

DISCUSSION AND RECOMMENDATIONS

The first section of the discussion provides a brief review of the results of surveillance of water-related fatalities for 1999, as well as trends for 1991-1999. Since this is intended to be a visual report, the user should not rely on the summary text, but should review the graphics and tables that pertain to his/her own specific interests. For each activity, the data are structured by personal, equipment, and environmental risk factors, as well as by time factors, rescue, and differences by regions of Canada. The first three types of risk factors correspond to one axis of the Haddon injury matrix, which is widely used for development of comprehensive approaches to injury prevention.

Information about modern principles of injury control as applied to water-related injury deaths, followed by a structured approach to prevention at all levels of society can be found in earlier publications (The Canadian Red Cross Society, 1998, 1997, 1996a, 1994a, 1994b). The Haddon injury matrix is useful for developing a comprehensive array of interventions, while the World Health Organization's Ottawa Charter for Health Promotion is helpful for deciding at what level of society interventions can be most successfully applied in a coordinated approach. For prevention of specific subcategories of drowning by activity or population high-risk groups, such as boating, swimming, or toddlers, the reader may also wish to refer to other special research reports published by The Canadian Red Cross Society (1994-1998). Detailed information for boating, for provinces and territories, by age and sex, and trends from 1991-1999 are included in the annexes at the end of the report.

OVERVIEW OF SURVEILLANCE FINDINGS FOR 1999 & TRENDS DURING 1991-1999

CIRCUMSTANCES AND INCIDENCE OF DROWNING AND NEAR DROWNING AMONG SUBGROUPS OF THE CANADIAN POPULATION, IN SPECIAL ENVIRONMENTS, & BY REGION

During 1991-1999, all drownings from boating, aquatic activities, falls into water, and bathing accounted for about 80% of water-related deaths, drownings associated with land and air transport for 15%, and injuries other than drownings for 5%.

MALES & FEMALES Drowning has been about 6 times more frequent among males than females, although in 1999 this ratio decreased to 4.5. Males accounted for 82% of victims (see Annex 3, and Table 1.1). For water-related fatalities from injuries other than drowning, 75% of victims were males.

During 1999, drowning rates were high among males at all ages from 1 to 4 and 15 to 75 years of age and older (see Figure 1.2). For hospitalizations from near drowning, the ratio of females to males is much higher than for drowning deaths. In 1999 there was 1 female hospitalized for every 2.1 males.

For drownings other than those related to land and air transport, among males boating accounted for 40%, aquatic activities 27%, falls into water 22%, bathing in a bathtub 4%, and unknown 7%. Among females, aquatic activities accounted for 31%, falls into water for 27%, bathing 18%, boating 16%, and unknown 8%.

ADULTS For all persons 25 years of age and older, boating accounted for 56% of all recreational drownings, excluding land and air transport (see Annex 3). With the improvement in toddler drowning rates between 1995-1999, males 15-74 years old now have the highest drowning rates. While the rate of hospitalization for near drowning is much lower among adults than small children, the average duration of hospitalization is much longer for adults.

CHILDREN For children and youth 0-19 years old, 37% of drownings involved 15-19 year old youth, 27% 1-4 year old toddlers, 22% 5-9 year olds, 14% 10-14 year olds, and 0% infants. Infants tend to drown while being bathed in bathtubs, toddlers by falling into swimming pools and natural bodies of water, 5-9 year olds by falling into water, swimming, and wading, 10-14 year olds by falling into water and swimming, and 15-19 year olds while swimming and boating. While infant and toddler drownings mainly occur in or

around the home, drownings of older children and youth tend to occur in large bodies of water such as lakes and rivers.

It is thus apparent that home safety is an important consideration for prevention of infant and toddler drownings. During 1999, home swimming pools accounted for 38% of toddler drownings and bathtubs 8%. Boating accounted for only 12% of all drownings of children between 0 and 14 years, and for 15% of drownings of youth 15-19 years old. For older children, activities and locations away from the home need to be targeted.

Among male toddlers, the average rate of *hospitalization for near drowning*, excluding in-hospital deaths, was 6.8 per 100,000 toddlers per year during the five-year period 1994-1999. For female toddlers, the 1994-1999 rate was 4.9. In comparison, the drowning death rate of male toddlers was 2.27 in 1999, and of females 0.98.

Although the time periods are not exactly the same *for deaths and hospitalizations*, there were about 3 survivors of hospitalization for near drowning for each death from drowning among male toddlers in Canada. Among female toddlers, there were 5 survivors of hospitalization for each death. Thus while small boys are at higher risk of both drowning and near drowning, girls have a higher risk of near drowning than expected from their drowning rate. Perhaps girls tend to drown more frequently than boys in or around the home. Hence resuscitation of girls may be more rapid, such that they survive to reach hospital and to be discharged alive. This requires further study.

As discussed below under trends, Quebec has a special drowning problem with its large numbers of home pools, and Quebec has accounted for about half of pool drownings in Canada for the past nine years. In other provinces, swimming pool drownings of toddlers have become relatively uncommon. Ontario had managed to improve its home pool drownings to an average of 2 toddlers per year for 1994-1997. Unfortunately, in 1998, 7 Ontario toddlers drowned in pools, but this decreased to 3 deaths during 1999. 1998 was the only year since 1991 when Ontario had more pool drownings than Quebec.

The overall rate of near drowning for all ages in Quebec is the lowest in Canada. For infants and toddlers, however, the near drowning rate in Quebec is higher than in Ontario and slightly higher than the Canadian average (Dandavino, 2002). The higher than average rate of near drownings among 1-4 year olds in Quebec is probably a result of the large number of home pools without self-closing and self-latching gates.

EPILEPSY Canadians with epilepsy continue to have rates of drowning estimated to lie somewhere between 7 and 18 times greater than for other Canadians. Because most victims are relatively young adults, the average economic loss per death associated with these drownings is very high. In 1999, 96% of victims were 15 years and older and 93% between the ages of 15 and 54. Bathtubs were the site of 52% of drownings of people with epilepsy. Swimming and activities near water such as walking and fishing were the other main hazardous activities for people with epilepsy.

ABORIGINALS In 1999, at least 13% of drownings in Canada occurred among aboriginal peoples; this figure excludes land and air transport. The drowning rate for aboriginals was 8 times higher than for other Canadians (9.0/100,000 population versus 1.2). This underestimates the true total for aboriginals, because in some provinces coroners do not routinely report aboriginal ethnicity of injury victims.

Boating accounted for 45% of drownings among aboriginals, aquatic activities for 26%, falls into water for 13%, bathing for 4%, and unknown 11%. Aboriginals accounted for 24% of drownings for snowmobiling, 17% for boating, 12% for aquatic activities, 8% for bathtubs, 7% for falls into water, and 6% for land and air transport other than snowmobile. Drowning of aboriginal toddlers represented 17% of the total of Canadian toddler drownings for 1999. Since aboriginals constitute about 3% of the population, they are over represented in most categories of drowning.

Alcohol was associated with at least 50% of drownings of aboriginal persons 15 years and older, as compared with about 40% for individuals of other or unspecified ethnicity. The wearing of flotation devices is even less frequent among aboriginal peoples than other Canadians, and no aboriginal boating drowning victim in 1999 or 1998 was properly wearing a flotation device. This compared with 10% for all boaters.

SWIMMING POOLS During 1991-1999, the number of toddler drownings in home pools per year was 16, 17, 21, 14, 7, 9, 10, 13, and 8 respectively. During 1991 to 1999, only 4% (5 of 115) toddler home pool victims were reported to have drowned in pools with a self-closing and self-latching gate. During the four most recent years from 1996 to 1999, only one toddler drowning occurred in a pool reported to be equipped with an automatic self-closing and self-latching gate.

BATHTUBS Bathtub drownings accounted for 6% of drownings other than land and air transport. There were 25 drownings in bathtubs during 1999, as compared with 20 in home or apartment swimming pools. Adults and children 5-64 years old with epilepsy comprised 56% of bathtub victims, and toddlers another 8%. Many of the other victims suffered from another health condition affecting mental alertness, or were elderly. Prior to 1995, several infants drowned each year in bathtubs in Canada, but since 1995 infant bathtub drowning have averaged less than one per year. *Young adults with epilepsy are now the main high-risk group to be targeted for prevention of bathtub drowning in Canada.*

DIFFERENCES BY REGION The Atlantic region and British Columbia had drowning rates 1.3 and 1.6 times greater than the national average respectively. The Prairies and Quebec had rates similar to the national average and Ontario below the national average. The northern territories, including Nunavut, the Northwest Territories, and the Yukon had a combined rate 4.5 times the national average. For near drownings during 1994-1999, British Columbia and the northern territories had hospitalization rates greater than the national average.

CIRCUMSTANCES OF DROWNINGS ASSOCIATED WITH SPECIFIC ACTIVITIES

BOATING There were an average of 186 boating drownings per year during 1991-1999. For 1999, the number of deaths was 145, which is the lowest during the period. In 1999, small open powerboats and canoes continue to be the most frequent source of boating drownings.

Blood alcohol levels above the legal limit were found in 21% of all recreational boating victims, and below the limit or suspected in another 16%. Given a proportion of unknowns, alcohol appears to have been a factor in at least 40% of boating drownings in Canada during 1999. While alcohol was associated with at least 30% of small powerboat drownings, more than 60% of canoeing drownings involved alcohol. The involvement of alcohol in boating collisions and propeller injuries was 20%.

About 10% of all boaters, 0% of aboriginal boaters, and 0% of occupational boaters were wearing a flotation device when they drowned. There has been no change in the proportion of victims who were wearing a flotation device between 1991-1999. Not a single canoeing drowning victim during 1999 was wearing a flotation device. Probably because of the low rate of wearing of a flotation device by boating victims, 57% of rescues of drowned boaters consist only of a search for the body. In only 30% of rescues for drowned boaters had there been a search for a potentially survivable victim.

Environmental factors such as strong winds, rough waves, and extremely cold water are associated with at least 30% of boating drownings. Other circumstances include personal and equipment factors. These include inappropriate behaviour such as standing up, abrupt turns, overloading, and collisions, and unsafe equipment such as an poorly designed or inappropriate boat, engine failure, and engines that keep running when the operator falls out of the boat. As for seasonal factors, the period for recreational boating drowning extends from May until October.

Among both victims and survivors, only about 25% stayed with the boat, while the remainder swam for shore immediately or after a delay. These data indicate that boaters need to be cognizant of the relative risks of swimming to shore as compared with hanging onto the boat, and adapt their response to the prevailing conditions. This would include assessing the probability of a rapid rescue before hypothermia becomes too advanced to allow either swimming or hanging onto the boat. Although the data are incomplete to assess swimming ability or wearing of a flotation device among survivors, it is evident that wearing of a flotation device and good swimming ability would be helpful assets for survival in either scenario, i.e., swimming or trying to hang on to the boat.

Although the number of deaths from boating collisions is small compared with the number of drownings, such incidents attract considerable publicity. While there has been no significant increase in the total number of collisions, personal watercraft had accounted for a greater proportion of the total during 1994-1997, with about 4 collisions per year involving these boats. During 1998 and 1999, there were 2 incidents per year involving personal watercraft. Further observation should confirm if this is a significant downward trend.

FISHING During 1999, 84% of recreational fishing drownings involved fishers in boats, mainly small open powerboats. Males 15 to 75 plus years, especially 35 to 65, were the main victims. Fishing is the most frequent activity associated with boating drownings, including 39% of recreational boating drownings, 55% of daily living boating drownings, and 55% of occupational boating drownings.

AQUATIC ACTIVITIES As in previous years, 15-24 year old males had the highest rate of swimming drownings, followed by 25-34 year olds. For all ages 15 years and older, alcohol was a frequent risk factor and was reported in 47% of aquatic drownings. Among the high-risk group of 15-24 year olds, alcohol was associated with at least 28% of deaths, as compared with at least 58% of victims 25 years of age and older. Rivers with their strong currents are a frequent risk factor, especially for younger swimmers between 5 and 24 years.

An acute rescue for a potentially survivable victim was attempted for 70% of swimming drowning victims. More than 50% of such rescues were initiated by a companion or bystander. Clearly rescue training, good swimming ability, and judgment are essential both to improve the success rate of rescues and to avoid death of the rescuer. During 1991-1999, an average of 4 Canadians per year died while attempting rescue of a swimmer or wader, 3 during attempted rescue of boaters, and 3 of individuals who fell into water.

Unfortunately swimming ability is still unspecified in a majority of coroners' and police reports of drownings. Where it was specified, about half of the victims between 5-14 years and 15 and older were weak swimmers or non-swimmers.

FALLS INTO WATER Rivers, lakes, and home swimming pools were the most frequent locations for drownings from falls into water during non-aquatic activities such as walking or playing near water or on ice. For 1-4 year old toddlers, swimming pools, rivers, and lakes were the most frequent types of body of water, with pools accounting for 50% of the total in this age group. For 5-14 year olds and for persons 15 years of age and older, rivers and lakes were the sites of most incidents, with rivers accounting for 60% of the total. This indicates that for parents, grandparents, and other caregivers of toddlers, it is important to provide automatic protection for home pools, and, for cottage holidays, to choose a cottage that is not immediately adjacent to a lake or river.

Many older children and adults, both swimmers and non-swimmers, appear to be unaware of the danger and enormous power of current, which poses a potential hazard for anyone walking near water or wading. At least 77% of all victims of falls into water, including both children and adults, were alone or accompanied only by a minor when the incident occurred. At least 18% of drownings from falls into water involved ice, nearly all on rivers and lakes. February was the most frequent month. This is an important point for prevention, since intuitively one might have suspected fall or spring months to be most frequent. Perhaps there is a false sense of security about the strength of the ice in the coldest month. Although swimming ability is frequently not reported by police and coroners, where it is, the majority of victims of falls into water over 5 years of age are non-swimmers.

SNOWMOBILING During 1991-1999, the average number of snowmobile drownings per year was 25. The number in 1999 was 17, less than average, while in 1998 there were 28 fatalities. Alcohol was associated with 56% of snowmobile drownings. Incidents occurred most frequently in lakes, followed by rivers and oceans. 24% occurred between 6 pm and 6 am, i.e., during darkness or twilight, and nearly all of the other incidents occurred after 2 pm, when darkness may also have been a factor. For the period 1991-1999, the Atlantic region, mainly due to Newfoundland, has had a snowmobile drowning rate nearly twice the Canadian average; however in 1999, there were no incidents in the Atlantic region. The highest rate of snowmobile drownings is in the Nunavut, Northwest Territories and Yukon region, with a rate 19 times the Canadian average. Nevertheless, 44% of all snowmobile drownings have occurred in Ontario.

On-Road Motor Vehicle Travel The highest rates of road traffic drownings were in the Atlantic region and British Columbia, with nearly half of incidents in rivers. Alcohol was a factor in at least 50% of incidents. For Canada, 42% of all incidents occurred in rivers, while in Quebec and British Columbia the proportion involving rivers was even higher.

CIRCUMSTANCES OF MULTIPLE-VICTIM DROWNING INCIDENTS

The most frequent activity associated with multiple-victim drowning incidents was boating, which accounted for 55%. One-third of boating victims drowned in multiple-victim incidents. There were 2.9 victims per incident in the multiple-victim boating incidents. For activities with many multiple-victim incidents, it is helpful to examine trends by rates of incidents, as well as by rates or numbers of victims (see example under the next section called “Trends”).

HOSPITALIZATIONS FOR NEAR DROWNING

Details of non-fatal hospitalizations for near drowning have been monitored during 1994 to 1999. The highest rates are among toddlers and infants. Nevertheless, we know from earlier analyses that the duration of hospitalization, and presumably the average severity, is greater among older victims. The average number of hospitalized survivors of near drowning per year during 1994-1999 was 355. During the same period, the average number of fatal drownings per year was 534. There was also an average of 43 non-survivors per year of hospitalization for near drowning, but all or at least most of these victims should have been investigated by coroners and included with the deaths.

Thus the *ratio of fatal drownings to survivors of hospitalization for near drowning in Canada is 1.5 to 1, that is to say that there is an average of about 1.5 drownings for each near drowning*. This ratio is quite different than some earlier reports from the United States, which described several near drownings for each drowning. Such differences between countries might be observed if only small children were considered in one of the two countries. In illustration, *if we consider only Canadian infants and toddlers during 1999, there were 4.2 survivors of near drownings for each drowning*. During 1991-1994, prior to the marked improvement in drowning rates among small children observed since 1995, the ratio was closer to 2 near drownings for each drowning among infants and toddlers. The improvement in near drowning has been much less than for drowning.

The average proportion of survivors of near drowning due to boating was 17% during 1994-1999. However, the true proportion attributable to boating could be as much as double this figure, since as for vital statistics, physicians often fail to mention that drownings occur during boating and such cases are then misclassified as non-boating incidents.

The regional rates for near drowning tend to be similar to or slightly less than the regional drowning rates, with the exception of Quebec. In Quebec, the rate of survivors of hospitalization for near drowning is significantly less than the drowning rate. The reasons for this difference are unknown, and could be related to reporting issues in Quebec hospitals, differences in rescue and resuscitation, or other factors.

RELATIVE IMPORTANCE OF DROWNINGS COMPARED WITH OTHER INJURIES

Among 15 to 24 year olds, drowning is the second most frequent cause of unintentional injury death after road traffic injury. For all ages, the four leading causes of unintentional injury death are traffic injuries, falls, poisoning, and drowning. Drowning used to be more frequent than poisoning as a cause of death. During the past several years, there has been some improvement in drowning rates, while unintentional overdoses of cocaine and other illegal drugs have remained frequent since the mid 1980's, especially among 25 to 44 year olds.

TRENDS

TODDLER AND INFANT DROWNINGS *The most encouraging medium-term trend in the 1990's was a 40% decline in drownings of 1-4 year old toddlers and 80% in infants less than 1 year old in Canada between the periods 1991-94 and 1995-99. The improvement has now been sustained for 5 years.* There is less than a 1 in 1000 probability that this magnitude of decrease in incidence rates of toddler and infant drowning occurred by chance alone. The dramatic change corresponds with the release of The Canadian Red Cross Society's special research report on toddler and infant drowning in 1994 and the extensive research-based revision of the national swimming and water safety programs and promotional/education campaigns across Canada. The latter incorporated programming based upon modern principles of injury prevention. Further investigation into the factors associated with this promising trend is ongoing.

Between 1991-1999, the annual rates of drownings per 100,000 toddlers were 3.0, 3.2, 3.1, 2.8, 1.6, 2.3, 1.8, 2.3, and 1.6 respectively. *Among infants, drownings virtually disappeared during 1995-1999.* Infant drownings mainly occur in adult bathtubs; the average number fell from 6 per year to 1 per year between 1991-94 and 1995-99. Between 1991-1999, the numbers of infant drownings were 5, 6, 6, 5, 0, 1, 2, 2, and 0 respectively.

Toddlers drown mainly in swimming pools, lakes, rivers, and to a lesser extent, bathtubs. Among toddlers, there were an average of 4 bathtub drownings per year during the three periods of 1991-1993, 1994-1996, and 1997-1999. During these same three periods, there were an average of 18, 10, and 11 pool drownings, 14, 12, and 7 lake drownings, and 7, 7, and 4 river drownings. There thus appear to be significantly improved trends in pool and lake drownings of toddlers during the latter half of 1991-1999, while there was no improvement in bathtub drownings in this age group.

Nevertheless, *there is still room for further improvement in toddler pool drowning rates.* Only 1 of 31 toddler swimming pool drownings in Canada during 1997-1999 and 5 of 115 during 1991-1999 were reported in a pool with a self-closing and self-latching gate. If all home pools were equipped with this simple and inexpensive device, nearly all toddler pool drownings and about one-third of all toddler drownings could be eliminated.

During 1991-1996, aboriginal toddlers and infants accounted for about one-third of drownings of all 0-4 year olds. During 1997 they represented only 11% of the national total, in 1998, 24%, and in 1999, 17%. It is unclear whether this change reflects a greater improvement among aboriginal toddlers than others, or whether it resulted from less complete recording of aboriginal status by data collectors or other staff during 1997-1999 as compared with the extra efforts for completeness made for complete reporting on aboriginals during 1991-1996.

Although the overall rate of toddler drowning in Quebec is close to the national average, Quebec has not shared to the same extent in the national decline in toddler pool drowning and continues to have the highest rate in Canada. During 1991-1999, Quebec, which accounts for 24% of Canada's population of toddlers, had 49% of the toddler pool drownings. Nevertheless, some encouragement can be taken from the fact that the pool drowning rate in Quebec appears to have improved somewhat since 1997, lagging by a couple of years the sharp downward trend first seen in Ontario in 1995. The high rate in Quebec reflects in part the large number of above-ground pools in Quebec that have been fitted with a terrace that leads into the living area of the house, which frequently also serves as a play area for children. Unfortunately, the model regulation for municipalities still does not include the key element of a self-closing and self-latching gate, and less than 10% of pools in one large region are fitted with such devices (Sergerie et al., 1997). If the toddler pool drowning problem in Quebec could be solved, the Quebec provincial toddler drowning rate would be the best in Canada, instead of only average.

DROWNINGS OF MALES AND FEMALES In previous years, the male to female ratio was about 5 to 1. In 1999, the ratio was 4.6 to 1, with 386 male and 84 female drownings. During 1999, there was a greater proportion of drowning victims who were female, as compared with previous years during 1991-1998. The reasons for this may become clearer over time if the trend is sustained, but may reflect changing patterns of activity, alcohol consumption, and other risk-taking behaviour for the two sexes.

BOATING DROWNINGS The number of boating drownings in Canada during 1999 was 145, which is 24% less than the 1991-1998 average of 191 per year and the lowest *since the national surveillance system began in 1991*. This is an encouraging change that will need to be confirmed by ongoing monitoring.

For boating, the reporting of drowning rates by incident rather than by victim smoothes out fluctuations that result from occasional incidents with several victims. Although less striking than the improvement in infant and toddlers drownings, there is a modestly favourable trend in the rate of fatal boating drowning incidents during the period 1993-1999, with 5.2, 5.3, 5.3, 5.1, 4.7, 4.7, and 3.7 incidents per million population respectively in each of the seven years. This trend will be an important one to monitor if a legal requirement for wearing of flotation device by users of small powerboats and canoes becomes a reality. Implementation and enforcement of such legislation would be expected to eliminate most boating drownings in Canada. The average number of victims per boating incident was 2.9 in 1999.

It is also important to develop better reporting of incidence rates based upon the numbers of different types of boats and average annual hours of exposure to boating activity. This may best be done by collaboration with Statistics Canada household surveys.

There is the suggestion of a positive trend in the overall number of fatal boating collisions during 1998-1999, since the average number of collisions was 8 per year during 1991-1997 and 4 per year during 1998-1999. Further observation will be required to verify whether this improvement is statistically significant. During 1996-1999, personal watercraft accounted for 57% (13/23) of all collisions between two boats and of a boat with a fixed object, as compared with 11% (3/28) during 1991-1995. Users of personal watercraft are also at increased risk of propeller injury from other boats, with 3 fatalities during 1991-1999, accounting for 38% of all victims of propeller injuries.

INTERPRETATION OF TRENDS

In comparing data from year to year, it is essential to avoid over-interpreting the significance of changes that may simply be a result of random fluctuation or of a single multiple-victim incident with several victims. With nine years of carefully collected and verified data for Canada, including data on multiple-victim incidents, it is now becoming possible to verify medium-term trends in specific subcategories of drownings. For example, the downward trends in toddler and infant drownings described above were found to be highly significant using statistical testing (Chi-square for trend and chi-square comparing before and after periods for toddler drownings gave a p value of <0.001). This result tells us that there is less than a 1 in 1000 probability that the observed downward trend was due to random variation. Verified surveillance data also provide an objective measure of outcome, and not simply process, for prevention programs. While process measures of evaluation such as knowledge, attitudes and practices are useful indicators of immediate change, in order to prove that a program is effective, such improvements must be followed by a positive and sustained trend in outcomes such as drowning, for the targeted activity or risk group. Positive trends are encouraging and can stimulate allocating additional resources for effective countermeasures. On the other hand, lack of improvement in outcome for specific risk groups, activities, or regions provide direction for new initiatives.

IMPLEMENTING PREVENTION OF DROWNINGS: KEY RECOMMENDATIONS FOR 2001 AND BEYOND

Injury countermeasures may be general or specific.

Alcohol is a substance that is associated with most types of water-related injuries. Interventions to render the use of alcohol on or near the water illegal and socially unacceptable would fall into the category of *general countermeasures*. This would protect nearly all high-risk groups including recreational boaters, adult male swimmers over 25 years of age, and snowmobilers. Children would also benefit, since caregivers would be required to be sober and alert, at least in waterfront situations.

For boaters, it is essential that both operators and passengers be protected by regulations and enforcement. Passengers are equally at risk of falling overboard when the boat is underway or stationary, and during

capsizing or swamping (Ciraulo et al, 2000; Logan et al., 1999; Howland et al., 1996). A simple standardized sobriety test for boaters has been developed for administration on the water (McKnight et al., 1999). Failure in this three-point test correlates well with blood alcohol levels above 100 mg %, and is reported to be useful to help decide who needs to be taken ashore for further testing.

Current evidence suggests that swimming ability and water safety training may be protective against drowning for persons 5 years of age and older (The Canadian Red Cross Society, 1996b). If this finding can be confirmed by further research, programs that provide such capabilities would be another example of a general countermeasure to protect boaters, swimmers, waders, people who fall into water, rescuers, and others.

Sustained downward trends since 1995 in toddler and infant drownings suggest that research based community water safety training programs and promotional/education campaigns introduced in 1995 across Canada for caregivers and children are having a positive impact. Unlike previous training, new programs are research-based and focus on key modifiable risk factors in Canada for prevention of drownings among toddlers and infants. The involvement of caregivers is now a key component of such programs, because there is greater awareness that infants and toddlers cannot be relied upon to recognize hazards and protect themselves.

Specific countermeasures consist of interventions that address a specific subcategory of injury and/or a targeted high-risk population. Examples would be a law to require wearing of a flotation device by users of small boats, or a regulation to require that all home pools be fitted with a self-closing and self-latching gate. The first example would target mainly adult male boaters, and the second, toddlers who live in, visit, or reside near houses with swimming pools.

Specific countermeasures need to address issues such as:

- Low rates of wearing of flotation devices while boating, especially by adult males;
- Low rates of wearing of flotation hypothermia protective garments while boating when low water temperature is a factor, especially during fishing, and during snowmobiling on ice;
- The absence of mandatory self-closing and self-latching gates to prevent toddler drownings in all home swimming pools, especially in Quebec;
- The risk of river currents for 15-24 year old swimmers;
- Alternative bathing practices to eliminate the risk of bathtub drownings for persons with epilepsy;
- The risk of current in rivers and at the outlet of lakes for children and adults who walk or play on ice.

There has been significant progress towards prevention of infant and toddler drownings in Canada during 1991-1999. For the largest high-risk group for drownings, male youth and adults, progress has been less striking.

There has been an improvement in bathtub drownings from an average of 45 per year during 1991-1995 to 32 per year during 1996-1999. Some but not all of this improvement is attributable to the decline in infant drownings already discussed. The largest remaining risk group for bathtub drowning is people with epilepsy, and special effort will be needed to better inform such individuals, their families, and their health providers.

Another category where definite improvement has become evident is boating drownings, with a decrease from an average of 199 drownings per year during 1991-1995 to 170 during 1996-1999. Part of this decrease was probably attributable to decreased exposure to occupational and subsistence fishing and boat travel, rather than specific interventions. The average number of recreational boating drownings per year during 1991-1995 was 146, and during 1996-1999, 134.

Injury countermeasures can be categorized as passive or active. *Passive or automatic measures provide a safe person-friendly environment or equipment by eliminating hazards.* Safety-based design of homes and boats provides passive protection. In illustration, a swimming pool gate that is both self-closing and self-latching provides automatic protection that reduces the need to rely entirely on constant active vigilance by a child's

parents. In contrast, active measures tend to require people to be constantly vigilant for their own or their family's safety whenever they are near a potential hazard. This also requires that people be aware at all times of all the hazards in their environment, even when they are tired or otherwise preoccupied.

Exhorting people to watch their children every moment while at the beach or other waterfronts is commendable and essential. Nevertheless, in and around the home it is impractical for caregivers to be constantly vigilant, since there are many tasks of daily life and other hazards that also demand attention. Hence safe home design is essential to ensure that there are no life-threatening hazards in the house or yard.

While education alone is insufficient to provide sustained prevention of injuries (Munro et al., 1995), education can be useful when supported and sustained by other countermeasures. These include effective and carefully targeted national, provincial, and municipal regulatory activity, including good building codes and municipal enforcement of these codes. Research-based education of decision-makers and trainers is also essential.

The importance of evaluating all new programs is that while some programs are found to be ineffective, others may actually produce the reverse effect of what was expected. Boaters in North Carolina, United States, who had received boating safety education, used alcohol more than persons without any education (Glover et al., 1995). Another study in the US found that boaters with formal training failed to wear flotation devices as often as those without such training, and were equally or more likely to use alcohol while boating (Bell et al., 2000).

Safety education and safety campaigns are rarely properly evaluated either before or after their widespread introduction. When they are, such interventions have sometimes been found to have a negative impact on behaviour and/or injury. The precise reasons for this require further study.

Sometimes such programs increase the number of people who participate in an activity and thereby increase the exposure to risk. This occurred with driver education programs in schools for teenagers in the United States. After the programs were introduced, more children started to drive right away at 16 years of age and more died. Any possible positive impact of the program was overshadowed by the fact of putting more children at risk of death on the road at this vulnerable age.

Other researchers have suggested that after certain types of courses, participants or caregivers may have a false sense of security about certain hazardous activities. While safety training for small children might be useful, it would be harmful if parents relied upon it to protect children in this vulnerable age group. An example would be water safety or swimming programs for toddlers that did not involve caregivers. Similarly, while it is probably useful to inform children under 10 about risks of traffic, it is still dangerous to let them walk to school at this age without adult supervision.

In other cases, it may be that both of these factors affect the risk of injury after education. After a gun safety or scuba diving course, the participant may be encouraged to buy a gun or scuba gear, and they are then more likely to use them with all the associated hazardous exposures. People are often injured during training, and they may also have a false sense of security having taken the course.

This is not to say that it is useless to provide training. Clearly, appropriate training and education can increase safety and enjoyment of new or favoured activities. What is essential is to include an adequate budget and time for evaluation and piloting of the impact on a small scale of all new programs prior to introduction on a larger scale. This may include evaluation of process objectives since as wearing of a flotation device during the pilot and evaluation of more uncommon outcomes such as decreases in boater drowning, after widespread adoption of the new course or training.

It is also essential that training and educational programs for injury prevention be based upon good research and surveillance data, and on scientific evaluation. This is increasingly required for all new and existing medical treatments and prevention programs, so called 'evidence-based medicine'.

Even for successful programs, evaluation clarifies the need for other coordinated strategies such as intervention. In illustration, a US educational program for boaters succeeded in raising wearing rates for

flotation devices from 20% to 30%, and this was rightly considered successful (Tresor et al., 1997). Nevertheless, it is also clear from these data that the majority of boaters were still unprotected after the programs and that regulation would be needed to protect the majority.

Surveillance and control of negative advertising is also essential. Popular movies often portray unsafe behaviour. In a review of the 25 most popular movies, it was observed that only 17% of 82 boaters wore personal flotation devices (Pelletier et al., 2000).

Another key issue in the success of prevention programs is the issue of cultural perceptions concerning the preventability of injuries. This can vary widely from one ethnic group and injury to another. A national survey in the United States reported that for all respondents, they believed that 67% of drownings were preventable (Girasek 2001). Such a population should be receptive to prevention programs, whereas in another culture the receptivity might be much less favourable.

In order to succeed, intervention programs for 2001 and beyond need to be carefully selected on the basis of major determinants of drowning, including key high risk populations, activities, equipment, and environments. Furthermore, all intervention programs must be regularly evaluated on the basis of measurable changes in Knowledge, Attitudes, Practices (KAP), and outcomes. Outcome measures include decreased deaths and hospitalizations among well-defined populations. A process measure of a practice would be the percent of users of small powerboats observed to be wearing a flotation device. Effective programs can be supported for national application, while ineffective programs should be dropped or modified.

The following activities, risk groups, and preventive strategies are recommended for action on the basis of trends analyzed during the nine-year period since the Canadian Surveillance System for Water-Related Fatalities began effective national reporting.

BY ACTIVITY

BOATING Boating, mainly recreational, continues to be the leading source of drowning in Canada, accounting for 40% of drownings. This situation differs from many other countries. In illustration, in Australia during 1992-1997, the non-boating unintentional drowning rate was 5 times greater than the rate of boating drowning, 1.44/100,000 population/year as compared with 0.29 (Mackie, 1999). In Canada our average boating drowning rate was 0.61/100,000 population per year during 1991-1999, versus 0.96 for non-boating, excluding land and air transport. Thus the Canadian ratio of all non-boating drownings to boating was only 1.6. Our recreational boating drowning rate is about twice that for the United States, where they had 783 deaths in 1994 (Logan et al., 1999).

The vast majority of boating victims in Canada are males between 15 and 74 years old. Most incidents involve small boats, including open powerboats, canoes, and others. Educational strategies alone have still not persuaded most boaters, especially at-risk males in small boats, to wear a flotation device. About 90% of drowning victims are found not wearing a personal flotation device (PFD) or a lifejacket, while for aboriginal boaters the figure is close to 100%. Studies of live boaters on the water have shown especially low wearing rates of only about 20% among users of motorboats in both Canada (Masson and Barss, 1996) and the United States (Quan et al., 1998).

It is frequently impossible for a boater to find and put on a device once immersed in water for several reasons:

- A majority of incidents involve falls into water, capsizing or swamping;
- Wind, waves, cold water, and darkness are frequent;
- In a not insignificant number of cases, there is no engine kill mechanism or it has been inactivated. When a solo operator falls in, the boat continues on its way.

Current legislation and local rules that require only carrying, not wearing, of a flotation device are insufficient to incite people to wear flotation at all times while boating. Unfortunately, many boaters do

not respect even the minimal regulatory countermeasure that simply requires the presence of appropriate flotation devices in the boat. If wearing of a flotation device were required, non-intrusive enforcement would be simpler, cheaper, and faster since compliance could be verified from a distance by direct view or with binoculars, rather than by stopping of boats to inspect their flotation devices.

The following elements should be included in a comprehensive approach to the prevention of boating-related fatalities:

- *Lobbying for legislation to improve boating safety*; for example, a new regulation requiring the wearing of a flotation device by all occupants of small open boats, canoes, and kayaks. While there are many naysayers for such regulatory activity, the fact is that similar regulations for automobile seatbelts have been enormously effective. While many adults are content to promote wearing of a flotation device for children, but not for themselves, the fact remains that child boating victims are rare. For such a regulation to have measurable impact, youth and adult males must be the key target group for legislation and enforcement.
- *Encouraging mandatory use of hypothermia protective garments in high risk activities*, such as spring and fall fishing and hunting or travel on large bodies of water under adverse conditions. Many fishing trips take place during spring when water temperatures are very low and supplementary protection is needed.
- *Developing better educational and promotional strategies to encourage the wearing of flotation devices while boating*; e.g. behavior-change research for high-risk groups, used in targeted marketing campaigns, partnerships/collaborative effort among organizations involved in water safety and injury prevention. To date, such strategies have not been very successful for the average boater. Safety-oriented club outings for canoeing and kayaking may be an exception.
- *Improving existing flotation device design to maximize safety, accessibility, comfort, temperature control and performance during vigorous activity*. While currently available flotation devices are far superior to cumbersome older models, the industry must continue its efforts to improve design in order to minimize objections to continuous wear. The marketing of flotation devices could be greatly improved. An appropriate variety of comfortable and appealing flotation devices that are suitable for vigorous activity such as canoeing should be available at affordable prices at major outlets and not only in specialty stores. Advertising should emphasize the need for continuous wearing, as well as both comfort and safety with the right device for each type of boating activity. Boaters (and fishers who use waders) should be aware of the risk of wearing rubber boots on or near the water, and always wear a flotation device when they are in a boat or the water with boots.
- *Implementing and regularly reevaluating appropriately targeted swimming and boating safety training programs*. Boating safety programs for primary school children were found to be ineffective (Leslie, 1990), probably because few children at this age are actively engaged in such activity. Better-targeted programs for high-risk youth and adult male boaters of all ages might be more productive. Nevertheless, careful assessment of Knowledge, Attitudes, and Practices following all new programs is needed, as well as ongoing surveillance of outcomes such as boating drowning rates in target groups.
- *Enforcing existing regulations limiting consumption of alcohol during boating*. Many boaters continue to transport and consume large quantities of alcohol. Alcohol continues to be involved in about one-third of boating drownings.
- *Creating safer user-friendly boating environments and well-trained employees in waterfront municipalities, marinas and parks*. Parks and rental staff should be provided with specific training and certification to competently advise boaters on appropriate routes and safety equipment, as well as the need for including bad weather layover days into planning for longer trips. Coast Guard and marine police should be trained to target their advice and enforcement so as to concentrate on key issues, such as wearing of flotation devices by all occupants of small boats.

- *Mandating our provinces, municipalities, and communities to collaborate in developing and evaluating appropriate regulations and enforcement to improve boating safety.* This is essential because many bodies of water are not included in the Coast Guard's mandate for patrolling. While some provincial police departments have a marine division, this is not universal.
- *Developing more effective engine kill mechanisms* is needed in order to halt the engine when an operator falls in. Data show that each year several boaters drown when they fall in and their boat continues on without them. It should be made impossible to disable such controls; however, they should be comfortable and non-obtrusive or users will devise means of bypassing them. Further development in this area could be encouraged by appropriate regulatory activity in the manufacturing and building codes.
- *Developing regulations to ensure that personal watercraft users wear both helmets and a flotation device at all times.* In collisions of personal watercraft, 54% of victims were ejected from the boat, and hence were at risk for both head injury and drowning (Jones, 1999). Head and limb injuries are the most frequent non-fatal injuries associated with collisions of personal watercraft (Jones, 2000). Head protection would appear to be especially important for rental users, since many have no experience.
- *Inclusion of protective guards on propellers* would help protect water-skiers, swimmers, and personal watercraft users who fall off their boat from death, amputations, and other severe propeller injuries (Jones, 2000; MMWR, 1998; Hargarten et al., 1994; Mann, 1980).
- *Improving the success of search and rescue for missions on water.* The probability of finding the subject(s) of a search and rescue mission alive is reported to be much lower for missions on water than on land. In one US study in Oregon, the chance of being rescued alive in a water incident was only 50%, which was 7.5 times less as compared with land (Scorvo et al., 2001). In order to improve the success rate for missions on water, it is essential to get to the incident site quickly, since during sustained immersion in water victims will become rapidly lose heat, become hypothermic and die. If all boaters traveling in a single boat or under adverse or remote conditions carried a personal locator beacon in a special pouch on the rear of their flotation device, search and rescue services could be alerted quickly enough of two key variables, including first, the existence of an emergency and second, the correct location. This would cut the response time and improve the success rate of locating the victims alive.

SWIMMING & WADING There was no sustained improvement in drowning associated with swimming and wading in Canada during 1991-1999. Although Red Cross instruction in swimming and water safety is available in almost all communities in Canada, toddlers, children, youths, and adults from the most vulnerable groups do not always participate in the available programs.

Mandatory testing of swimming ability is now a requirement at school entry in some Australian states. Policy makers in Canada should seriously consider the introduction of such testing. Swimming training needs to be provided for all children who are unable to complete an appropriate test.

Children from certain subgroups of the population are often unable to access swimming training. In Australia, it was found that 95% of all children could swim by the age of 11; however, in lower socio-economic levels, only 75% could swim (Nixon et al., 1979). Similarly, in the United States, the risk of drowning in a swimming pool was 15 times greater among black male children 5 to 19 years old than among white children (Brenner et al., 1995). Nevertheless, an encouraging study indicates that well-designed curriculum-based programs for elementary children from disadvantaged backgrounds may be helpful. Children with the lowest baseline scores on safety knowledge and behaviour for various injuries, including drowning, had the greatest improvement in scores from the program (Gresham et al, 2001).

While training should be available for all children, by emphasizing the need to pass a test special emphasis would be directed to more intensive teaching of children of low-income families, immigrants, or other isolated subgroups of the population in order to bring them up to a reasonable standard. Such children might otherwise not receive such training. However, testing of all children should ensure that schools would have to arrange suitable training so that everyone is qualified. Children and caregivers who had had no previous access to swimming and water safety training would probably need more time and attention than those who had already received it.

Fast river currents and alcohol are two major risk factors for swimmers. Safety training for teenagers should emphasize suitable strategies for avoiding and coping with the hazardous situation of river currents. About one-third of swimmers who drown are impaired by alcohol. Hence the feasibility of controls to limit alcohol consumption by swimmers should be assessed, especially for those between 25 and 44 years old. Education also needs to target young males between about 20 and 40.

Both swimmers and boaters need to be aware of the extreme danger of entrapment in recirculating hydraulics at the base of even small dams. Dams need to be made safer by known technical advances (Stairs and Brown, 1998), and access blocked.

DROWNINGS ON OFF-ROAD VEHICLES The issues around snowmobile drownings resemble those for boating, since both involve travel on water/ice. As long as people continue to take risks by travelling at high speed over ice after dark, flotation and protection against hypothermia will be key to prevention of fatalities. Wearing of a flotation garment that also protects against hypothermia should be the norm and mandatory for travel over ice by snowmobile. Mandatory testing with licensing or certification to ensure driver knowledge and competency for current high-speed machines should be introduced, as it is for motorcycles and boats. A special training module for travel on ice could be helpful. There are also design and engineering issues to be resolved. At current top speeds, it is unclear whether existing design of headlights and brakes allow sufficient time to see a hole in the ice in time to stop the machine safely. Newfoundland, Quebec, Ontario, Nunavut, and the Northwest Territories are key regions for prevention of snowmobile drownings.

DROWNINGS IN ON-ROAD VEHICLES Clearly preventable are drownings that result from unsafe barriers on bridges. Most of these drownings occur in regions with a hilly terrain and large numbers of rivers. Quebec and British Columbia are priority regions for prevention by improved legislation for bridge design, and for targeting improvements to existing high-risk areas.

BY SPECIAL HIGH-RISK GROUPS

TODDLERS Sustained attention to four key subcategories could further cut the number of drownings of vulnerable 1-4 year old children in Canada by at least half. These subcategories include pool drownings in Quebec and Ontario, lake drownings in Ontario, bathtub drownings across the country, and drownings of aboriginal toddlers in natural bodies of water.

Virtually no drownings of Quebec and other Canadian toddlers have occurred in pools fitted with automatically self-closing and self-latching gates during 1991-1999. Similar results were found in the state of Victoria, Australia between 1992-1997 (Blum and Shield, 2000). Other studies have confirmed the value of appropriate fencing (Thompson and Rivara, 2000). Isolation as opposed to perimeter fencing is more effective, since otherwise a child can obtain access to the pool via the home. Pool fencing ordinances are only effective, however, if building codes, enforcement, and operation and maintenance by pool owners are effective (Morgenstern et al., 2000).

Hence, the first recommendation includes development, implementation, and enforcement by Quebec provincial and municipal authorities of a model provincial regulation that mandates effective self-closing and self-latching gates for all home pools, especially for above-ground pools with a terrace joining the pool to the home. This will require updating of the municipal norm to include not simply fencing, but also a self-closing and latching device for the gate. If there is direct access to the pool from the home, a similar protective mechanism is needed for doors and low windows that open into the pool area. There was a recent working group in Quebec dedicated to exactly this task, but their recommendations are awaiting approval and implementation by decision-makers. Professionals who work in federal consumer safety also have a role to play in formulating national norms for pool safety.

Insurance vendors can also help in prevention. All home insurance policies should clearly identify whether a pool of any kind is present, and if so, whether it is fitted with a functioning self-closing and self-latching gate. National and provincial building codes may also need to be revised.

Pool vendors should be playing a much greater role in safety. Many large vendors offer an extraordinary variety of pool accessories, with the only exception being safety equipment. Just as automobile

manufacturers were required to supply *all* automobiles with safety equipment, *and not only as an option* for the rich or the safety conscious, *pool vendors should be required to supply pools with essential safety equipment* and ensure that it is installed before the pool is filled. Provision of safety information and equipment by pool vendors needs to be made mandatory. Purchasers of pools should also be required to sign that they have been advised of risks, and that they have been offered a fence with a self-closing and self-latching gate mechanism prior to installation.

Pool vendors should not be allowed to install a pool without also installing a self-closing and self-latching gate. They could be allowed to subcontract this, but should not fill the pool and hand it over to the owner until the area is safe for children occupying the home of the owner and the children of neighbours.

Finally, use of adult bathtubs by younger toddlers (and infants) must be considered a hazardous activity and other safer alternatives considered when designing bathrooms. Otherwise, constant uninterrupted supervision by a parent or other caregiver is essential. Such supervision cannot be replaced by the presence of other slightly older children. A small attractive warning label could be required for all new adult bathtubs, and also be provided to parents in water safety programs and at maternity wards.

YOUTH AND YOUNG ADULTS While drowning rates are lower among 5-14 years olds than toddlers, age-specific rates rise to another peak again at 15-24 years. Unlike younger children, youth and young adults are at significant drowning risk during both swimming and boating. Even university students, who might be expected to be in a more favourable category for risk-taking than the general population, demonstrate high-risk behaviours that put them at significant risk for several of the leading health problems. In the United States, a college risk-behaviour survey found that 30% of students who had gone swimming or boating during the 12 months preceding the survey had consumed alcohol during the activity (MMWR, 1997). Many youth and young adults swim in rivers with current, even near waterfalls and dams, and appear to be uninformed regarding the force of current and the level of risk associated with such locations. Special approaches are needed to reach and to communicate risk for this vulnerable age group.

ABORIGINAL PEOPLES The major target groups in preventing aboriginal drownings are toddlers and adult males. A key to prevention in all aboriginal risk groups would include a major shift in perception of drowning as unacceptable and avoidable, rather than as an inevitable hazard of daily life. For toddlers, the central issue is how to prevent drowning in large natural bodies of water, as well as smaller man-made collections near homes.

For aboriginal adults, wearing of a flotation device at all times while boating and snowmobiling should be a welcome regulatory activity that would make wearing of a flotation device mandatory for all occupants of small boats (Hughes, Sawyer, Barss, Macintyre, 1997).

Nevertheless, community workshops with elders and others will undoubtedly be needed to allow aboriginal peoples the opportunity to reconsider their perception of the preventability of hazards associated with activities that are considered to be "traditional." All aboriginal people, and indeed all Canadians, need to be more fully aware of the tremendous risk of consuming alcohol on, in, or near the water. Model programs developed by the US Indian Health Service and Tribal Governments are reported to have been successful in drowning prevention (Pediatrics, 1999). Essential features of such programs included attention to local sovereignty, as well as unique cultural aspects of health care and communication. Training courses vary from a half-day to a year (Smith et al., 2000).

Fatalistic attitudes towards injury appear to be gradually changing in many countries. In the United States, a national telephone survey revealed that respondents believed that 67% of drownings were preventable (Girasek, 2001). When all Canadians, including indigenous peoples, are convinced that at least 90% of drownings are preventable, truly effective prevention could become a reality and not only a vision.

PERSONS WITH EPILEPSY There has been no improvement in the number of persons with epilepsy who drown each year in Canada during 1991-1999. There were 26 victims during 1996, 24 in 1997, 15 in 1998, and 27 in 1999. This number of preventable deaths is unacceptable, more so because most victims are otherwise healthy young adults between 15-54 years of age. Hence, in economic terms, these deaths represent a substantial loss. Since half of these drownings occur in home bathtubs, the message is clear.

Bathing alone in a standard bathtub for an individual with a seizure disorder is a high-risk activity, whereas taking a shower is much safer. All health workers and families of affected persons should be warned about this hazard on every possible occasion, and information about drowning in bathtubs and other bodies of water, together with other injury risks, should be included in all educational material for new patients. The bathtub warning labels noted above for infants and toddlers could also include a few words about people with epilepsy for similar purposes.

EMERGING PRIORITIES

DIVING INJURIES IN HOME POOLS Although there are relatively few deaths reported from diving, there are about 60 hospitalizations per year in Canada for spinal cord injuries from diving, i.e., about 2 per million population per year. All or nearly all victims of spinal cord injuries from diving develop tetraplegia (Schmitt and Gerner, 2001). Tetraplegia is paralysis of all four limbs from cervical spinal cord injury. This is a devastating injury that cripples for life.

In some countries, diving is now the leading cause of sports-related injury, even at incidence rates somewhat less than we see in Canada (Katoh et al., 1996, Schwarz et al., 2001)

Although hospitalizations for such injuries are not included in the database of the Canadian Surveillance System for Water-Related Fatalities, prevention needs to be highlighted. The author of this report has studied such injuries with one of his students (Djerrari, 1999).

Diving victims are overwhelmingly young males. Lifetime maintenance costs about \$4 million for a 20-year old. Most victims were unaware at the time of their injury of the risk of tetraplegia associated with diving head-first into water. This would provide support to the recommendation of Ontario groups who have advocated mandatory inclusion of diving safety in the school curriculum (Bhide et al., 2000). Nevertheless, any injury prevention measure such as the educational videos proposed by the authors should be carefully evaluated for effectiveness.

In the United States, nearly half of spinal cord injuries from diving occurred during parties and during the victim's first visit to that pool (DeVivo and Sekar, 1997). Nearly all occurred in residential pools and most resulted from ordinary dives.

The injury pattern of untrained casual divers appears to be quite different from that for competitive divers. Injuries of competitive divers are more frequently associated with the entry phase of back and reverse dives from platforms. In competitive divers, the wrist, shoulder, and lumbar spine are the most frequent sites for injury (Rubin 1999).

The research in Quebec has shown that common designs of home pools as currently sold, even with diving boards, put tall divers at risk since the deep ends of most pools are both too shallow and too short. The mass and height of adult males puts them at special risk. Divers strike the ascending slope of in-ground pools. Although most injuries occur at relatively shallow depths, such injuries also affect people who dive into depths of 8 and 9 feet in 30-foot long pools, but strike the ascending slope where the water is much shallower.

Although diving is supposed to be prohibited in above-ground pools, spinal cord injuries continue to occur in such pools. Current warning labels are not much larger than a postage stamp, and too small to be visible under most conditions. Diving safety labels for pools need to be much larger and brighter than for bathtubs and whirlpools, since during parties adults may be standing on a deck well above the edge of the pool, often under conditions of low light levels and limited visibility.

Safer feet-first alternative methods of water entry should be encouraged. Where diving is taught, it is essential that safe diving skills be included in the curriculum (Blitvitch et al., 2000, 1999; Blankensby et al., 1997). Safety practices were reported to include learning to steer up to the surface, head protection with the arms, and only diving when absolutely necessary.

UNDERWATER DIVING Diving with scuba or other gas sources has been qualified as a high-risk sport, with about 3 to 9 deaths per 100,000 divers per year in the United States (Spira 1999). It is stated that about 60% of deaths of divers occurs from drowning and most of the other from pulmonary illnesses.

In Canada, we see each year in the surveillance data on average about 3 or 4 diving deaths from drowning, 4 from air embolism, and 1 from various other causes such as nitrogen narcosis. Some of these deaths occur from panic, rapid ascent, and the resulting barotrauma in inexperienced divers, or dangerous occupational dives among casual sport divers completely untrained for such activity.

Nevertheless, careful review of coroners' enquiries not infrequently reveals extreme risk-taking in experienced divers or instructors. Such individuals would have been expected to know better than to subject their own lives or lives of their students to a risk that frequently appeared to be out of all proportion to the potential pleasure to be derived from such dives, which often involved extreme depth and poor visibility. In fact, extreme divers and their companions would do well to obtain skilled assessment of not only their physical health, but also the psychological (Hunt, 1996).

WHIRLPOOLS/HOT TUBS These devices have become more prevalent, and drownings associated with them took 8 lives during 1996, 4 during 1997, 3 in 1998, and 6 during 1999. Building codes and design standards should include adequate enclosure of such devices to protect children, as for home pools. Another issue to be addressed is how best to design the suction intakes so that they cannot entrap a child or frail adult beneath the surface. Mandatory education of owners prior to purchase about the potential hazards and safeguards of these devices might be helpful. As for pools, vendors are unlikely to provide and emphasize safety information unless it is mandatory to do so. As for bathtubs and pools, appropriate safety warning labeling should be required.

PERSONAL WATERCRAFT These powerful boats have caused considerable controversy because of their high speed, noise, and intrusiveness in rural environments. Nevertheless, there have been few drownings associated with their use; for example, there was only 1 during 1996, 3 in 1997, 4 in 1998, and 2 in 1999, and an average of 2 per year during 1991-1999. On average, personal watercraft accounted for 1.4% of recreational boating drownings during 1991-1999. A small survey in British Columbia indicated that users of personal watercraft more frequently wear a personal flotation device than other boaters (Barss and Masson, 1996). Nevertheless, there are published reports of severe non-fatal injuries among users of such boats (Swinburn, 1996, Hamman, 1993). Since about half of personal watercraft users have been reported ejected from the boat during a collision (Jones, 1999), they are at high risk of propeller injuries from other boats. All outboard motors should be equipped with propeller guards. This safety device, available from outboard motor manufacturers, should be sold as a mandatory safety protection device at the time of purchase. Propeller injuries tend to cause laceration of major arteries, which are followed by rapid death from hemorrhage and shock (MMWR, 1998).

The overall number of trauma deaths from boating collisions from all types of boats averaged 6 deaths per year during 1991-1999. There were an average of 6.3 collisions per year during 1991-1993, 8.7 in 1994-1996, and 5.3 in 1997-1999. If we consider only 1998-1999, the average was 4.0 per year. The number of collision deaths attributed to personal watercraft was 2 in 1995, 5 in 1996, 4 in 1997, 2 in 1998, and 2 in 1999. There was a larger than expected number of deaths from personal watercraft during 1995-1997, which appears to have led to an increase in the number of deaths in boating collisions during that period. Although the numbers are small and these trends need to be confirmed by further observation, there may have been improvement in 1998-1999. Nevertheless, while personal watercraft account for only 1% of boating drownings, they still account for about 50% of trauma deaths from boating collisions. Hopefully new regulations and enforcement for competency of boating that were introduced in 1999 will be helpful in reducing deaths and other fatalities associated with boating collisions. As for motorcycles, which have a high death rate, special licensing requirements are needed for operators of high-speed boats.

CARBON MONOXIDE POISONING IN ENCLOSED BOATS Recreational boaters who use large older boats with enclosed cabins and powered by a gasoline motor have been found to be at increased risk of carbon monoxide poisoning in the United States (Silvers and Hampson, 1995). It is recommended that such boats be fitted with a carbon monoxide detector. Some incidents are fatal, and many more are hospitalized. Of 512

patients treated for unintentional carbon monoxide poisoning in a single US hospital, 8% resulted from recreational boating. Such incidents also occur in Canada, but a systematic review has not been published.

DROWNING AMONG TRAVELERS AND IMMIGRANTS Coroners normally report on drownings within their geographic boundaries. Hence Canadian tourists who drown abroad are not usually included in the annual drowning reporting. Nevertheless, it is important for Canadians to be aware that the two leading causes of death among travelers are now traffic injuries and drowning, not exotic infectious diseases. Tourists may participate in potentially hazardous activities in unfamiliar locations and climate. Appropriate safety equipment may be unavailable and guides or boat operators are not always properly trained. For economic reasons, tourists may be allowed to join group activities for which they are not adequately prepared, trained, or equipped. Alcohol may be abused. Medical examinations to detect disqualifying health conditions such as asthma may be neglected by diving instructors in low-income countries.

In Australia, overseas tourists comprised 25% of all scuba drownings, 18% of surf and ocean drownings, and 5% of all non-boating drownings (Mackie, 1999). In Denmark, foreigners were reported to be at 3 to 4 times greater risk of drowning than Danes (Lindholm and Steensberg, 2000). Even more frequent than deaths among visitors are hospitalizations for water-related injuries. In Australia, in the state of Queensland alone during 1996-1998, there were 296 overseas visitors admitted to hospital for water-related injuries, with an average of two admissions per visitor (Wilks and Coory, 2000). Decompression illness associated with use of diving equipment accounted for 55% of the conditions treated and drowning and non-fatal submersion for 15%.

Immigrants may be at higher risk of death from injury, including drowning both in their new country and while on holiday in their country of origin. In illustration, Turkish and Moroccan child immigrants in Holland had a risk of injury, including drowning, double that of native Dutch children (Schulpen et al., 2001). For these immigrant children, it was found that 25% had died while on holiday in their country of origin.

Hence while travelers and immigrants should not neglect their immunizations, they should also immunize themselves against injury by verifying their fitness before leaving for potentially hazardous activities, and take a well-fitting flotation device with them that is appropriate for projected boating activities. This is especially important in low-income countries where travel in overloaded boats may be especially hazardous and safety equipment unavailable.

DROWNING IN FARM PONDS OR DUGOUTS Most years in Canada, one or more children drown in dugouts or other farm ponds, especially in western Canada. Incidents occur by falls into dugouts or falls through ice. Hutterite colonies appear to be at special risk. In Australia, drowning is the most common fatal farm-related injury among children from 0 to 9 years of age (Mitchell et al., 2001). Appropriate regulations and other interventions are needed for drowning prevention on farms to protect young children of farmers.

DROWNING ASSOCIATED WITH 'ECSTASY' INTOXICATION Ecstasy or PCP has become a popular drug at parties such as 'raves' among the young. During the past several years, a number of drownings in the Canadian surveillance data have been associated with this drug. The victim is usually a young person who enters the water in an intoxicated state. Their histories and statements to survivors or other witnesses prior to death suggest that the victims believed they could do almost anything, even while intoxicated in the water after dark.