.

2.6.4 Beach capacity

It has been suggested that recreational water areas should have an estimated load (number of bathers/visitors) that they may carry safely. While overcrowding may

impede effective lifeguarding and therefore contribute to drowning, in practice this is difficult to enforce, and user needs and perceptions vary considerably between areas. Of more importance is the adequate management of the recreational water use area in order to minimize risk.

2.7 Monitoring and assessment

2.7.1 Assessing hazards

Physical characteristics that may present hazards to recreational water users consist of five interrelated phenomena, four of which are common to most coastal beaches:

- water depth, particularly when greater than chest deep;
- variable beach and surf zone topography, such as tides, bars, channels and troughs;
- breaking waves;
- surf zone currents, particularly rip currents; and
- localized hazards, such as reefs, rocks, offshore platforms, inlets, offshore winds, tidal currents, cold water, kelp beds, weirs and locks. The construction of jetties, piers, wharfs and other artificial structures can also contribute to the hazard.

The assessment of hazards in a beach or water environment is critical to ensuring safety. The assessment should take into account several key considerations, including:

- the presence and nature of natural or artificial hazards;
- the severity of the hazard characteristic as related to health outcomes;
- the ease of access to the recreational water area;
- the availability and applicability of remedial actions;
- the frequency and density of use; and
- the level of development for recreational use.

As outlined in chapters 1 and 4, health risks that might be tolerated for an infrequently used and undeveloped recreational area may result in immediate remedial measures at other areas that are widely used or highly developed.

Potential health outcomes associated with various hazards are summarized in Tables 2.1–2.4. The severity of the outcomes associated with a hazard can be related to the relative risk in Figure 1.2 and can serve as a tool to highlight or emphasize priority protective or remedial management measures and to initiate further research or investigation into the reduction of risk.

The hazard assessment could lead to a 'hazard rating'. Short (2003) outlines a beach hazard rating based on the physical characteristics of a beach (i.e., whether they are wave dominated, tide-modified or tide dominated). The resulting classification consists of a general beach hazard rating and a prevailing beach hazard rating, which depends on prevailing wave, tide and wind conditions. Such as rating could be

expanded to include other hazards. This could form the basis for developing a safety plan, detailing the level of resources required to reduce the level of risk.

2.7.2 Inspection programmes and protocols

Inspection of a site for existing and new hazards should be undertaken on a regular basis in order to promote remedial action if required.

The inspection protocol for a recreational area, in terms of injury hazards may comprise the following:

1. Determining what is to be inspected and how frequently.
2. Monitoring changing hazards and use patterns periodically.
3. Establishing a regular pattern of inspection of conditions and controls.
4. Developing a series of checklists suitable for easy application. Checklists should reflect national and local standards where they exist.
5. Establishing a method for reporting faulty equipment and maintenance problems.
6. Developing a reporting system that will allow easy access to statistics regarding "when", "where", "why" and "how" questions needing answers.
7. Motivating and informing participants in the inspection process through in-service training.
8. Use of outside experts to critically review the scope, adequacy and methods of the inspection programme.

The frequency of inspection will vary according to the size of the recreational water area, the number of features, the density of use, the speed of change in both the hazards encountered and the remedial actions in place at a specific location, and the extent of past incidents or injuries. Timing of inspections should take account of periods of maximum use (e.g., inspection in time to take remedial action before major use periods) and periods of increased risk.

The criteria for inspections and investigations may vary from country to country. In some countries, there might be legal requirements and/or voluntary standard-setting organizations.

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