Drowning and near drowning among infants and toddlers in Canada, 1991-1998: Trends, incidence, and risk factors.

by

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CONTRIBUTION OF AUTHORS

The topic of the research was proposed by Peter Barss, my thesis supervisor. He also gave me access to the Canadian Surveillance System for Water-Related Fatalities database. Because the database was in Boolean format and not utilizable by usual softwares such as SAS and Excel, I worked several weeks to transform the data. I requested and got access to the Canadian Institute for Health Information through the Graduate Student Access Program. I also got vital statistics from the World Health Statistics and from Statistics Canada. I met with representatives from the Canadian Red Cross Society and Canadian Lifesaving Society. I performed background research on the topic. I developed the analyses in collaboration with Peter Barss, but I conducted them entirely by myself. I obtained statistical advice from Jim Hanley and epidemiological advice from Jean-François Boivin, my committee members. I wrote the text and created the tables and figures. Peter Barss reviewed and corrected the text, tables and figures of the two manuscripts. I interpreted the data in consultation with Peter Barss. I was responsible for the final layout of the thesis.

ABSTRACT

Trends in incidence and risk factors for drowning among infants aged less than 1 and toddlers aged 1 to 4 in Canada from 1991-98 were compared to other injury deaths. Incidence, risk factors and in-hospital mortality of infant and toddler hospitalizations due to near drowning from 1994-98 were compared to other injuries. Drowning rates decreased by 79% among infants, from 1.4 per 100,000 person-years during 1991-94 to 0.3 during 1995-98 ($0.001<p<0.0025$ by χ^2) and by 38% among toddlers, from 3.2 to 2.0 ($p<0.0005$ by χ^2). The rate of near drowning hospitalization among *children aged 0-4* decreased by 30% from 1991-92 to 1997-98 ($0.01<p<0.02$ by χ^2 for trends). Near drowning was the source of 5% of infant and 28% of toddler in-hospital injury deaths in 1994-98. The case-fatality ratio of near drowning hospitalizations was the highest of all injuries with 7% mortality among infants and 12% among toddlers. The decrease in incidence of drowning among infants and toddlers was not paralleled by a similar dramatic decrease in the incidence of other injury deaths in the same period in Canada, nor of near drowning hospitalization, and could be linked to prevention interventions from the Canadian Red Cross Society.

RÉSUMÉ

Les tendances dans l'incidence et les facteurs de risque associés aux noyades au Canada chez les bébé de moins d'un an et les tout-petits de 1 à 4 ans pendant 1991-98 furent comparés aux décès suite aux autres traumatismes. L'incidence, les facteurs de risque et le taux de mortalité intra-hospitalière des hospitalisations suite à des quasi-noyades pendant 1994-98 furent comparés aux autres traumatismes. Entre 1991-94 et 1995-98, le taux de noyade a diminué de 79% chez les bébés, passant de 1.4 par 100,000 personnes-années à 0.3 ($0.001<p<0.0025$ par χ^2), et de 38% chez les tout-petits, passant de 3.2 à 2.0 ($p<0.0005$ par χ^2). Le taux d'hospitalisation suite aux quasi-noyades a diminué de 30% entre 1991-92 et 1997-98 ($0.01<p<0.02$ par χ^2 pour les tendances). Les quasi-noyades ont entraîné 5% des décès à l'hôpital suite à des traumatismes chez les bébés et 28% chez les tout-petits. Le taux de mortalité intra-hospitalière des quasi-noyades fut le plus élevé parmi tous les traumatismes, soit 7% chez les bébés et 12% chez les tout-petits. La diminution de l'incidence des noyades observée chez les bébés et tout-petits n'a pas été accompagnée d'une diminution équivalente des décès reliés aux autres traumatismes, ni des hospitalisations suite aux quasi-noyades et pourrait être reliée à des interventions de prévention de la Société canadienne de la Croix-Rouge.

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To all of you, and to all those that I forget, my most sincere thanks,

Mylène Dandavino

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One of the keys to success in preventing childhood injury is infinite patience.

from Bergman and Rivara, 1991

Sweden's Experience in Reducing Childhood Injuries

CHAPTER 1: General introduction and literature review

This thesis was undertaken to assess trends in the incidence of infant and toddler drowning in Canada during the 1990's. This assessment includes changes in risk factors and new surveillance and prevention programs. Drownings are compared to other injury deaths and to hospitalizations for near drowning and other injuries.

I. THE BURDEN OF DROWNING

A. Mortality from drowning

During the early 1990's, an average of 6 *infants aged less than 1* and 50 *toddlers aged 1 to 4* drowned per year in Canada (*The Canadian Red Cross Society, 1994*). Drowning was the fourth most common cause of injury death among *infants* and the second most common cause among *toddlers* in Canada (*Source: Statistics Canada; The Canadian Red Cross Society, 2000).*

Drowning was the second most common cause of unintentional injury death among *children less than 15* in Australia, the Netherlands, Germany and Japan (*Unicef, 2001*) and the leading cause of unintentional injury death among *children less than 5* in the United States (*Grossman, 2000; O'Flaherty et al, 1997*).

In 1995, male toddler drowning rates in Canada of 1.8 per 100,000 person-years were more than double the United Kingdom and Sweden rates of 0.5 and 0.6 respectively. Rates in Canada were however slightly lower than in Finland, about two thirds those in the United States and about one-third those in Norway, New Zealand and Australia (*The Canadian Red Cross Society, 1994; World Health Statistics,1995*).

B. Morbidity from near drowning

Near drowning occurs when a drowning victim is resuscitated and survives to reach hospital. In Canada, in 1990-1991, for every *child aged less than 5* who drowned, 3.1 others were hospitalized for near drowning (*The Canadian Red Cross Society, 1994*). During 1990-1993, 62% of *toddlers* seen for near drowning in the 15 emergency departments participating in the Canadian Hospital Injury Reporting and Prevention Program were admitted (*CHIRPP database, LCDC, Ottawa, 1994*).

In 1991-1992, the rate of near drowning hospitalization of 8.5 per 100,000 person-years among *toddlers* in Canada was comparable to Finland's rate of 7.6, and more than 3 times higher than Scotland's of 2.3. Canada's rate was however only one-third that of the United States, Australia and New Zealand (*The Canadian Red Cross Society, 1994*).

The severity of complications following near drowning is remarkable in comparison with other injuries. Of all age groups, toddlers were shown to have the lowest rate of survival after near drowning (*Patrick et al, 1979*). It was reported in Australia that 69% of near drowning victims of all ages will have complete neurological recovery, 28% will suffer some selective deficit and 3% will survive in a permanent vegetative state (*Fenner, 2000*). In the United States, some authors have estimated that 93% of near drownings made a full recovery, 1% suffered moderate brain damage, and 6% were left with severe brain damage in a chronic vegetative state (*Zamula, 1987; Hazinski et al, 1993*); others found the consequences of near drowning to be bimodal, with most of the cases either completely recovering or remaining severely disabled due to permanent brain damage (*Wintemute, 1990*). In the United Kingdom, it was reported that 5% of children admitted for near drowning sustained severe neurological deficit (*Kemp and Sibert, 1992*). In California, in 1990, the in-hospital case-fatality ratio among hospitalized victims was as high as 15% (*Wintemute, 1990).*

Even if the outcome of a near drowning can be improved by initiating cardiopulmonary resuscitation immediately at the scene, some studies report that every patient that required CPR developed permanent brain damage and that delayed deaths from near drowning approach the number of deaths from drowning (*Peterson, 1977*).

C. Economic burden of drowning and near drowning

Cost of injury can be divided into direct and indirect costs. *Direct* health costs include expenditures on hospitalization, plus other medical and rehabilitative costs. *Indirect* costs include loss of productivity in the workplace and in the household, including loss of production by family members who forego paid employment to care for people with acute injuries or long-term disabilities (*Barss et al, 1998*).

The economic cost of death can be evaluated by two alternative methods. The *human-capital approach* places a value on human life by estimating future productivity

on the basis of the earning capacity of the individual according to the person's age and sex, calculating loss of productivity years. The *willingness-to-pay approach* values human life based upon estimates of the amount a person would be willing to pay to prevent that death. This latter method is however highly subjective and culture specific (*Barss et al, 1998*).

In Canada, the cost of a paediatric bed stay was approximately $1,350 per day in 1990-1991. As there was an average hospital stay of 6.2 days after a near drowning in male preschoolers aged less than 5 years old and of 3.7 days in females, direct cost estimates for acute hospitalization of infant and toddler near drownings for the fiscal year 1990-1991 were about $1.1 million dollars for both sexes together. Direct costs are however only a small proportion of costs related to drowning and with indirect costs; the total (direct and indirect) cost of each death in this age group was estimated at $2,500,000 (*The Canadian Red Cross Society, 1994*).

In the United States, near drownings result in the most expensive hospitalization of all injuries, with an estimated average direct hospitalization cost of $21,000 US per victim as compared with $20,500 for motor vehicle-pedestrian, $17,600 for motor vehicle-bicycle and $17,400 for unintentional firearm injuries (*Miller et al, 2000*). According to the United States Consumer Product Safety Commission (CPSC), medical costs during the initial hospitalization range from an estimated $2,000 US for a victim who recovers fully to $80,000 US for a victim with severe brain damage sequelae. Some of the severely affected children must stay in the hospital for more than 100 days and then require home care, which costs more than $150,000 US per year. If they live to reach 70 years old, this could mean cost of $10,500,000 US for lifetime care for each victim (*CSPS, 2001*). Estimates from the state of Western Australia indicate that the total (both direct and indirect) costs of drowning among children in 1997 were over $3 million Australian dollars per year (*Royal Life Saving Society, 1997*).

The potential lifetime-worth of production that is lost along with the death of a young person is also a substantial contributor to the economic burden of drowning. In the United States, the total productivity costs due to all types of unintentional injuries to children aged 0 to 19 were estimated at $66.5 billion US in 1996 (*Miller et al, 2001*).

Another important indirect cost associated with childhood injuries is the productivity losses experienced by their caregivers.

Moreover, the loss of a child due to drowning is a heavy price to pay for parents and can result in lifelong emotional stress, anguish, and guilt as well as profound psychological burdens on the family, the siblings, and the marital relationship.

II. TRENDS IN INFANT AND TODDLER DROWNING

Between 1920 and 1950, the drowning rate in children aged 0 to 4 years old in Canada was relatively stable at about 20.0 per 100,000 person-years. Between 1951 and 1990, the rate gradually declined to 3.0 per 100,000 person-years. This rate was stable during 1991 to 1994 at an average of 2.8 per 100,000 person-years, but declined abruptly in 1995 to 1.3 per 100,000 person-years (*The Canadian Red Cross Society, 1994*). It was then stable during 1995-1998 at an average of 1.7 per 100,000 person-years.

In Australia, even though there has been a decrease in drowning among children aged 0-18 since the 1970's, drowning rates in children aged 0-4 have remained relatively static in spite of prevention strategies (*Fenner, 2000; Cass et al, 1991*). In the United States, drowning rates have declined little among children and have actually increased among infants as of 1999 (*Smith and Howland, 1999; Brenner et al, 1994*).

III. RISK FACTORS FOR INFANT AND TODDLER DROWNING

The probability of injury for an individual is affected by several circumstances including: hazardous activities, personal factors, equipment factors, environmental factors and temporal factors. Major *personal* risk factors include age, sex, intoxication, physical and medical factors, occupation, socio-economic status, education, family size and ethnicity. *Equipment* factors include the design of products as well as the use or non-use of safety equipment. *Environmental* factors are both physical and psychosocial and include weather, temperature, rural vs. urban setting, and the presence of a parent or other caregiver. *Temporal* factors include day of the week, time of day, season and climate (*Barss et al, 1998*).

A. Supervision and infant and toddler drowning

In Canada and other similar countries, a substantial proportion of drownings occur during the momentary absence of a caregiver (*The Canadian Red Cross Society, 1994,*

2001; Kemp and Sibert, 1992). Marital disharmony between parents, and the situation where one parent is alone, exhausted or ill ranked high in factors associated with childhood immersion accidents (*Pearn and Nixon, 1977*). Most infant bathtub drownings in Canada occurred when the parent or other caregiver had left the baby alone or with another toddler in the bathtub for just a moment (*The Canadian Red Cross Society, 1994, 2001*).

B. Hazardous activities associated with infant and toddler drowning

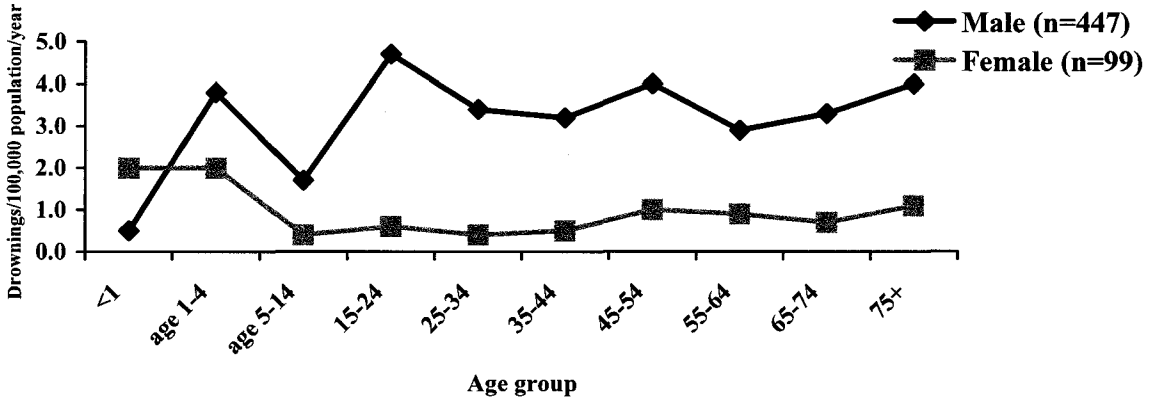
In Canada, in 1991-1992, some 55% of infants drowned during bathing in an adult bathtub. In the same period, 62% of toddler drownings in swimming pools occurred when the child was playing near the water, and 3% when he/she was walking near the water (*The Canadian Red Cross Society, 1994*). In the United States also, the most frequent activity of the toddler before a swimming pool drowning was either playing or walking near the water (*Patrick et al, 1979; Dietz and Baker, 1974*). A young toddler is by nature inquisitive and water offers exciting possibilities, especially if objects are floating on the surface. Reports from Australia and the United States showed that in the majority of pool drownings, the child had been unsupervised for less than five minutes and was not swimming or engaged in any other water-related activities (*Pitt and Balanda, 1991; Wintemute, 1990*).

C. Personal factors for drowning among infants and toddlers

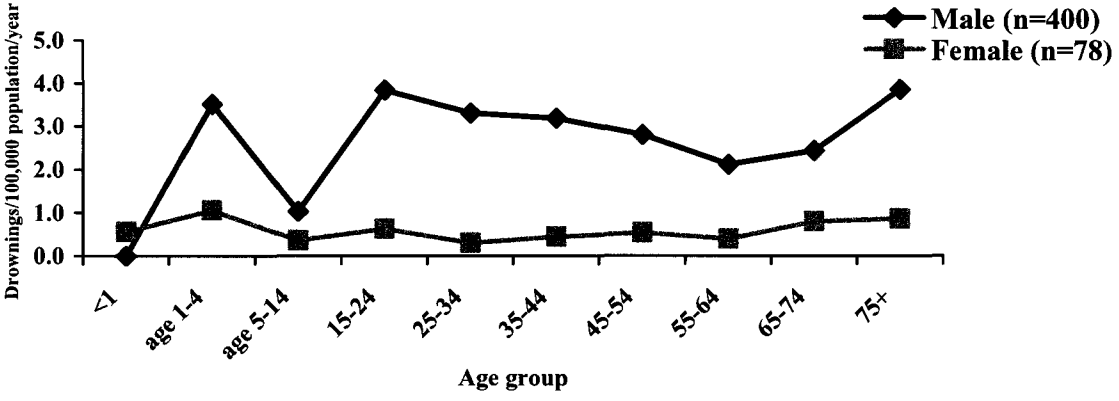
Age and sex are important personal risk factors for drowning. Males have higher drowning rates than females at all ages, including the toddler age, with the exception of infancy when the rates in males and females are similar (*Kemp and Sibert, 1992*). In Canada, female infants were shown to have higher drowning rates than infant males (Fig. 1.1, *The Canadian Red Cross Society, 2000; MacLachlan, 1984*). Possible explanations for this include more frequent exposure to baths, or misreporting of female infanticides as unintentional drowning (*The Canadian Red Cross Society, 1994*). The toddler years is the period during which an individual is at greatest risk for drowning (*Barss et al, 1998*; *Wintemute, 1990; Wintemute et al, 1987; Howland et al, 1996; Hazinski et al, 1993*). In Canada, in 1996, drowning rates were the highest between ages 1 and 4 for both male and female children. This was also the case in Australia where the peak frequency of drowning is at age 2 (*Cass et al, 1991*). Toddlers are at high risk of

Figure 1.1 Rate of drowning by age and sex, Canada, 1991 and 1996

1991 (n=546)



1996 (n=478)



Source: Canadian Surveillance System for Water-Related Fatalities,1993,1998

drowning because they are able to walk but they are unstable and unaware of risks in their environment. They also lack the physical capacity and knowledge to rescue themselves if they fall into the water (*Barss et al, 1998; Quan et al, 1989).*

In the United States, individuals from low-income families have drowning rates 3-4 times higher than individuals from high-income families. The opposite may be true for swimming pool drownings, especially inground pools, as they are often associated with higher income families (*Wintemute et al, 1987; Baker et al, 1987; Dietz and Baker, 1974*). In Canada, especially in Quebec, however, inexpensive above-ground pools are a major cause of pool drownings (*The Canadian Red Cross Society, 2001*). In low-income countries, large family size and reliance on older siblings for supervision of young children have also been noted as risk factors for drowning (*Barss et al, 1998*).

Aboriginal toddlers and infants are known to be at increased risk for drowning. This is probably due to their frequent proximity to open bodies of water and perhaps to other factors such as family size, income, supervision and rural location. Children with seizure disorders were also reported to be at increased risk for drowning, especially in adult bathtubs (*Wintemute, 1990; Diekema et al, 1993*), but in high-income countries, they tend to be older than infants or toddlers (*Barss et al, 1998*; *The Canadian Red Cross Society, 1994*).

D. Equipment factors for drowning among infants and toddlers

1. Bathtubs and swimming pools

Hazards in and around the home account for more than half of the infant and toddler drownings and near drownings (*The Canadian Red Cross Society, 2000*). As infants can drown in less than 1 inch of water, adult-type bathtubs are a particular threat and are in fact the most common site of infant drowning (*Committee on Injury and Poison Prevention, 1993; Hazinski et al, 1993; Pearn et al, 1976*). Children 6 to 12 months old can often sit but may not be able to upright themselves if submerged. Infant bathtub seats are dangerous since they give a false sense of security but can tip over.

Toddlers are at high risk of home swimming pool drowning (*The Canadian Red Cross Society, 2000; Hazinski et al, 1993; Pearn et al, 1976).* The rate of swimming pool drownings among toddlers is many times higher than that of any other age group (*The Canadian Red Cross Society, 1994; Wintemute, 1990; Pitt and Balanda, 1991*). In

Canada, domestic swimming pools were reported in 1994 by the Canadian Red Cross Society to be the single most frequent location of toddler drowning, accounting for 34 out of 96 toddler drownings in 1991 and 1992.

Home swimming pools were also reported to be one of the major dangers for young children in Australia, and were the setting of over 37% of childhood drownings (*Cass, 1991; AIHW, 1998*). In New Zealand, 54% of injury deaths of children under the age of 5 in between 1979 and 1982 occurred in home swimming pools (*Geddis, 1984*). In the United States, emergency departments reported in 1991 about 320 fatal drownings and nearly 2,300 non-fatal near drownings in residential swimming pools among children younger than 5 years (*CPSC, 1991*). Between 60-90% of drownings among children aged 0-4 years occurred in residential swimming pools. Of those, nearly two thirds took place in the child's own home pool and one third in a pool owned by friends or relatives (*Logan et al, 1998*; *CDC, 2001*).

2. Safety equipment

Other important risk factors are safety equipment-related. Of particular importance is the equipment surrounding home swimming pools, such as self-closing, self-latching gates and suitable fences (*Blum and Shield, 2000*; *Logan et al, 1994; Lawson and Oliver, 1978; Fergusson and Horwood, 1984; Nixon et al, 1986; Pearn et al, 1979; Pitt and Balanda, 1991; Geddis, 1984; Horwood et al, 1981).* Recommended fences should isolate the pool from the home and yard and be at least 1.5 meters high (*Hazinski et al, 1993; Wirtz et al, 2001; Pitt and Balanda, 1991; Kemp and Sibert, 1992*).

It is possible that almost all swimming pool drownings of toddlers in Canada, thus one third of all toddler drownings, could be eliminated by installing self-closing and self-latching gates as well as fences around every home pool. In 1991, only 3% of swimming pool drownings in Canada occurred in pools that were reported to be equipped with a self-closing, self-latching gate (*The Canadian Red Cross Society, 1994*). Studies in the United States and in Australia showed that adequate fencing decreased the number of pool drownings and near drownings by more than 50% (*Committee on Injury and Poison Prevention, 1993; Pearn and Nixon, 1977; Milliner et al, 1980; Horwood et al, 1981*). However, according to another study conducted in the

United States, only 19% of pool-related drownings among children less than 5 years old might have been prevented with adequate fencing (*Logan et al, 1994*), an estimate similar to those reported in Australia and New Zealand (*Fergusson and Horwood, 1984*). In Australia, however, the absence of an effective safety gate and fence constituted the single most important cause of childhood immersion accidents, being implicated in 77% of the incidents (*Pearn and Nixon, 1977*).

The wearing of a floatation device was not an important determinant in infant and toddler drownings as, in 65% of the incidents in 1991-92, the child was not undergoing any water-oriented activity but was merely playing or walking near the water (*The Canadian Red Cross Society,1994)*. The fact that most drownings arise from falls or unplanned entries into the water is reflected in United States data, where only 30% of the children who drowned in pools in 1986 were wearing swimsuits (*Wintemute, 1990*).

E. Time factors for swimming pool drowning among toddlers

The swimming pool drowning rate of toddlers is the highest in the afternoon or early evening. It is possible that around dinner time, caretakers are preoccupied with other school-aged children now around and requiring supervision in addition to the meal to prepare, which leaves opportunity for the toddler to wander off unnoticed (*O'Flaherty et al, 1997; The Canadian Red Cross Society, 1994*).

Regions with warmer climate have been associated with higher pool drowning rates *(Quan et al, 1989)*. In Canada, the warmer months of May to August were associated with the majority of swimming pool drownings (*The Canadian Red Cross Society, 1994*).

IV. THE IMPACT OF EDUCATION IN INJURY PREVENTION

Prevention initiatives for children's injuries can be passive or active. *Passive* methods include environment or product modifications that alter the child's physical surroundings. *Active* methods, on the other hand, require that a child or caregiver change his or her behaviour each time the child undergoes the risky activity and include educational and training strategies (*Deal et al, 2000; Hazinski et al, 1993*).

Although infants and toddlers are a high-risk group for drowning, almost all of these drownings should be preventable. Inadequate supervision is a factor in a

substantial proportion of the infant and toddler drownings. Educational strategies for injury prevention in children are based on the premise that when parents and children learn how to prevent injuries, they will alter their behaviour and/or surroundings to do so. The effectiveness of educational campaigns and other so-called "active" measures to prevent injuries is generally assumed to be low compared with other types of interventions, mainly because the link between changes in knowledge and attitudes and changes in behaviour is believed to be weak (*Deal et al, 2000; Schlesinger et al, 1966; Manciaux, 1985; Hazinski et al, 1993; Bass et al, 1993; Munroe et al, 1995*). This opinion is very common among clinicians and may be partly responsible for the limited time they usually allow for injury prevention education in their consultations (*Barkin and Gelberg, 1999; Cohen and Runyan, 1999; Pless, 2000*). Paediatric health care providers should however be encouraged to systematically include time for injury prevention education in their practice as they could potentially play a significant role in preventing child injury (*Hazinski et al, 1993*).

In general, so-called "passive" environmental strategies are the most effective because they provide automatic protection to large groups of people, including those least likely to undertake active measures (*Deal et al, 2000; Barss et al, 1998*). This is the case for children, for whom passive strategies are the most feasible. A successful intervention was the adoption of legislation enforcing fencing of all four sides of home pools in New Zealand and some states of Australia in the 1980's, which led to a significant reduction in the incidence of pool drownings in these regions (*Fergusson, et al, 1984; Nixon et al, 1986*). Implementation of passive strategies can however be complex as it necessitates legal and/or regulatory enforcement as well as support of the public and politicians.

There have, on the other hand, been reports of educational programs that showed reductions in injury morbidity, mortality, and risky behaviour (*Svanström et al, 1995; Nixon et al, 1986; Bennett et al, 1999; Lawson and Oliver, 1978*). One of these is the Seattle Helmet campaign (*Durkin et al, 1999*). Elements associated with successful injury prevention programs were: working through a coalition, a narrow focus, a specific age group, and the use of mass media and coupons to reduce the cost of

whatever safety equipment was targeted (*Bennett et al, 1999; Ellsäber and Berfenstam, 2000; Hazinski et al, 1993; Bergman and Rivara, 1991*).

Progress in community-based injury prevention efforts has also been hampered by the lack of a comprehensive evaluation framework appropriate for such programs (*Pitt and Balanda, 1991*). It is difficult to evaluate the impact of prevention programs, as it is not possible to determine with causal certainty how many events were prevented by their implementation. Moreover, evaluation of outcomes requires large populations an/or long-term studies in order to accumulate enough data to reach clear conclusions.

Education should not be used alone, but integrated with other interventions that ensure passive protection. However, strong education campaigns may prove to be the best start for effective injury prevention programs.

V. ORGANISATION OF THESIS

This thesis is divided into two independent but related chapters, each of which constitutes a manuscript. The principal objective of this work was to investigate trends and risk factors in the incidence of drowning among infants and toddlers between 1991 and 1998 in Canada and a possible association with national drowning surveillance and related prevention programs. In order to evaluate whether the trends were specific to this type of injury death, deaths due to other injuries were also assessed. Chapter 2 presents the trends in incidence and risk factors for drowning among infants and toddlers in Canada between 1991 and 1998. Drownings are also compared with deaths from other injuries. Chapter 3 presents the trends in incidence and in-hospital mortality for near drowning hospitalizations among infants and toddlers in Canada from 1994 to 1998. Hospitalizations due to near drowning are compared with hospitalizations for other injuries.

CHAPTER 2:
Drowning among infants and toddlers in Canada, 1991-1998: Trends in incidence and risk factors.

Drowning among infants and toddlers in Canada, 1991-1998: Trends in incidence and risk factors.*

Mylène Dandavino, Peter Barss

I. ABSTRACT

Objectives: To investigate the trends in incidence and risk factors for drowning among infants aged less than 1 and toddlers aged 1 to 4 in Canada from 1991 to 1998 in comparison to other injury deaths and in the light of prevention activities led by the Canadian Red Cross Society in the 1990's.

Methods: Using data from the Canadian Surveillance System for Water-Related Fatalities, the 28 infant and 321 toddler drownings that occurred in Canada between 1991 and 1998 were examined. Statistics Canada Vital Statistics for 1991 to 1997 were also used to compare drownings to other injury deaths. The principal risk factors examined were type of body of water and region where the drowning took place.

Results: Between 1991-94 and 1995-98, drowning rates in Canada improved by 79% among infants, from 1.4 per 100,000 person-years during 1991-94 (n=23) to 0.3 during 1995-98 (n=5) ($0.001<p<0.0025$ by χ^2). The improvement in infant drowning rates resulted from the near elimination of bathtub drownings. Among toddlers, drowning rates decreased by 38%, from 3.2 per 100,000 person-years during 1991-94 (n=195) to 2.0 during 1995-98 (n=126) ($p<0.0005$ by χ^2). The improvement in toddler drowning was greatest among swimming pool drownings. Of the pool drownings among toddlers, 46% occurred in inground pools, 27% in above ground pools, and 27% in pools of unspecified type.

The average rate of injury deaths excluding drowning decreased by 13% among infants, from 14.3 per 100,000 person-years during 1991-94 (n=231) to 12.5 during 1995-97 (n=138) ($0.20<p<0.25$ by χ^2) and by 14% among toddlers, from 9.1 (n=556) to 7.8 (n=364) ($0.025<p<0.05$ by χ^2). Fire/burns deaths were the only injury deaths apart from drowning showing statistically significant improvement, with the rate among infants decreasing by 75% from 0.8 per 100,000 person-years during 1991-94 (n=13) to

* Manuscript to be submitted to an injury prevention or public health journal

0.2 during 1995-97 (n=2) ($p<0.0005$ by χ^2), and by 48% among toddlers, from 2.1 (n=131) to 1.1 (n=52) ($0.025<p<0.05$ by χ^2).

Conclusion: There was a significant decrease in infant and toddler drowning rates in Canada between 1991-94 and 1995-98. The drop in drowning rates was not associated with a decrease of similar magnitude of other injury deaths in Canada. The timing of this decrease to the years after the implementation of nation-wide surveillance based prevention programs targeting infants, toddlers and their caregivers by the Canadian Red Cross Society and other organisations suggests that such programs may have been effective in reducing the incidence of drowning among infants and toddlers in Canada.

II. INTRODUCTION

Drowning was the second most common cause of injury death among toddlers in Canada between 1991 and 1998 (*The Canadian Red Cross Society, 2000; Statistics Canada*).

Between 1920 and 1950, the drowning rate of children aged 0 to 4 years old in Canada was relatively stable at about 20.0 per 100,000 person-years. Between 1951 and 1990, the rate gradually declined to 3.0 per 100,000 person-years. The rate was stable at about 2.8 during 1991 to 1994, but declined abruptly in 1995 to 1.3 per 100,000 person-years (*The Canadian Red Cross Society, 1994, 2000*). The rate remained relatively stable during 1995-98 at 1.7 per 100,000 person-years.

In this paper, we present a detailed analysis of trends in the incidence of drowning in Canada between 1991-94 and 1995-98 among infants and toddlers. We also describe certain risk factors for drowning in these age groups, including type of body of water and geographical region. We also assess trends in these risk factors. We use data from the Canadian Surveillance System for Water-Related Fatalities, which is based upon coroner and police reports for all provinces and territories. This report also uses vital statistics to examine the trends in deaths due to other injuries during the 1990's.

In light of these trends, we consider the association between the improvement in infant and toddler drowning rates in the mid 1990's and prevention activities introduced at that time by the Canadian Red Cross Society. New national safety standards and new

community water safety and training programs for both children and parents were introduced and existing programs revised. A prevention program consisting in the diffusion of radio and television commercials, press releases and distribution to authorized providers of packages containing posters, interactive information cards, fact sheets and colourable cartoons, was launched. For the first time, it focused on key modifiable risk factors, and involved to a greater extent parents and other caregivers.

III. METHODS

This study was a longitudinal assessment of the incidence of drowning and of the risk factors for drowning among infants and toddlers in Canada, for calendar years 1991 through 1998, both yearly, and in tow periods of 4 years each, corresponding to the "pre" and "post" Canadian Red Cross Society program. We also assessed trends in the incidence of other injury deaths in these age groups. All unintentional drownings that took place in Canada among infants and toddlers between 1 January, 1991 and 31 December, 1998 were included in this study. Data were obtained from two different sources, the Canadian Surveillance for Water-Related Fatalities and Statistics Canada.

The incidence and risk factors for drowning were obtained from the database of the *Canadian Surveillance System on Water-Related Fatalities*. This database is updated annually since its creation in 1992. It covers all provinces and territories and is based upon systematic review of coroners' and police reports for all unintentional drownings and other water-related fatalities. In Canada, a coroner investigates all drownings. Structured questionnaires are completed by volunteers. They are then verified and corrected centrally by trained professionals. Only unintentional drownings were included in this study as they were the drownings targeted by water safety prevention programs. No observations were because of missing data. The final dataset contained information on 28 infant and 321 toddler drownings.

Mortality data for other injuries were those published yearly by *Statistics Canada* in Catalogue No. 84-208-XPB Causes of death for years 1991-1997. At the time this thesis was prepared, data for 1998 were not available. These 1991-1997 data are based upon death certificates completed by physicians. Death certificates are mandatory in Canada. The Statistics Canada dataset extracted by the first author from this catalogue pertains to deaths from injury in 395 infants and 1188 toddlers; it

includes unintentional drownings of 26 infants and 268 toddlers. This database was also used to validate the number of drownings in the Canadian Surveillance System for Water-Related Fatalities database.

Descriptors studied included the type of body of water and the province in which the drowning occurred. These were chosen in order to attempt to characterize any observed changes in drowning rates. The most frequent types of body of water involved in drowning incidents were swimming pools; bathtubs; lakes, ponds and reservoirs; and rivers. Due to the low numbers of events in less populous provinces, Newfoundland, Prince Edward Island, Nova Scotia, and New Brunswick were considered together as the Atlantic provinces for the analyses. The same was done for Manitoba, Saskatchewan and Alberta, referred to as the Prairies, and for the Northwest Territories (NWT) and Yukon. The latter region includes what is now known as the Nunavut.

Denominators for rate calculations were based upon national census data published by Statistics Canada. We used the age-group specific 1991 census population for years 1991 to 1994 and the 1996 census for years 1995 to 1998, presuming that the true population size for 1995 is closer to the 1996 than to the 1991 population. Intercensal projections for 1992 to 1995 were not used because they overestimated the infant and toddler population. Regional populations of infants and toddlers were calculated using the average of the 1991 and 1996 census data. For pre- and post-program rates, denominators were the total number of person-years from 1991 to 1994 and from 1995 to 1998.

Causes of death were classified using the *ninth version of the International Classification of Diseases (ICD-9).* Injury deaths were grouped in the following categories: traffic injury (E800-807, E833-848), poisonings (E852-858, E860-869), falls (E880-888), choking (suffocation) (E911-915), fire/burns (E890-899 and E924), and injuries due to assault/neglect of the child (E960-969 and E904). All other unintentional injuries were grouped in a category designated as "Other". This category included: injuries due to natural and environmental factors (E900-909), late effects of injury (E929), injuries classified under Other accidents (E916-928) and injuries undetermined whether accidentally or purposely inflicted (E980-989). Deaths due to iatrogenic causes

were excluded (E870-879, E930-949). There were no suicides among infants and toddlers in this period.

A research report on infant and toddler drowning was published by the Canadian Red Cross Society in 1994 (*The Canadian Red Cross Society, 1994*). Surveillance and evidence-based prevention activities were introduced shortly afterwards, as were the development of newly developped national water safety and swimming programs. We obtained information on these revisions and on other new drowning prevention programs in Canada during the study period through meetings with the Canadian Red Cross Society and the Lifesaving Society. Because of these new interventions, 1994 was used as the dividing point to separate the pre- and post-program periods.

Chi-square analysis was performed to compare drowning rates in the pre- and post-program periods i.e. 1991-94 and 1995-98. The null hypothesis tested was that the numbers of drowning in the two periods were proportional to the person-years in the two periods. The number of degrees of freedom was 1. An α error of 0.05 was used to determine statistical significance.

IV. RESULTS

A. Trends in drowning and other injury deaths among infants and toddlers

-Drowning-

As reported in the Canadian Surveillance System for Water-Related Fatalii\ties, there were 28 *infant* and 321 *toddler* drownings in Canada between 1991 and 1998 (Table 2.1). Among *infants*, drowning was the cause of 7% of injury deaths, fourth after choking (31%), assault/neglect (21%) and traffic injuries (18%) (Fig. 2.1). Among *toddlers*, drowning was the cause of 24% of injury deaths, second only to traffic injuries which account for 31%.

From 1991-94 (pre-program) to 1995-98 (post-program), among *infants*, the drowning rate decreased from 1.4 (n=23 events) per 100,000 person-years to 0.3 (n=5 events), a 79% decrease ($0.001<p<0.0025$ by χ^2, Fig. 2.2). The drowning rate among *toddlers* decreased from 3.2 (n=195 events) per 100,000 person-years to 2.0 (n=126 events) during the same period, a decrease of 38% ($p<0.0005$ by χ^2). Data from 1999 indicate that the improvement in drowning rates of infants and toddlers has been maintained (0.0 per 100,000 person-years among infants and 1.6 among toddlers).

-Other injuries-

For the period 1991 to 1997, Statistics Canada reported 395 infant and 1188 toddler deaths from injury other than drowning in Canada. These included 26 infant and 268 toddler unintentional drownings (Table 2.2) (Note that the period of study for injury deaths (1991-1997) differs slightly from the period of study of drowning deaths (1991-1998)).

Among *infants*, the average rate of injury deaths excluding drowning was 14.3 per 100,000 person-years during 1991-94 (n=231) and 12.5 during 1995-97 (n=138), a decrease of 13% ($0.20<p<0.25$ by χ^2, Fig. 2.3), which is not statistically significant. Among *toddlers*, the rate was 9.1 per 100,000 person-years during 1991-94 (n=556) and 7.8 during 1995-97 (n=364), a statistically significant decrease of 14% ($0.025<p<0.05$ by χ^2).

Significant reductions were also seen in the rates of deaths caused by fire/burns (Fig. 2.4). Among *infants*, the rate of fire/burns deaths was 0.8 per 100,000 person-years during 1991-94 (n=13) and 0.2 during 1995-97 (n=2), a statistically significant decrease of 75% ($p<0.0005$ by χ^2). Among *toddlers*, the rate was 2.1 per 100,000 person-years during 1991-94 (n=131) and 1.1 during 1995-97 (n=52), a statistically significant decrease of 48% ($0.025<p<0.05$ by χ^2).

B. Incidence of drowning among infants and toddlers by type of body of water

1. Bathtubs and infant drowning

The great majority (75%) of *infant* drownings in Canada occurred in bathtubs (Fig. 2.5). Infant bathtub drowning rates decreased from 1.1 per 100,000 person-years between 1991-94 (n=16) to 0.3 between 1995-98 (n=5), a statistically significant decrease of 73% ($0.025<p<0.05$ by χ^2, Fig. 2.11).

Bathtubs were the main setting for infant drowning in each of the Canadian regions, except for the Prairies and the Territories (Fig. 2.9). Only 2 bathtub incidents occurred in each of these regions. The 1991-98 national average rate of bathtub drowning was 0.7 (n=21). The 1991-98 bathtub drowning rate were 6.4 per 100,000 person-years in the Northwest Territories/Yukon (n=1), 1.1 in British Columbia (n=4), 0.8 in the Atlantic region (n=2), 0.7 in Ontario (n=8), 0.7 in Quebec (n=4), and 0.2 in the Prairies (n=1).

2. Swimming pools and toddler drowning

The most frequent settings for *toddler* drownings in Canada from 1991 to 1998 were: swimming pools (all types), 34% (n=109); lakes, ponds and reservoirs, 29% (n=92); and rivers, 15% (n=50) (Fig.2.5).

Swimming pool drowning rates decreased by 36%, from 1.1 per 100,000 person-years during 1991-94 (n=69) to 0.7 during 1995-98 (n=40) ($0.005<p<0.025$ by χ^2), which is statistically significant. Ontario's toddler pool drowning rate decreased by 45% from 1.1 per 100,000 persons during 1991-94 (n=25) to 0.6 during 1995-98 (n=13) ($0.025<p<0.05$ by χ^2), and Quebec's by 29% from 2.1 (n=30) to 1.5 (n=22) ($p=0.2$ by χ^2, Fig. 2.14).

Of Quebec toddlers who drowned between 1991 and 1998, 64% (52/81) did so in swimming pools, as compared to 38% (38/101) in Ontario, 25% in British Columbia (10/40), 21% in the Atlantic region (4/19) and 7% in the Prairies (5/74) (Fig. 2.9). No pool drownings occurred in the Northwest Territories/Yukon region.

Of the swimming pool drownings in Canada, 47% (n=52) occurred in Quebec and 35% (n=38) in Ontario. These provinces account for 23% and 37% of the toddler population respectively (Fig. 2.12). Swimming pool drowning rates were 1.8 per 100,000 person-years in Quebec, 0.8 in Ontario, 0.7 in British Columbia, 0.4 in the Atlantic region and 0.2 in the Prairies. The national average was 0.9 (Fig. 2.13).

From 1993-98, in Canada, 46% of the pool drownings occurred in above ground pools, 27% in inground pools and 27% in pools of unspecified type. In Quebec, however, 64% of the incidents occurred in above ground, 17% in inground pools and in 18% the type of pool was unspecified (Fig. 2.15). In Ontario, the corresponding proportions were 29%, 33% and 38% respectively.

3. Lakes, ponds and reservoirs and toddler drowning

This category includes the major large bodies of water. "Lake" will hereafter also include ponds and reservoirs. In Canada, toddler lake drowning rates decreased from 0.9 per 100,000 person-years during 1991-94 (n=55) to 0.6 during 1995-98 (n=37), a decrease of 33% ($0.05<p<0.10$ by χ^2, Fig. 2.17). However, the only statistically significant reduction in the rate of lake drowning occurred in British

Columbia, with the rate falling from 1.1 per 100,000 person-years in the pre-program (n=8) to 0.3 in the post-program period, a decrease of 73% (n=2, $0.025<p<0.05$ by χ^2).

The average rate of lake drowning for 1991-98 for Canada was 0.7 per 100,000 person-years. This rate was 1.6 per 100,000 person-years in the Territories (n=1), 1.3 in the Prairies (n=30), 0.8 in Ontario (n=35), 0.7 in British Columbia (n=10), 0.6 in the Atlantic provinces (n=6), and 0.4 in Quebec (n=10) (Fig.2.16).

4. Rivers and toddler drowning

Some 50 *toddlers* drowned in rivers across Canada from 1991 to 1998. The average rate of river drowning among toddlers for all Canada was 0.5 per 100,000 person-years for 1991-94 (n=30) and 0.3 for 1995-98 (n=20) ($0.10<p<0.15$ by χ^2, Fig. 2.19); this is not a statistically significant reduction.

The national rate of toddler river drownings was 0.4 per 100,000 person-years. The regional rates were 1.6 per 100,000 person-years in the Northwest Territories/Yukon (n=1), 0.6 in the Prairies (n=15), 0.6 in British Columbia (n=9), 0.3 in Quebec (n=9), 0.3 in Ontario (n=14) and 0.2 in the Atlantic provinces (n=2) (Fig. 2.18). There were no significant changes in rates between 1991-94 and 1995-98 in any of the regions.

C. Region-specific trends in drowning among infants and toddlers

Among *infants*, the drowning rates in Ontario were 1.3 per 100,000 person-years during 1991-1994 (n=8) and 0.2 during 1995-1998 (n=1), a statistically significant improvement of 85% ($0.02<p<0.05$ by χ^2, Fig 2.7). In Quebec, rates fell from 1.3 (n=5) to 0.3 (n=1), a large but not statistically significant reduction of 77% ($0.10<p<0.15$ by χ^2, Fig. 2.8).

Among *toddlers*, the drowning rate fell from 3.8 per 100,000 person-years during 1991-1994 (n=27) to 1.7 during 1995-1998 (n=13) in British Columbia, a statistically significant reduction of 55% ($0.01<p<0.02$ by χ^2), from 3.1 (n=69) to 1.5 (n=34) in Ontario, a statistically significant reduction of 52% ($p<0.0005$ by χ^2), and from 3.4 (n=48) to 2.3 (n=33) in Quebec, a non statistically significant reduction of 32% ($0.05<p<0.10$ by χ^2). The other regions showed no statistically significant improvement.

During 1991-98, the average drowning rate among *infants* by region was: 19.2 per 100,000 person-years in the Northwest Territories/Yukon (n=3), 1.7 in the Atlantic

provinces (n=4), 1.1 in British Columbia (n=4), 0.8 in Quebec (n=6), 0.8 in Ontario (n=9), and 0.4 in the Prairies (n=2).

Among *toddlers*, the 1991-98 average drowning rates were 6.3 per 100,000 person-years in the Northwest Territories/Yukon (n=4), 3.2 in the Prairies (n=74), 2.8 in Quebec (n=81), 2.8 in British Columbia (n=40), 2.2 in Ontario (n=103) and 2.0 in the Atlantic provinces (n=19).

V. DISCUSSION

Relative importance of infant and toddler drowning in Canada

Between 1991 and 1997, in Canada, drowning was the fourth most common cause of *infant* injury death after choking, assault/neglect and traffic injuries, and the second most common cause of *toddler* injury deaths after traffic injuries. The Canadian Surveillance System for Water-Related Fatalities reported 28 infant and 321 toddler drownings between 1991 and 1998 across the country. The average rate of drowning for all of Canada for 1991-98 was 0.9 per 100,000 person-years among infants and 2.6 among toddlers.

We compared data from the Canadian Surveillance System for Water-Related Fatalities (CSSWRF) with Canadian vital statistics to detect differences in the reporting of infant or toddler unintentional drowning between these databases. Statistics Canada infant drowning numbers for years 1991 to 1997 were: 3, 7, 7, 4, 0, 2, 3 compared with 5, 7, 6, 5, 0, 1, 2 (CSSWRF). Statistics Canada toddler drowning numbers for years 1991 to 1997 were: 42, 45, 50, 45, 27, 33, 26 compared with 49, 50, 50, 46, 25,36, 29 (CSSWRF). It is known in the United Kingdom that death registration significantly misclassifies the year of death, often because of pending inquests (*DiGuiseppi et al, 1997*), and this may in part explain the different yearly totals. In Canada, there are frequent delays in closing coroners' files, which can result in deaths being reported a year late.

Trends of infant and toddler drowning in Canada

Canadian *infant* drowning rates decreased by 79% between 1991-94 and 1995-98, from 1.4 per 100,000 person-years to 0.3 ($0.001<p<0.0025$ by χ^2). *Toddler* drowning rates decreased by 38%, from 3.2 to 2.0 in the same period ($p<0.0005$ by χ^2). Both these changes were highly statistically significant. Unpublished data from the Canadian

Surveillance System for Water-Related Fatalities indicate that these low rates were maintained in 1999 (0.0 per 100,000 person-years among infants and 1.6 among toddlers) (*Canadian Red Cross Society, 2001, in press*). The improvement in drowning rate was seen all across Canada for infant drownings, and more particularly in Quebec, Ontario and British Columbia for toddler drownings.

Canada in comparison with other high-income countries regarding drowning among infants and toddlers

Drowning has a comparable importance in other high-income countries and in Canada regarding infant and toddler mortality. In New Zealand, during 1990-94, drowning was the fourth most common cause of fatal injury among infants and second among toddlers. Drowning was also the second most common cause of unintentional injury death among children less than 15 in Australia, the Netherlands, Germany, Japan (*Unicef, 2001*) and in the United States (*Grossman, 2000; O'Flaherty et al, 1997*). It must be kept in mind, however, that some of these countries differ from Canada with respect to the distribution of the various types of body of water and to the length of the swimming season.

From 1991 to 1994, drowning rates among infants and toddlers in Canada were higher than other comparable countries, such as England with 0.7 per 100,000 person-years, Sweden with 1.2 and Scotland with 1.6 (*The Canadian Red Cross Society, 1994*). In Sweden, Finland, Denmark, Norway and New Zealand, less than 1 infant drowned per year from 1990 to 1994 and the yearly number of toddler drownings varied between 5 and 9 (*Source: World Health Statistics Annuals, 1991 to 1994*).

With the rates attained since 1995, infant and toddler drowning rates in Canada of 0.3 per 100,000 person-years and 2.0 respectively are now comparable to, and even lower than many other high-income countries. In Australia, drowning rates for infants in 1996 were 3.1 per 100,000 population for males and 2.4 for females, while for toddlers they were 5.6 for males and 4.5 for females (*AIHW, 1998*). However, Australia has a warmer climate and thus a longer exposure to swimming pools, and Canada may be more comparable to more northern countries. Drowning rates in Canada for 1995-98 are still higher than the 1995 United Kingdom rates of 1.2 per 100,000 person-years among

infants and 0.5 among toddlers and than the 1995 Sweden rates of 0.0 among infants and 0.6 among toddlers (*World Health Statistics, 1995*).

The improvement in infant and toddler drowning rates during the 1990's seems to be specific to Canada. In Australia, it was reported that despite prevention strategies, drowning rates in young children aged 0-4 have remained relatively static (*Fenner, 2000*). Drowning rates among children aged 0 to 4 years old have been decreasing in the United States during the past 20 years (*Grossman, 2000; Cummings and Quan, 1999*), but no reduction was seen in the mid-1990's as it was seen in Canada. The drowning rate of U.S. infants is even reported to have increased as of 1999 (*Smith and Howland, 1999; Brenner et al, 1994*).

Trends in infant and toddler injury death in Canada and in comparison to other countries

The average mortality rate due to all unintentional and intentional injuries other than drowning decreased by 13% among infants, from 14.3 per 100,000 person-years during 1991-94 to 12.5 during 1995-97 ($0.20<p<0.25$ by $\chi 2$), and by 14% among toddlers, from 9.1 to 7.8 ($0.025<p<0.05$ by $\chi 2$). Fire/burns deaths were the only other injury deaths showing statistically significant improvement, with the rate among infants decreasing by 75% from 0.8 per 100,000 person-years during 1991-94 to 0.2 during 1995-97 ($p<0.0005$ by $\chi 2$), and by 48% among toddlers, from 2.1 to 1.1 ($0.025<p<0.05$ by $\chi 2$).

This is consistent with the decrease of 12% in unintentional injury incidence and death that has been observed in Canada for every age group and for nearly all causes of injury (*CIHI, 2001*). The average rate of injury death among children less than 15 in the most populous OECD member countries decreased from 22.8 per 100,000 person-years in 1971 to 11.5 in 1995 (*Unicef, 2001).* A decrease in the number of childhood injury deaths is also reported in the United States *(Deal et al, 2000*).

Canada is comparable to countries such as Denmark and Belgium where the rates of toddler injury death were respectively 9.1 and 9.8 per 100,000 person-years in 1991-95, but still must continue its efforts to equal countries such as Sweden and United Kingdom where the injury death rates were 5.6 and 7.3, respectively, the lowest in the world (*Unicef, 2001*).

Major sites for infant and toddler drowning in Canada

a. Bathtubs and infant drowning

Bathtubs were the setting of 75% of the infant drownings in Canada from 1991 to 1998. This is similar to estimates from New Zealand where it was reported that 68% of the drownings and near drownings in the first year of life occurred in the household bath (*Geddis, 1993*). Bathtubs are widely known to be the main threat for drowning among infants (*Committee on Injury and Poison Prevention, 1993; Hazinski et al, 1993; Pearn et al, 1976*). In Canada, 18% of bathtub victims were infants and toddlers. Most of the other bathtub drownings involved individuals 15 and older who suffer from conditions that lead to loss of consciousness, such as epilepsy (*Canadian Red Cross, 1994,2000*).

It is estimated that in the United States between 7% and 27% of supposedly unintentional injury deaths of young children were in reality due to abuse or neglect, and that this is frequent with infant bathtub drownings (*Deal et al, 2000; McClain et al, 1993; Kemp et al, 1994; Lavelle et al, 1995*). In Canada, known intentional drownings are excluded from the Canadian Surveillance System for Water-Related Fatalities.

Infant bathtub drowning rates decreased from 1.1 per 100,000 person-years during 1991-94 to 0.3 during 1995-98 for Canada, a statistically significant reduction of 73% ($0.025<p<0.05$ by χ^2). There is no reason to believe that the number of bathtubs or number of baths taken per capita has changed during these two periods.

b. Swimming pools and toddler drowning

From 1991 to 1998 in Canada, 34% of the toddler drownings occurred in swimming pools. The fact that toddlers are at high risk of swimming pool drowning is widely recognized (*Hazinski et al, 1993; Pearn et al, 1976; Wintemute, 1990; Pitt and Balanda, 1991).* Domestic swimming pools were reported to be the setting of over 37% of childhood drownings in Australia (*Cass, 1991; AIHW, 1998*), and of 54% of drownings among children under the age of 5 in New Zealand (*Geddis, 1984*). However these countries have a warmer climate and the exposure of toddlers to pools is longer than in Canada.

Of the Canadian pool drownings, 47% (52/109) occurred in Quebec. In that province, 62% of toddler drownings occurred in swimming pools, which is strikingly

higher than the comparable 38% in Ontario and than the Canadian average of 34%. Quebec's toddler swimming pool drowning rate of 1.8 per 100,000 person-years was twice the national average of 0.9. This is at least in part due to higher prevalence of swimming pools per capita in Quebec in comparison to other provinces.

Above ground pools are a major cause of drowning in Quebec where 64% of toddler drownings occurred in such pools, as compared to 29% in Ontario. However, in 38% of the incidents in Ontario and in 18% of those in Quebec, the type of pool was unspecified, so the total involvement of above-ground pools may be much higher in both provinces. The type of pool was not systematically reported in the Canadian Surveillance System for Water-Related Fatalities questionnaires before 1993, and is not included in many police and coroner reports.

Pool vendors estimated that, in 2001, the ratio of sales of above to inground pools was about 4:1 in Quebec but only 2:1 in Ontario. This is in part due to the fact that while the cost of inground pools is around $15,000-20,000 in both provinces, in Quebec, above ground pools cost between $2,500 and $4,500 while they cost between $4,000 and $7,000 in Ontario. Above-ground pools often are directly accessible from the home by an elevated deck, and it may be easier for toddlers to enter the pool deck, get close to the water and tumble in.

In 1998, among toddlers, swimming pool drowning occurred most commonly after the child fell into the water while playing or walking near the water, at a rate of 1.6 per 100,000 person-years (*The Canadian Surveillance for Water-Related Fatalities, 2000*). Between 1991-98, 68% of toddler pool drownings occurred during the week, but the most frequent days were Fridays and Saturdays with 21% and 20% of the toddler swimming pool drownings respectively. The most frequent months of toddler pool drownings were June, July, August and May with 27%, 27%, 19% and 10% respectively.

Factors associated with the decrease in infant and toddler drowning in Canada between 1991-1994 and 1995-1998

a. The Canadian Surveillance System for Water-Related Fatalities

The decline in the drowning rates of infants and toddlers in Canada was observed the year that followed the 1994 release of the Canadian Red Cross Society's

Special Research Report on toddler drowning (*The Canadian Red Cross Society, 1994*). This report had been rendered possible because of data collection by the Canadian Surveillance System for Water-Related Fatalities. This surveillance system, unique to Canada, is based upon systematic review of coroners' and police reports for all drownings and other water-related injuries. Collaborators include The Canadian Red Cross Society, Lifesaving Society, a team of public health/university researchers, the National Association of Coroners and the Canadian Coast Guard. This surveillance program was created for monitoring both incidence and circumstances of different types of water-related fatal unintentional injuries, including major subcategories of types of drownings. The results are published in annual surveillance reports and special research reports. The Canadian Surveillance System for Water-Related Fatalities offers Canada a unique source of data and knowledge about the incidence of all categories of drownings as well as the characteristics of individuals, equipment, and environments that are associated with increased drowning risk. The System became operational in 1993 with the first general reporting for 1991 data.

b. The Canadian Red Cross Society prevention activities

Based on the surveillance and research reports published in 1993 and 1994 and on modern principles of injury control, swimming and water safety manuals across the country were extensively revised in 1994-95. New national safety standards and new community water safety and training programs for both children and parents were introduced and existing programs revised. Estimates from 1996 indicate that 300,000 toddlers and their parents and other caregivers participate each year in the Canadian Red Cross parent-toddler swimming classes (*Canadian Red Cross national office, personal communication, 2001*).

Also based on these findings, a national mass media-led prevention program was introduced in 1994 by the Canadian Red Cross Society under the theme *WaterWatch*. For the first time, this program focused on key modifiable risk factors, and involved to a greater extent the parents and other caregivers. Some of the components of the program were the diffusion of radio and television commercials, press releases and distribution to the authorized providers of packages containing posters, interactive information

cards, fact sheets and cartoons to be coloured by the children. Among the authorized providers were 90% of the public pools in Canada.

This surveillance and prevention program thus included several of the components that have been reported to be efficient for injury prevention i.e. working through a coalition, a narrow focus, a specific age group and use of mass media to disseminate the prevention message (*Bennett et al, 1999; Bergman and Rivara, 1990; Hazinski, 1993; Ellsäber and Berfenstam, 2000*).

The timing of the decrease in infant and drowning rates observed in Canada to the year after the implementation of these interventions suggests that this researched-based program may be partly responsible for this decrease. Moreover, the fact that the decrease has been sustained from 1995 to 1999 shows that it may continue to be effective.

Limitations

Even if the temporal association is strong, it is not possible to prove that the prevention activities of the Canadian Red Cross Society and/or of other organizations are causally linked to the decreasing trends in drowning in Canada seen between 1991 and 1998. However, to our knowledge, no other changes were implemented during the critical period that could have led to such an improvement in drowning rates. The coding or investigation of drownings did not change. It is possible that there might have been incomplete data collection by some provincial coroners' offices. The drowning numbers were however validated with Statistics Canada vital statistics data from death certification, and there was no underreporting in the Canadian Surveillance for Water-Related Fatalities database in these age groups.

There were no modifications in the emergency protocols across the country that could have led to an increased effectiveness of the emergency care system. Moreover, there is evidence that medical care plays little role in downward trends in drownings (*Smith et Howland, 1999; Cummings et Quan, 1999*).

One reason that has been suggested for the decreasing mortality due to drowning in the United States is the migration of the population away from bodies of water (*Cummings et Quan, 1999*). Although it is possible that the long-term decrease in

drowning in Canada may have been affected by such migration, it is unlikely that there was a massive migration around 1994-1995 in Canada.

It is also unlikely that the bodies of water implicated in the majority of infant and toddler drownings, i.e. bathtubs and swimming pools, have become intrinsically safer, as no specific legislations were introduced around that time. Swimming pool regulations are implemented and enforced at a municipal level. However, the provincial norm for swimming pools in Quebec still does not include the requirement for self-closing/self-latching gates. There is no reason to believe that there was a change in the prevalence of adult bathtubs in homes, or in bathing rates of infants or toddlers.

The numbers of infant and toddler drownings in Canada are relatively small, since the rates are now among the lowest in the world. Therefore, in some subgroups, rates were based upon small numbers and may be unstable and subject to random variation. They must thus be interpreted cautiously.

The 1996 census population was used as the denominator for the calculation of rates for year 1995 as it was a better approximation of the true population than the 1991 census. The 1996 census may have been a better approximation of the true population for year 1994 as well. This is unlikely to have had a significant impact on any of the findings even if it would statistically bias the results towards the null hypothesis among infants and away from it among toddlers, as the population of infants decreased between 1991 and 1996, while the population of toddlers increased between these years.

Since infanticides are sometimes concealed as unintentional drownings (*The Canadian Red Cross Society, 1994; Deal et al, 2000; McClain et al, 1993; Kemp et al, 1994; Lavelle et al, 1995*), it is possible that a small proportion of infant drownings have been infanticides that were successfully hidden from the coroner. Moreover, the vital statistics data contained 40 infant and 23 toddler deaths that were coded as "injury undetermined whether accidentally or purposely inflicted", that may contain some cases of assault/neglect injuries.

Recommendations for drowning prevention and future research

The preventive value of self-closing, self-latching gates in association with appropriate isolation fencing of at least 1.5 meters around home swimming pools is widely recognized (*Wirtz et al, 2001; Fergusson et al, 1984; Nixon et al, 1986;*

Grossman, 2000; Pitt and Balanda, 1991; Geddis, 1984; Milliner et al, 1980; Lawson et Oliver, 1978; Logan et al, 199; Hazinski et al, 1993; Kemp and Sibert, 1992; Pearn and Nixon, 1977). In 1991-98, only 3% of swimming pool drownings in Canada occurred in pools that were reported to be equipped with a self-closing, self-latching gate (*The Canadian Red Cross Society, 1994*). Almost all swimming pool drownings of toddlers in Canada, thus one third of all toddler drownings from 1991 to 1998, could probably have been eliminated by installing self-closing and self-latching gates as well as fences around every home pool. In 1999, an estimated 8 toddler deaths could have been prevented.

In Quebec, it was found that about 95% of home pools were not equipped with self-closing/self-latching gates (*Régie régionale de la santé publique de la Montérégie, unpublished data, 1998*). The provincial norms for home swimming pools currently do not include requirements for self-closing/self-latching gates. Canada should follow Australia and New Zealand in implementing legislation that requires and enforces the installation of self-closing, self-latching gates and of appropriate fencing for every newly constructed swimming pool, and for the existing swimming pools. In Canada, however, nearly all toddler pool drownings occur when the children gained access to a pool via an open gate.

Enforcing such a law may not be easy. Studies in Australia have reported a "fierce" resistance on the part of many parents to the erection of safety barriers around their pool, even after drowning and near drowning incidents involving their children (*Pearn and Nixon, 1977).* Wintemute and Wright report a 61% opposition from swimming pool owners to a universal barrier requirement, and a 49% opposition to a requirement for new pools only (*Wintemute and Wright, 1990*). However, a survey conducted in 1991 in the United States reported that about 75% of homeowners favoured a law requiring pool fencing for all pools, not only newly constructed pools (*Liller et al, 1993*). Canadians are generally favourable towards safety legislation as compared with the United States, so their reaction may differ. Incentive methods such as discounts on the purchase of self-closing, self-latching gates might also help although these mechanisms are already inexpensive. In addition, lowering the pool owner's insurance premium could be an effective way to increase their use.

To prevent infant bathtub drowning, parents must be taught to remain with their child throughout bath times. To prevent toddler swimming pool drowning, parents and other caretakers should be educated about water safety including the importance of constant monitoring of children when a pool is in proximity, the need for a telephone and rescue equipment at the pool, and the possible value of cardiopulmonary resuscitation (CPR) training for adults and older children residing in homes with swimming pools. A survey conducted in 1991 in the United States reported that only 50% of respondents knew that the best method to prevent child drownings is supervision and that 53% did not know how to perform CPR on an infant or a child (*Liller et al, 1993*).

In addition, caretakers should be instructed to remove toys from pool after use so children are not tempted to retrieve them. Some have suggested that the child's swimming suit should be removed, and the child dressed in street clothes to signal that swimming is over and that automatic closing and locking doors be installed on the home to prevent unsupervised departure of toddlers (*Hazinski et al, 1993*). Parents who spend holidays at cottages should be encouraged to rent cottages at a safe distance from the water, or with safe enclosure so that toddlers cannot wander near the water.

Pediatric health care providers should realise that they can play a significant role in preventing child injury (*Hazinski et al, 1993*). Unfortunately, very few physicians practice systematic counselling, due in part to the belief that injury prevention education has a weak impact on risky behaviour and consequently on the incidence of injury (*Barkin and Gelberg, 1999; Cohen and Runyan, 1999; Pless, 2000*). Nevertheless, physicians should start taking a more active role in pediatric injury prevention efforts.

Future research should include a continuing follow-up of infant and toddler drowning trends in Canada, using data from the Canadian Surveillance System for Water-Related Fatalities, to establish whether the encouraging trends in the 1990's are maintained and improved upon in the future. The reach and efficacy of the various components of the prevention program led by the Canadian Red Cross Society and/or other organisations on Canadian families should be rigorously investigated using proven research methods. Differences in the diffusion of the prevention information activities between the provinces, if any, should also be documented and assessed.

The effectiveness of educational injury prevention campaigns is generally thought to be low, mainly because of the weak link between changes in knowledge and attitudes and changes in behaviour (*Deal et al, 2000; Bass et al, 1993; Hazinski et al, 1995; Schlesinger et al, 1966; Manciaux, 1985*). There have, however, been reports of educational programs that showed positive improvement in injury morbidity, mortality or at least risky behaviour (*Bergman and Rivara, 1990; Svanström et al, 1995; Nixon et al, 198; Bennett et al, 1999; Lawson and Oliver, 1978; Liller et al, 1993*).

A major impediment to the development of successful injury prevention strategies has been the lack of sound and systematic injury surveillance systems for epidemiological research. The Canadian Surveillance System for Water-Related Fatalities is an excellent example of one such program, and every country where drowning prevention is a concern should follow Canada's initiative.

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Table 2.1 Numbers and rates* of drowning among infants and toddlers by year, Canada, 1991-1998

A – Infants (n=28)

Numbers	1991	1992	1993	1994	1995	1996	1997	1998	91-98
Atlantic	1	1	0	1	0	0	0	1	4
Quebec	1	1	2	1	0	0	1	0	6
Ontario	1	4	1	2	0	0	1	0	9
Prairies	1	0	1	0	0	0	0	0	2
British Columbia	0	1	1	1	0	1	0	0	4
NWT/Yukon	1	0	1	0	0	0	0	1	3
Canada	5	7	6	5	0	1	2	2	28
Rates									
Atlantic	3.13	3.13	0.00	3.13	0.00	0.00	0.00	3.80	1.72
Quebec	1.03	1.03	2.06	1.03	0.00	0.00	1.17	0.00	0.82
Ontario	0.67	2.67	0.67	1.33	0.00	0.00	0.71	0.00	0.77
Prairies	1.29	0.00	1.29	0.00	0.00	0.00	0.00	0.00	0.35
British Columbia	0.00	2.22	2.22	2.22	0.00	2.21	0.00	0.00	1.11
NWT/Yukon	50.00	0.00	50.00	0.00	0.00	0.00	0.00	52.49	19.21
Canada	1.24	1.73	1.49	1.24	0.00	0.27	0.55	0.55	0.91

B- Toddlers (n=321)

Numbers	1991	1992	1993	1994	1995	1996	1997	1998	91-98
Atlantic	2	1	5	2	1	4	2	2	19
Quebec	10	10	15	13	8	9	7	9	81
Ontario	21	19	13	16	6	7	11	10	103
Prairies	10	10	12	7	9	10	6	10	74
British Columbia	5	9	5	8	1	4	3	5	40
NWT/Yukon	1	1	0	0	0	2	0	0	4
Canada	49	50	50	46	25	36	29	36	321
Rates									
Atlantic	1.58	0.79	3.95	1.58	0.88	3.52	1.76	1.76	1.98
Quebec	2.83	2.83	4.24	3.67	2.16	2.43	1.89	2.43	2.80
Ontario	3.72	3.36	2.30	2.83	1.01	1.18	1.86	1.69	2.22
Prairies	3.30	3.30	3.97	2.31	3.22	3.58	2.15	3.58	3.18
British Columbia	2.83	5.10	2.83	4.54	0.53	2.13	1.60	2.66	2.75
NWT/Yukon	12.66	12.66	0.00	0.00	0.00	24.97	0.00	0.00	6.29
Canada	3.20	3.26	3.26	3.00	1.61	2.32	1.87	2.32	2.60

*Note: *Rates are expressed in number of events/100,000 population/year. The denominators are based on the Canadian census population of 1991 for 1991 to 1994 and of 1996 for 1995 to 1998. Atlantic refers to Newfoundland, Prince Edward Island, Nova Scotia and New Brunswick; Prairies refers to Saskatchewan, Alberta and Manitoba. Infants are <1 year old, toddlers are 1-4 years old.*

Table 2.2 Number and rate of injury deaths among infants and toddlers, Canada, 1991-1997

a) Infants (n=369)

Numbers	1991	1992	1993	1994	1995	1996	1997	1991-1997
Choking	28	15	20	16	17	11	18	125
Assault/Neglect	12	9	17	15	10	16	5	84
Traffic	6	12	12	11	12	6	14	73
Drowning**	**3**	**7**	**7**	**4**	**0**	**2**	**3**	**26**
Fire/burn	7	3	1	2	1	1	0	15
Fall	2	3	1	2	1	1	0	10
Poisoning	0	1	3	0	2	1	0	7
Other	9	5	12	7	6	5	11	55
All injuries	67	55	73	57	49	43	51	395
Rates								
Choking	6.94	3.72	4.95	3.96	4.64	3.00	4.91	4.60
Assault/Neglect	2.97	2.23	4.21	3.72	2.73	4.36	1.36	3.09
Traffic	1.49	2.97	2.97	2.72	3.27	1.64	3.82	2.69
Drowning**	**0.74**	**1.73**	**1.73**	**0.99**	**0.00**	**0.55**	**0.82**	**0.96**
Fire/burn	1.73	0.74	0.25	0.50	0.27	0.27	0.00	0.55
Fall	0.50	0.74	0.25	0.50	0.27	0.27	0.00	0.37
Poisoning	0.00	0.25	0.74	0.00	0.55	0.27	0.00	0.26
Other	2.23	1.24	2.97	1.73	1.64	1.36	3.00	2.03
All injuries	16.60	13.62	18.08	14.12	13.36	11.73	13.91	12.82

b) Toddlers (n=920)

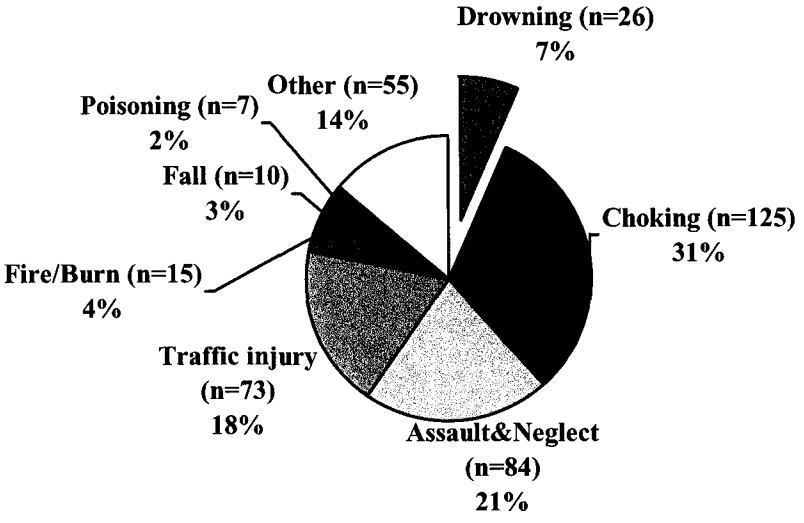
Numbers	1991	1992	1993	1994	1995	1996	1997	1991-1997
Traffic	53	53	56	67	63	43	50	385
Drowning**	**42**	**45**	**50**	**45**	**27**	**33**	**26**	**268**
Fire/burn	25	44	27	35	17	22	13	183
Choking	15	19	12	14	16	16	13	105
Assault/Neglect	16	13	8	11	15	15	19	97
Fall	5	5	6	3	5	3	5	32
Poisoning	0	2	7	1	0	2	2	14
Other	15	13	13	18	15	13	17	104
All injuries	171	194	179	194	158	147	145	1188
Rates								
Traffic	3.46	3.46	3.65	4.37	4.06	2.77	3.22	3.57
Drowning**	**2.74**	**2.94**	**3.26**	**2.94**	**1.74**	**2.13**	**1.68**	**2.49**
Fire/burn	1.63	2.87	1.76	2.28	1.10	1.42	0.84	1.70
Choking	0.98	1.24	0.78	0.91	1.03	1.03	0.84	0.97
Assault/Neglect	1.04	0.85	0.52	0.72	0.97	0.97	1.22	0.90
Fall	0.33	0.33	0.39	0.20	0.32	0.19	0.32	0.30
Poisoning	0.00	0.13	0.46	0.07	0.00	0.13	0.13	0.13
Other	0.98	0.85	0.85	1.17	0.97	0.84	1.10	0.96
All injuries	11.16	12.66	11.68	12.66	10.19	9.48	9.35	9.63

*Note: Infants are aged less than 1 year old; toddlers are aged 1 to 4 years old. Injuries were ranked using 1991-1997 rates.** Drowning numbers are from Statistics Canada Vital Statistics (Unintentional immersion E910, E830, E832).*

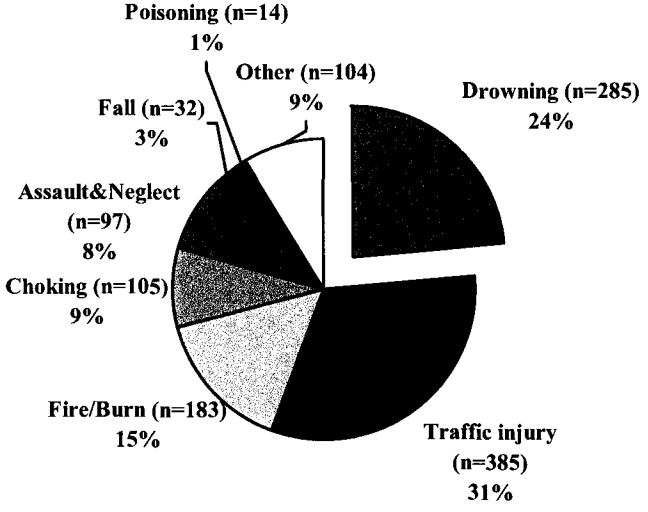
Source: Statistics Canada, 1991-1997

Figure 2.1 Deaths among infants* and toddlers* by injury, Canada, 1991-1997

a) Infants (n=395)



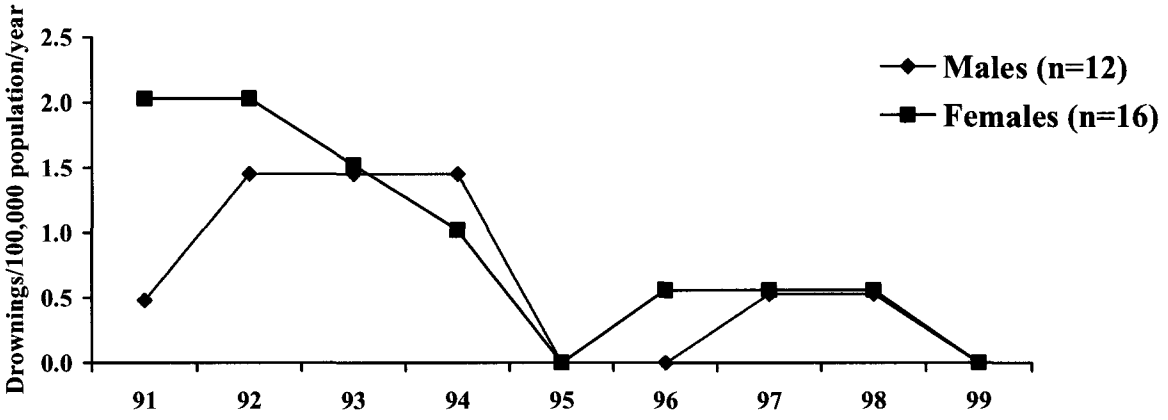
b) Toddlers (n=1188)



** Infants are children less than 1 year old, toddlers, 1 to 4 years old.*
Note: Drowning numbers were those of the Canadian Surveillance System for Water-Related Fatalities
Source: Statistics Canada, Canadian Surveillance System for Water-Related Fatalities, 1993-1999

Figure 2.2 Rate of drowning for infants* and toddlers* by sex and by year, Canada, 1991-1999

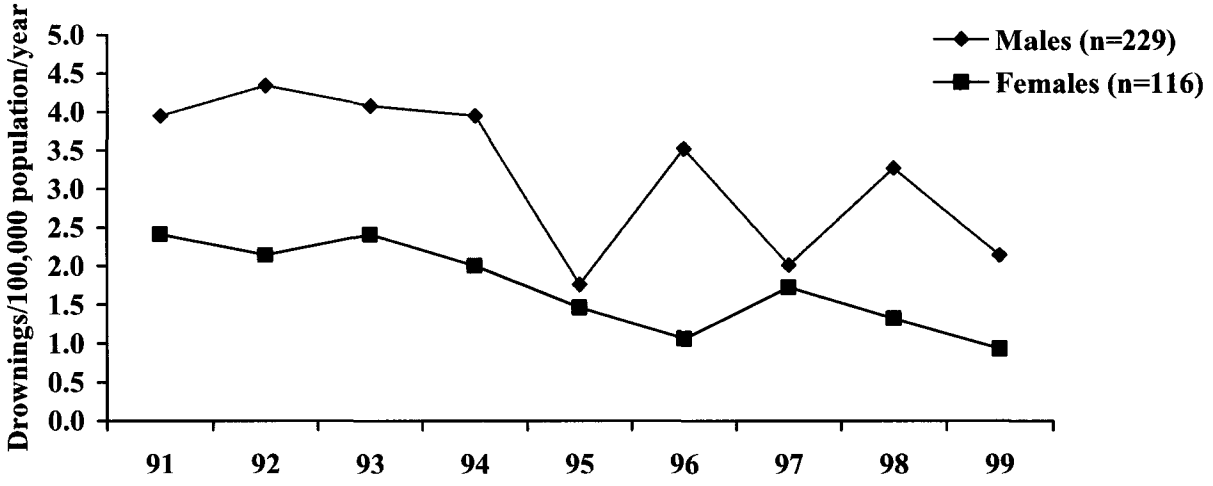
a) Infants (n=28)



Numbers :

Male	1	3	3	3	0	0	1	1	0
Female	4	4	3	2	0	1	1	1	0
Both	5	7	6	5	0	1	1	1	0

b) Toddlers (n=345)



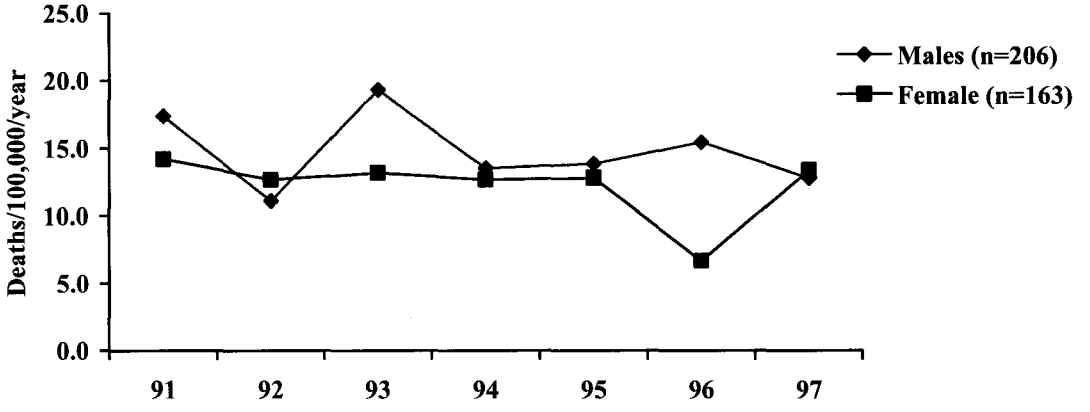
Numbers :

Male	31	34	32	31	14	28	16	26	17
Female	18	16	18	15	11	8	13	10	7
Both	49	50	50	46	25	36	29	36	24

**Infants are <1 year old, toddlers are 1-4 years old.*
Source: The Canadian Surveillance System for Water-Related Fatalities, 1993-2001

Figure 2.3 Mortality rate among infants and toddlers for all injuries excluding drownings, by sex and year, Canada, 1991-1997

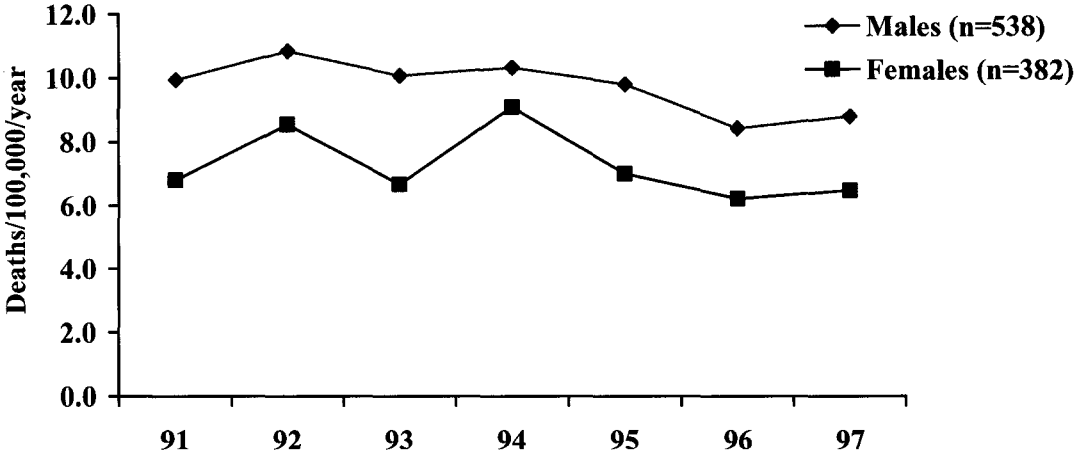
a)Infants (n= 369)



Numbers :

Male	36	23	40	28	26	29	24
Female	28	25	26	25	23	12	24
Both	64	48	66	53	49	41	48

b)Toddlers (n=920)



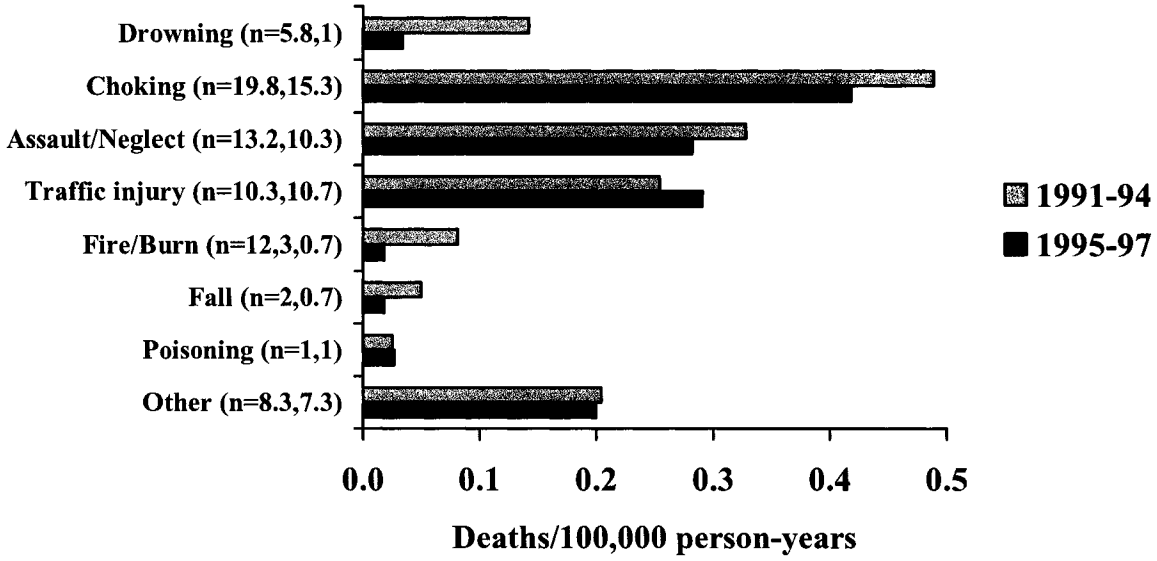
Numbers :

Male	78	85	79	81	78	67	70
Female	51	64	50	68	53	47	49
Both	129	149	129	149	131	114	119

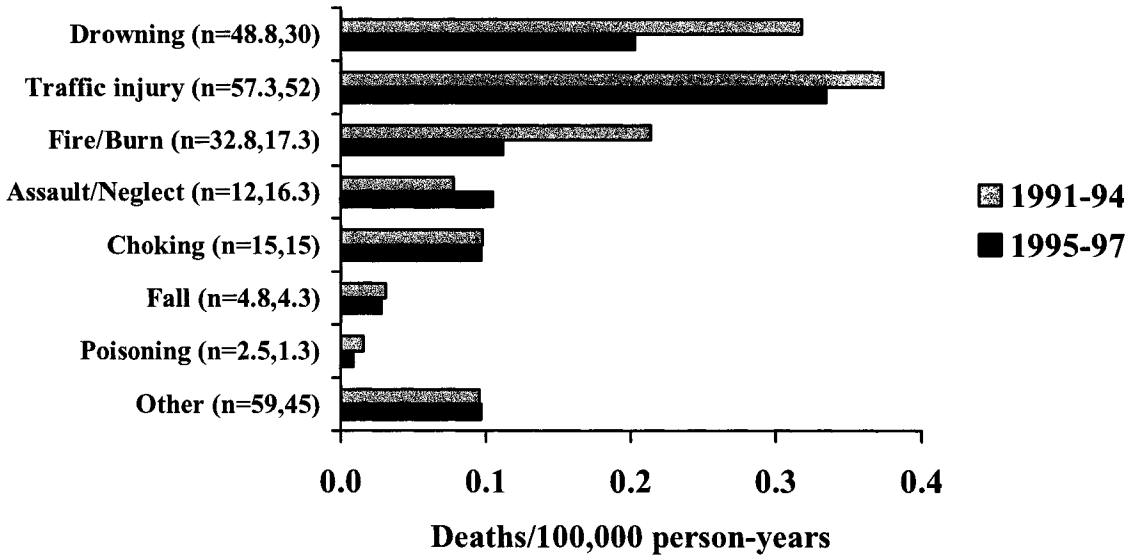
Note: Infants are <1 year old, toddlers are 1-4 years old.
Source: Statistics Canada, 1991-1997

Figure 2.4 Mortality rate among infants and toddlers during 1991-94 and 1995-97 periods, by injury, Canada, 1991-1997

a) Infants (n=395)



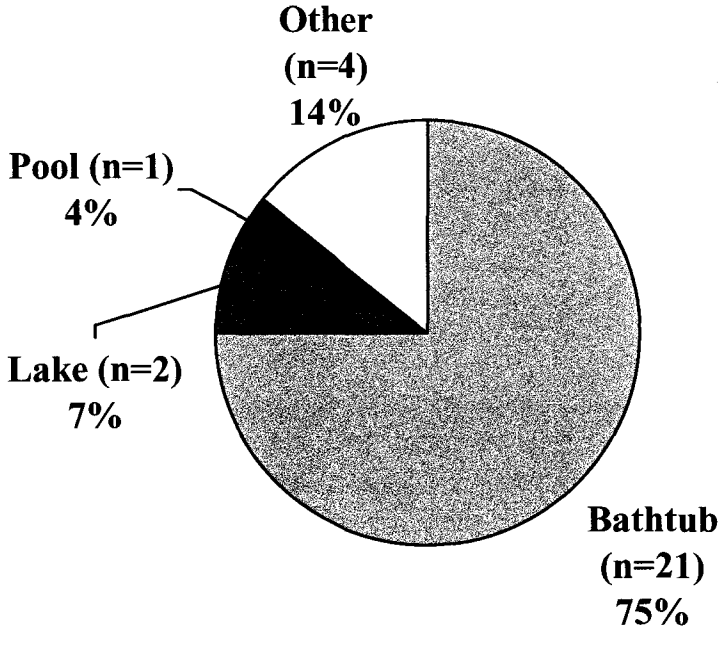
b) Toddlers (n=1,188)



Note: Rates are averages for 1991-1994 and 1995-1997. Numbers in parentheses are average number of incident per year for 1991-94 and 1995-97. Infants are <1 year old, toddlers are 1-4 years old.
Source: Statistics Canada, Canadian Surveillance System for Water-Related Fatalities, 1993-1999

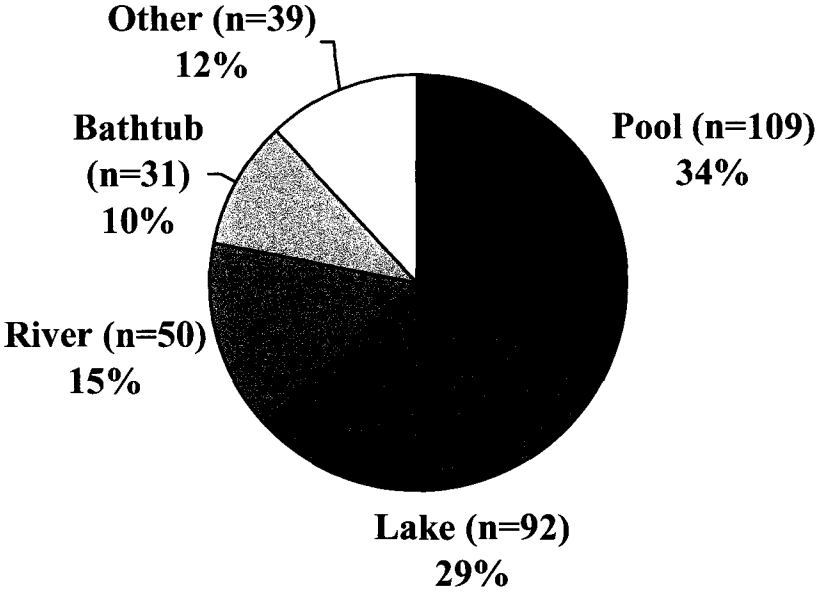
Figure 2.5 Drownings among infants and toddlers by type of body of water, Canada, 1991-1998

a)



Infants (n=28)

b)

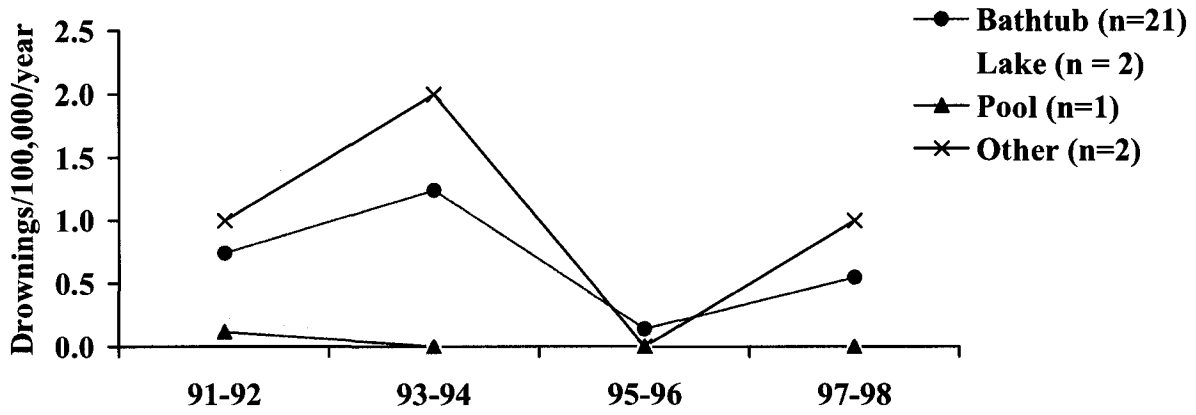


Toddlers (n=321)

Note: *Lake also includes ponds and reservoirs; For infants, "Other" includes 2 ocean, 1 hot tub and 1 toilet. For toddlers,"Other" includes: 7 ocean, 7 hot tub, 6 sewage and 16 other bodies of water. Infants are <1 year old, toddlers are 1-4 years old.*
Source: Canadian Surveillance System for Water-Related Fatalities, 1993-2000

Figure 2.6 Trends in drownings by type of body of water by 2-year periods among infants and toddlers, Canada, 1991-1998

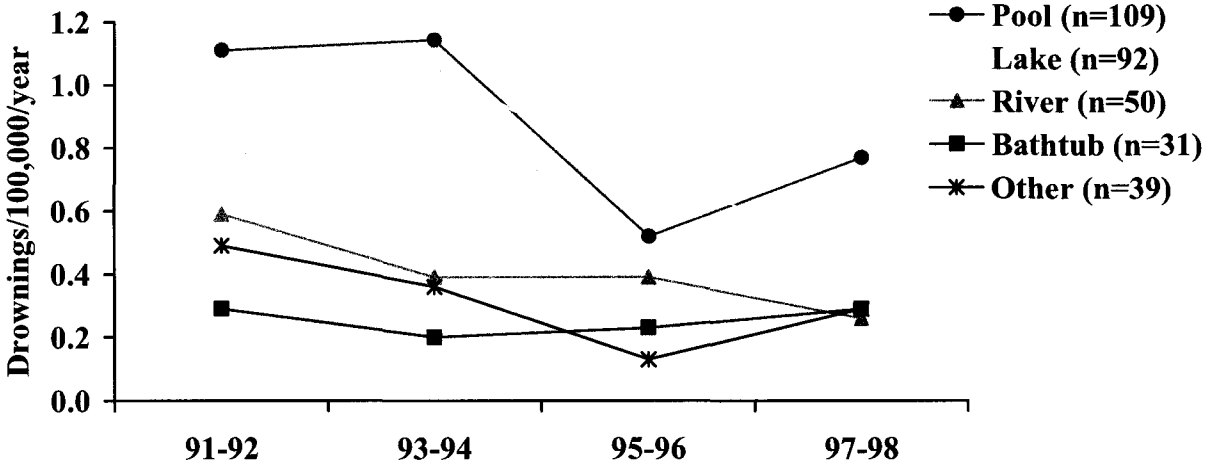
a) Infants (n=28)



Numbers :

Bathtub	6	10	1	4
Lake	2	0	0	0
Pool	1	0	0	0
Other	3	1	0	0

b)Toddlers (n=321)



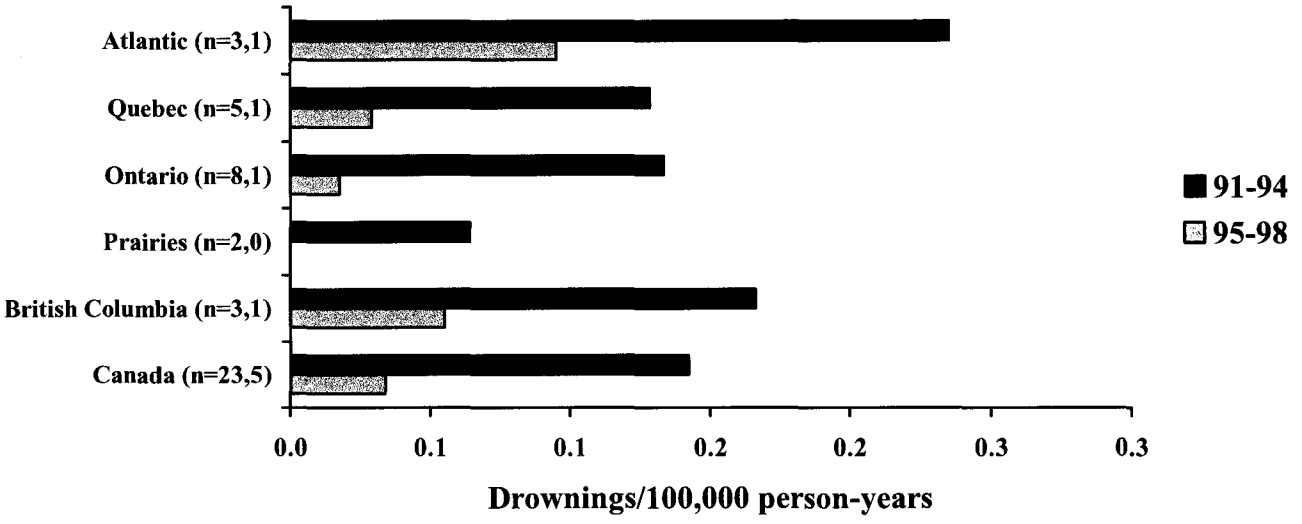
Numbers :

Pool	34	35	16	24
Lake	23	32	22	15
River	18	12	12	8
Bath	9	6	7	9
Other	15	11	4	9

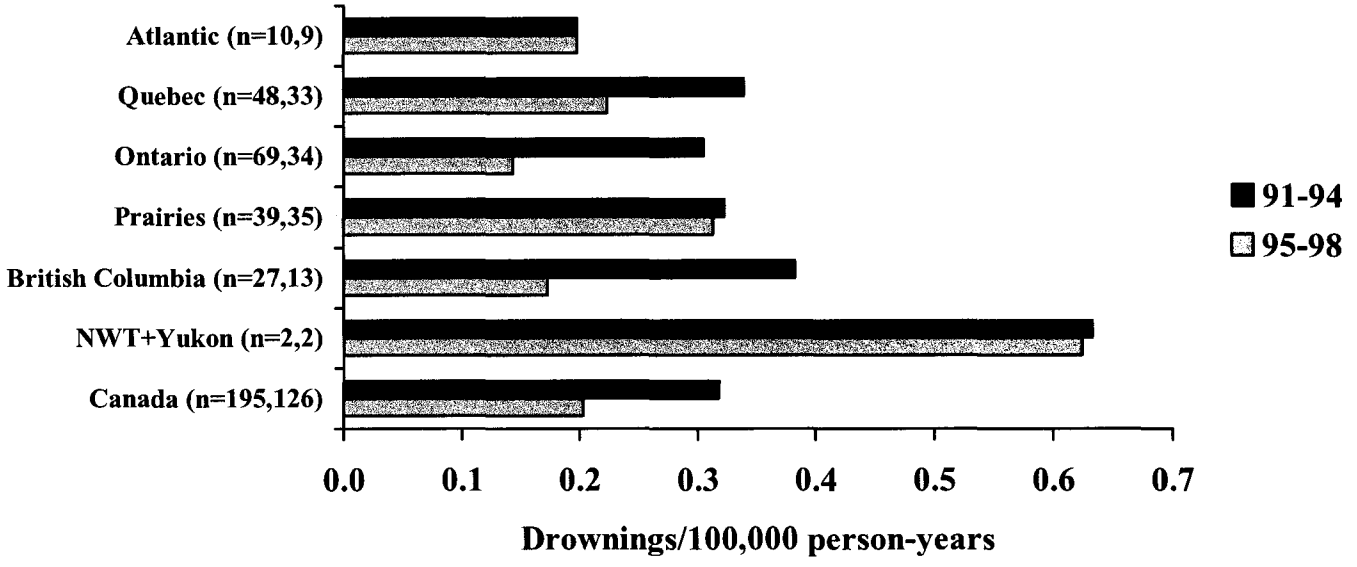
Note: Infants are <1 year old, toddlers are 1-4 years old.
Source: The Canadian Surveillance System for Water-Related Fatalities, 1993-2000

Figure 2.7 Drowning* rate among infants and toddlers for pre- and post-program periods by region, Canada, 1991-1998

a) Infants (n=28)



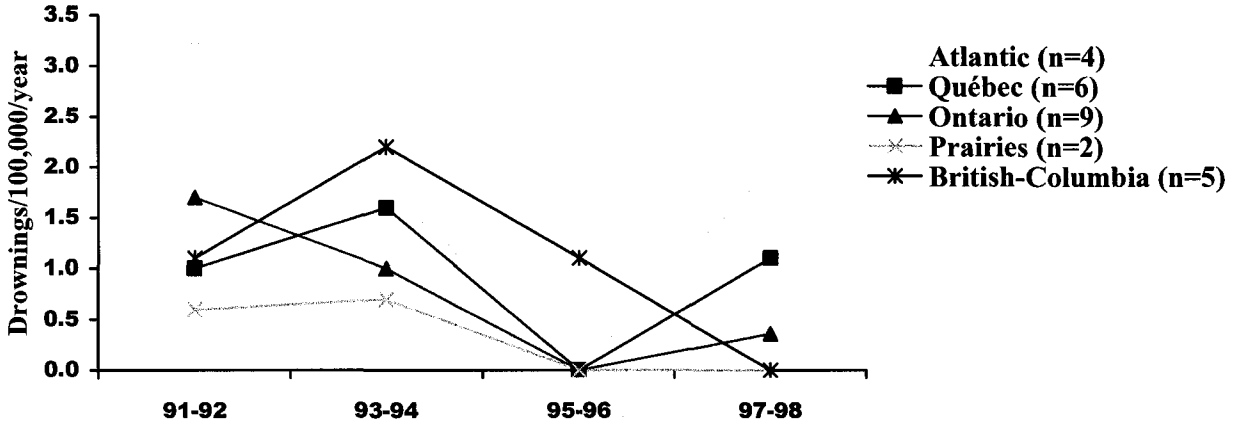
b) Toddlers (n=321)



**Rates are averages for 1991-94 and 1995-98*
Note: NWT/Yukon infant drowning rates not shown (91-94 (n=2): 25.0, 95-98:13.3 (n=1)). Infants are <1 year old, toddlers are 1-4 years old.
Source: Canadian Surveillance System for Water-Related Fatalities, 1993-2000

Figure 2.8 Rate of drowning among infants and toddlers by region and 2-year periods, Canada, 1991-1998

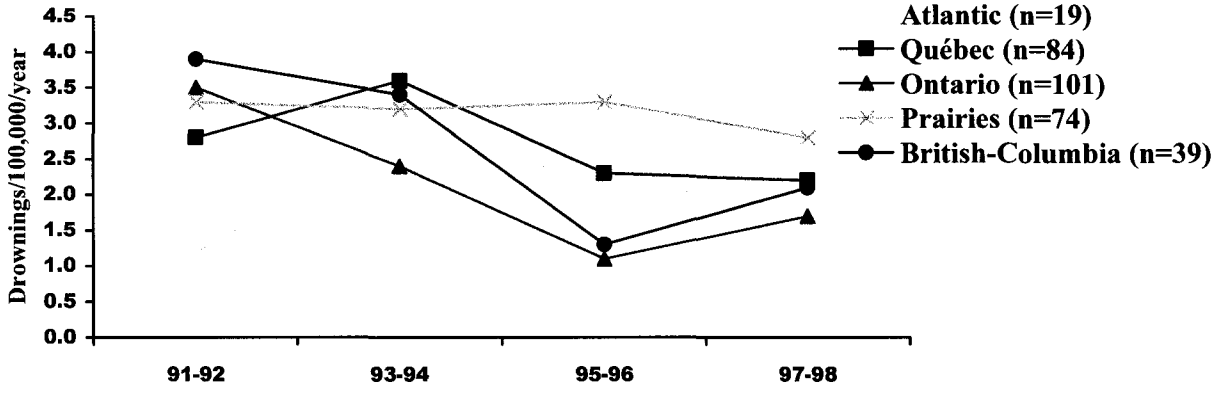
a) Infants (n=28)



Numbers :

Atlantic	2	1	0	1
Quebec	2	3	0	1
Ontario	5	3	0	1
Prairies	1	1	0	0
British Columbia	1	2	1	0

b) Toddlers (n=321)



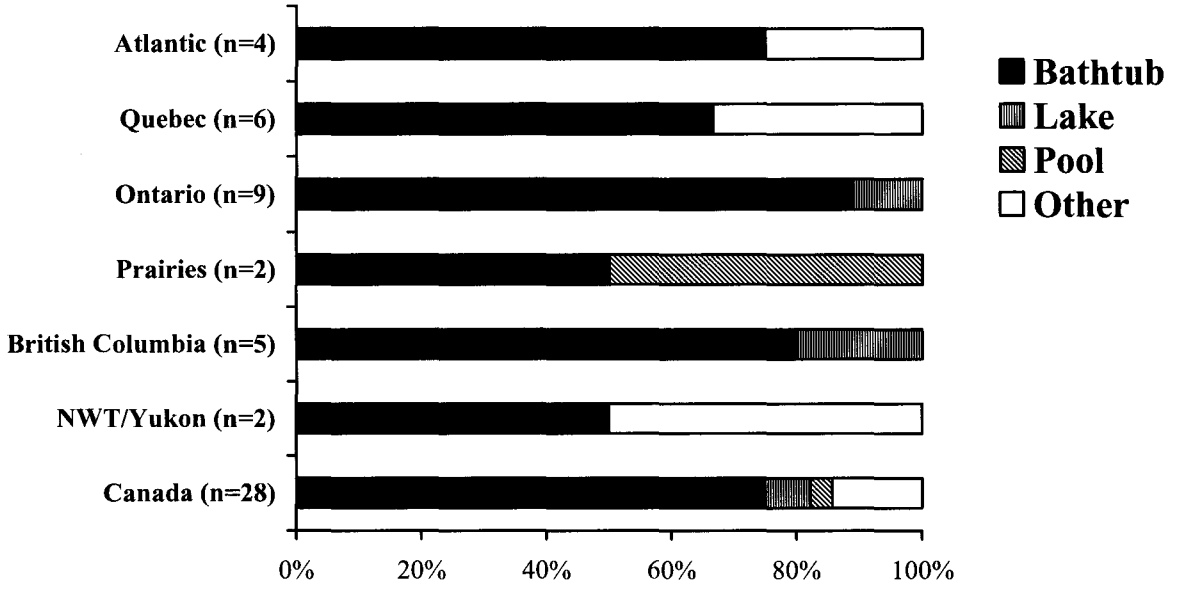
Numbers :

Atlantic	3	7	5	4
Quebec	20	28	17	16
Ontario	40	29	13	21
Prairies	20	19	19	16
British Columbia	14	13	5	8

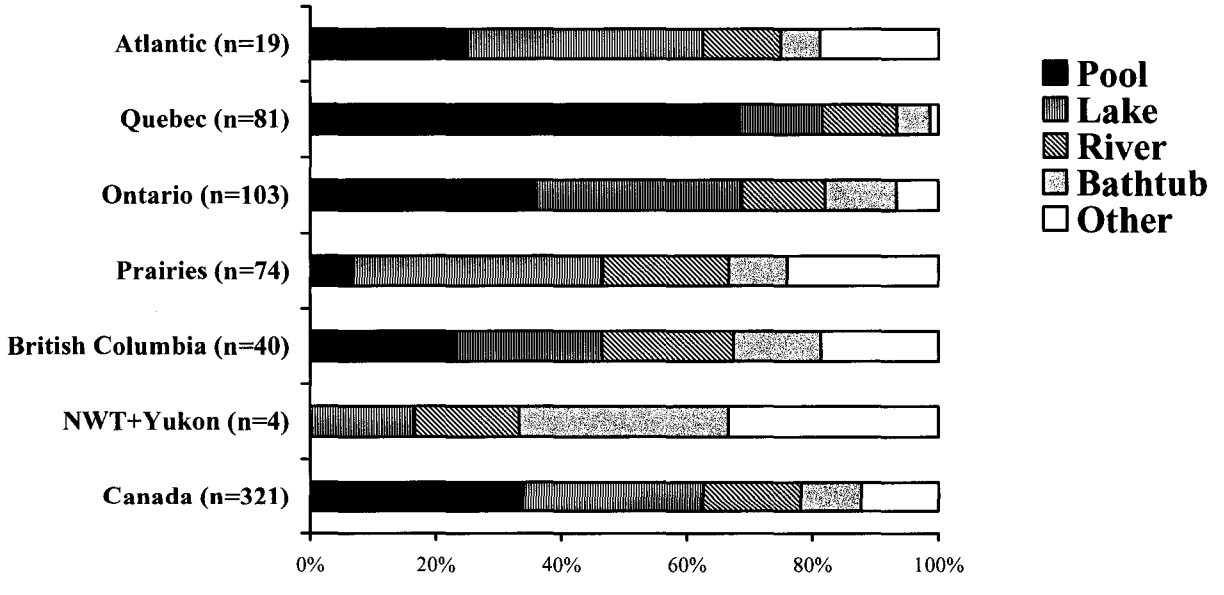
Note: NWT/Yukon rates not shown (Infants: 25.0(n=1), 25.0(n=1), 0.0(n=0), 26.3(n=1); Toddlers: 12.7(n=2),0.0 (n=0), 12.5(n=2),0.0 (n=0)). Infants are <1 year old, toddlers are 1-4 years old.
Source: Canadian Surveillance System for Water-Related Fatalities,1993-2000

Figure 2.9 Drownings among infants and toddlers by region and by type of body of water, Canada, 1991-1998

a) Infants (n=28)

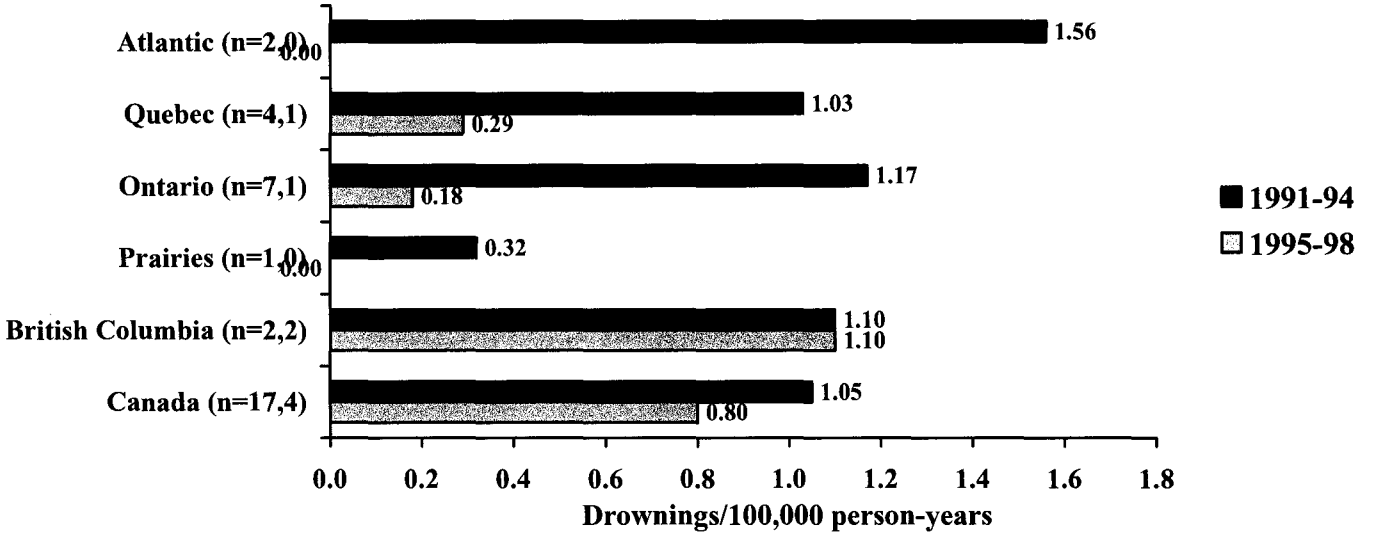


b) Toddlers (n=321)



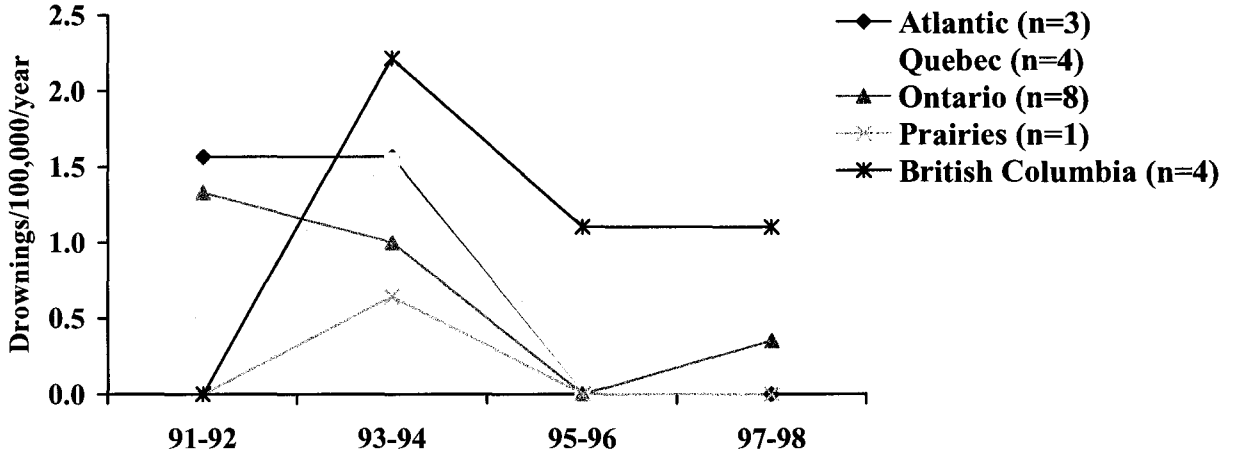
Note: Infants are <1 year old, toddlers are 1-4 years old.
Source: Canadian Surveillance for Water-Related Fatalities, 1993-2000

Figure 2.10 Rate* of bathtub drowning among infants by region, for pre- and post-program periods Canada, 1991-1998 (n=21)



**Rates are averages for year 1991-94 and 1995-98*
Note: NWT/Yukon rate is not shown (12.50 per 100,000 person-years (n=1) and 0.00 (n=0).Infants are <1 year old.
Source: Canadian Surveillance for Water-Related Fatalities, 1993-2000

Figure 2.11 Bathtub drowning among infants by region and by 2-year periods, Canada, 1991-1998, (n=21)

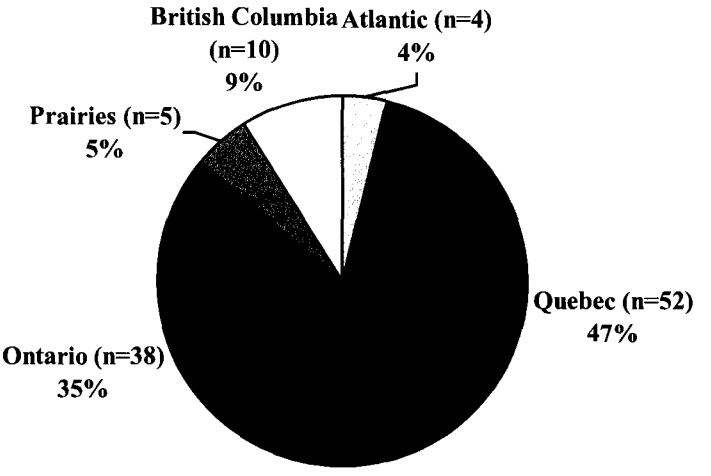


Numbers :

Atlantic	1	1	0	0
Quebec	1	3	0	1
Ontario	4	3	0	1
Prairies	0	1	0	0
British Columbia	0	2	1	1

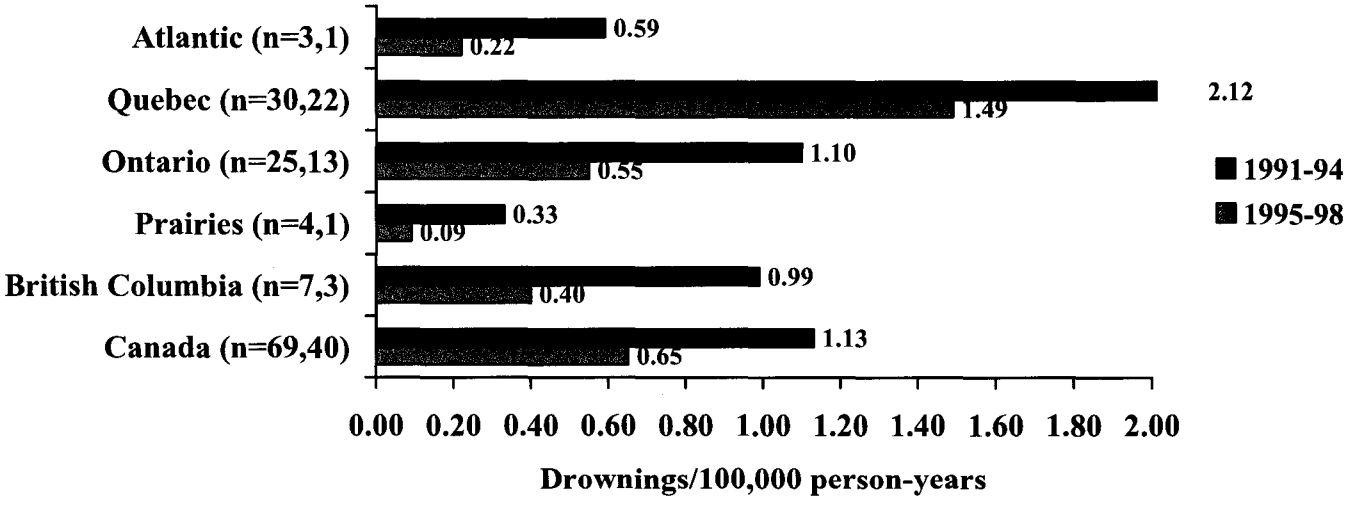
Note: NWT+Yukon rates not shown (0,0(n=0), 25,0(n=1), 0,0(n=0), 0,0(n=0)). Infants are <1 year old.
Source: Canadian Surveillance for Water-Related Fatalities, 1993-2000

Figure 2.12 Swimming pool drownings of toddlers by region, Canada, 1991-1998 (n=109)



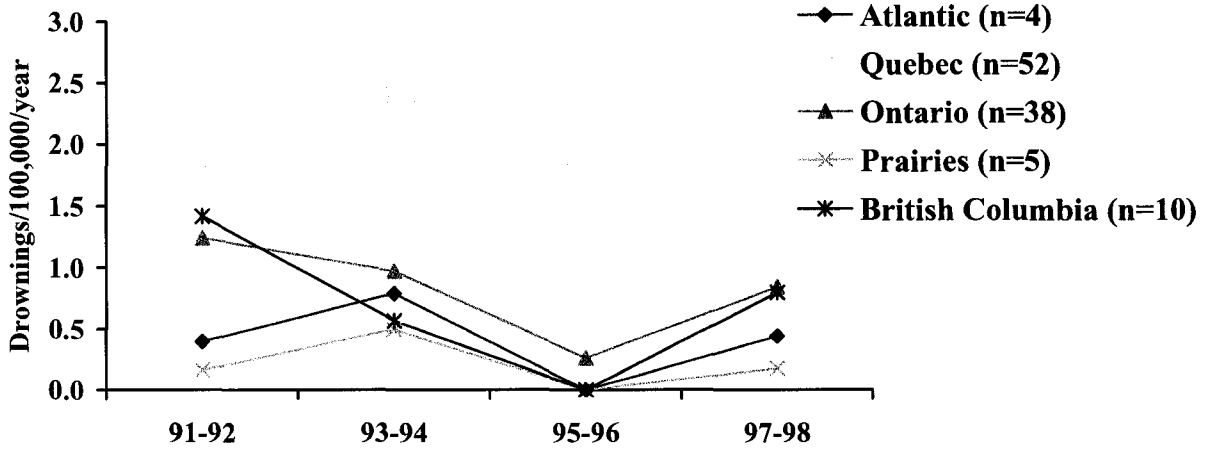
Note: Toddlers are 1-4 years old.
Source: Canadian Surveillance for Water-Related Fatalities, 1993-2000

Figure 2.13 Rate* of swimming pool drowning among toddlers for pre- and post-program periods, by region, Canada, 1991-1998 (n=109)



**Rates are averages for year 1991-94 and 1995-98*
Note: Toddlers are 1-4 years old.
Source: Canadian Surveillance for Water-Related Fatalities, 1993-2000

Figure 2.14 Swimming pool drowning rate among toddlers by region and by 2-year periods, 1991-1998, (n=109)

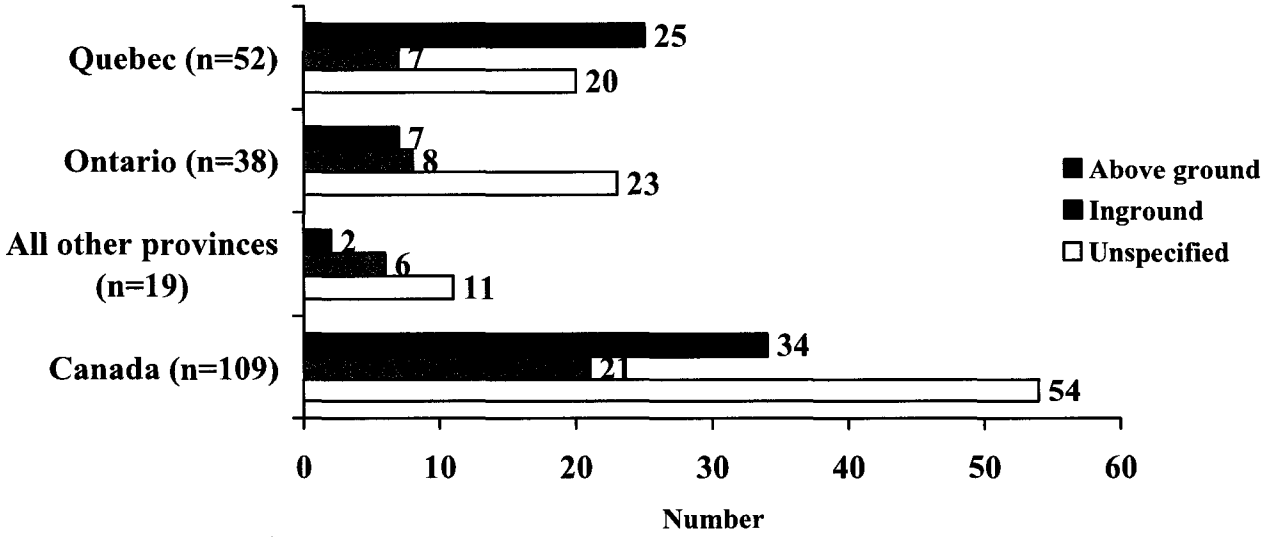


Numbers :

Atlantic	1	2	0	1
Quebec	13	17	13	9
Ontario	14	11	3	10
Prairies	1	3	0	1
British Columbia	5	2	0	3

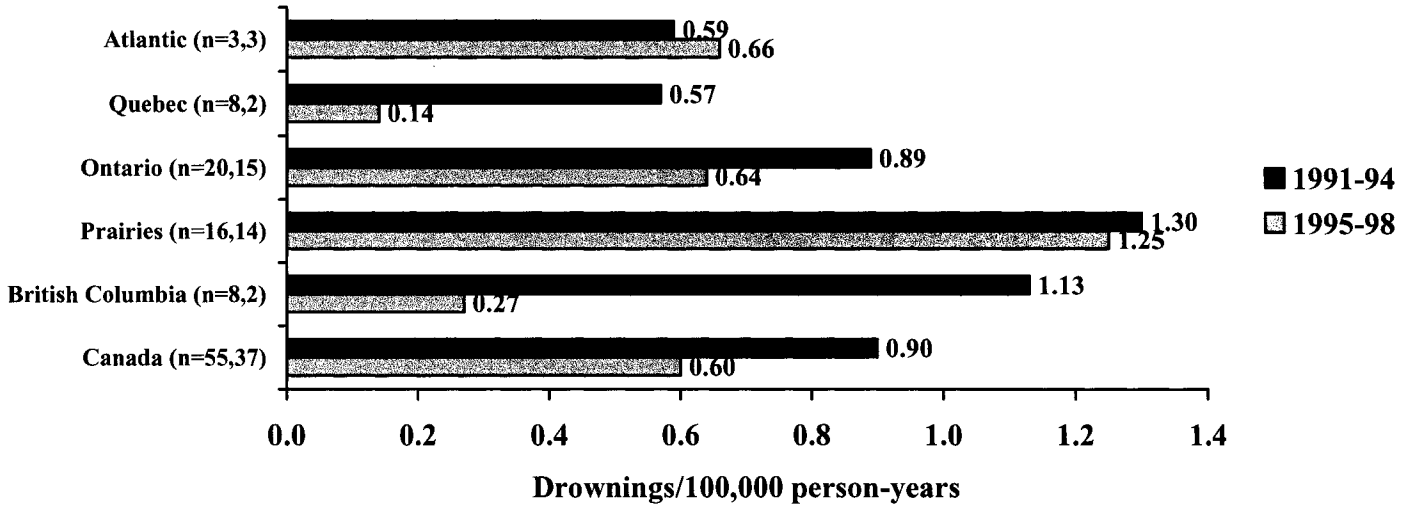
Note: No pool drowning occurred in NWT/Yukon. Toddlers are 1-4 years old.
Source: Canadian Surveillance for Water-Related Fatalities, 1993-2000

Figure 2.15 Distribution of toddler pool drownings by type of pool and by region, 1991-1998



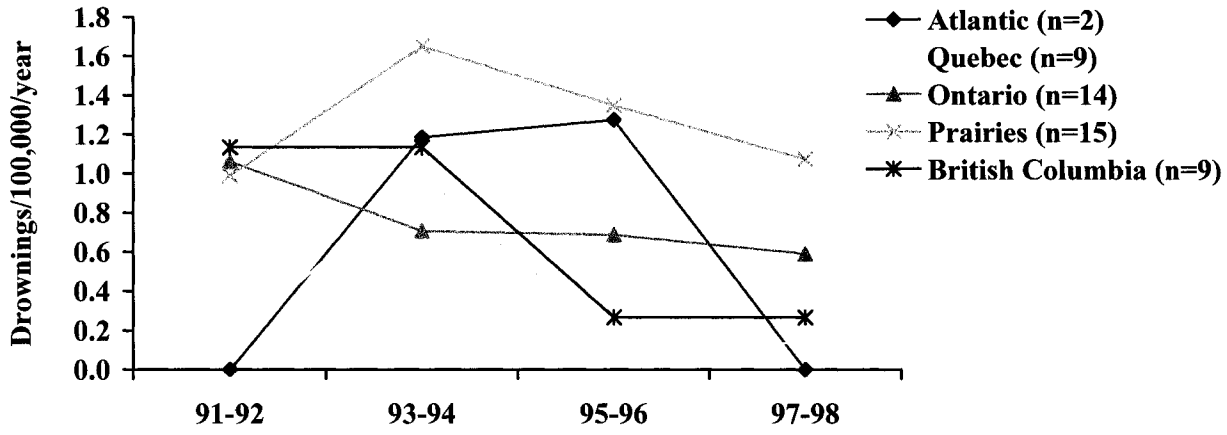
Note: Toddlers are 1-4 years old.
Source: Canadian Surveillance for Water-Related Fatalities, 1993-2000

Figure 2.16 Rate* of lake drowning among toddlers for pre- and post-program periods by region, Canada, 1991-1998 (n=92)



**Rates are averages for year 1991-94 and 1995-98*
Note: Lake also includes ponds and reservoirs; NWT/Yukon rate not shown for figure clarity (0.00 per 100,000 person-years (n=0) and 3.12 (n=1)). Toddlers are 1-4 years old.
Source: Canadian Surveillance for Water-Related Fatalities, 1991-1998

Figure 2.17 Lake drownings among toddlers by region, by 2-year periods, Canada, 1991-1998 (n=92)

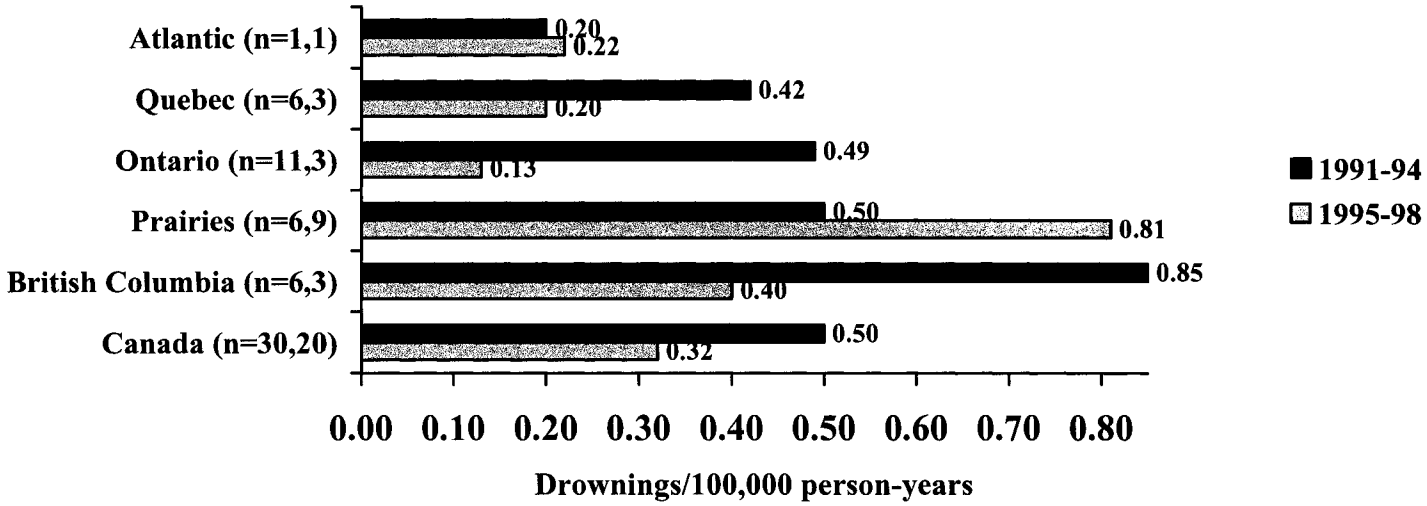


Numbers :

Atlantic	0	3	3	0
Quebec	1	7	1	1
Ontario	12	8	8	7
Prairies	6	10	8	6
British Columbia	4	4	1	1

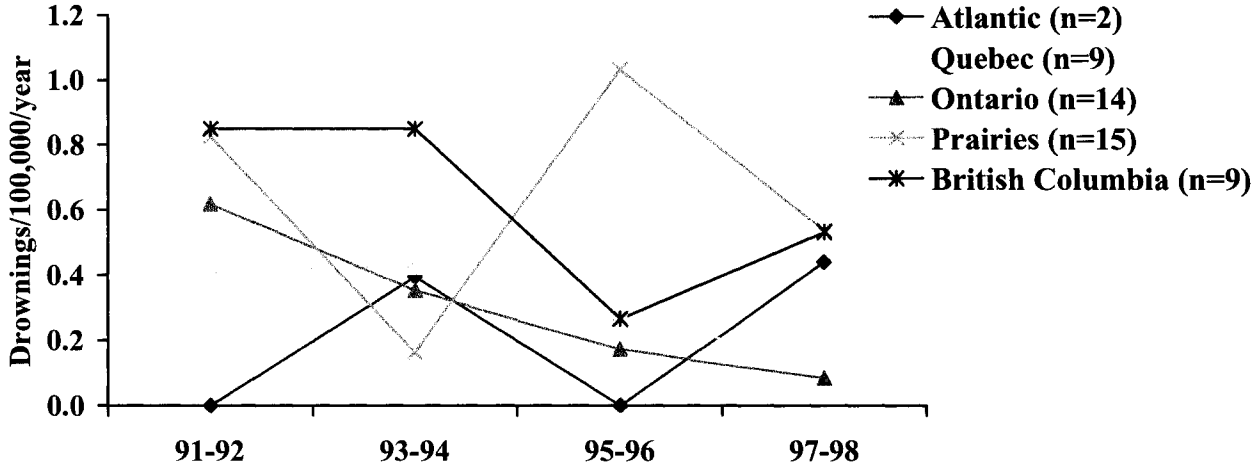
Note: NWT/Yukon rates not shown (0.0(n=0), 0.0(n=0),6.2(n=1), 0.0(n=0). Toddlers are 1-4 years old.
Source: Canadian Surveillance for Water-Related Fatalities, 1991-1998

Figure 2.18 Rate of river drowning among toddlers by region for pre-and post-program periods, Canada, 1991-1998 (n=50)



**Rates are averages for year 1991-94 and 1995-98.*
Note: NWT/Yukon rate not shown for figure clarity (0.00 per 100,000 person-years (n=0) and 3.21(n=1)).Toddlers are 1-4 years old.
Source: Canadian Surveillance for Water-Related Fatalities, 1991-1998

Figure 2.19 River drowning rate among toddlers by region and by 2-year periods, 1991-1998 (n=50)



Numbers :

Atlantic	0	1	0	1
Quebec	3	3	2	1
Ontario	7	4	2	1
Prairies	5	1	6	3
British Columbia	3	3	1	2

Note: NWT/Yukon rate not shown (0,0 (n=0), 0,0 (n=0), 6,42 (n=1), 0,0 (n=0)). Toddlers are 1-4 years old.
Source: Canadian Surveillance for Water-Related Fatalities, 1991-1998

CONNECTING MATERIAL

Near drowning occurs when a drowning victim is resuscitated and survives to reach the hospital. Near drownings are closely associated with drownings because of their similar risk factors.

In the previous chapter, we identified a significant decrease in drowning among infants and toddlers in Canada between 1991-94 and 1995-98. Interventions or other factors that changed the incidence of drownings may also have had an impact on the incidence of near drownings. Prevention of drowning might be expected to prevent near drownings, and a lower incidence of the latter could also be observed. From 1970 to 1990 in Canada, however, the opposite was observed. As the rate of drowning deaths decreased steadily, the rate of hospitalization for near drownings actually increased. It is possible that a shift in the bodies of water where drownings occurred to home pools, more rapid cardiopulmonary resuscitation, increased awareness of risk or better knowledge of cardiopulmonary resuscitation by parents and other caregivers would decrease the severity of the immersion incident, causing a shift from drowning to near drowning. In that case, near drowning incidence would not be reduced and could even be increased.

The next chapter uses hospitalization data to verify whether the improvement that was seen in drowning rate among infant and toddlers in Canada between 1991-94 and 1995-98 was paralleled by changes in the incidence of near drownings. Incidence of other injuries was also considered and compared to near drownings. The case-fatality ratio for the hospitalizations for near drowning was also assessed.

CHAPTER 3:
Hospitalization for near drowning and other injuries among infants and toddlers in Canada, 1994-1998: Incidence, risk factors and in-hospital mortality.

Hospitalization for near drowning and other injuries among infants and toddlers in Canada, 1994-1998: Incidence, risk factors and in-hospital mortality.*

Mylène Dandavino, Peter Barss

I. ABSTRACT

Objective: To investigate the incidence, risk factors and in-hospital mortality of near drowning hospitalizations among infants aged less than 1 and toddlers aged 1 to 4 in comparison to hospitalizations due to other injuries in Canada.

Methods: Using data from the Canadian Institute for Health Information, the 62 infant and 440 toddler near drowning hospitalizations that took place between fiscal years 1994-95 and 1997-98 were analyzed and compared to hospitalizations due to other injuries. Determinants examined were sex, region of hospitalization and external cause of injury. In-hospital mortality and duration of stay in hospital are also reported.

Results: In Canada, the rate of near drowning hospitalization among children aged 0-4 decreased by 33%, from 7.2 per 100,000 person-years in 1991-94 to 4.8 in 1995-98 ($p<0.0005$ by χ^2). No significant improvement was seen in infant near drowning hospitalization rates between 1994-95 and 1997-98, while rates of hospitalization due to near drownings decreased by 25% among toddlers ($0.025<p<0.05$ by χ^2 for trends). From 1994-95 to 1997-98, rates of hospitalization after all injuries decreased by 7% among infants ($0.005<p<0.01$ by χ^2 for trends), and by 20% among toddlers ($p<0.0005$ by χ^2 for trends).

Among *infants*, near drownings constituted approximately 1% of the injury hospitalizations in Canada during 1994-98, but caused 5% of their in-hospital injury deaths. Among *toddlers*, near drownings also constituted 1% of the injury hospitalizations but caused 28% of the toddler in-hospital deaths in that period. The case-fatality ratio of near drowning hospitalization was the highest of all injuries with 7% mortality among hospitalized infants and 12% among toddlers.

Conclusion: The progressive downward incidence of near drowning among toddlers may be related to the significant improvement in drowning rates that was seen

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* Manuscript to be submitted to an injury prevention or public health journal

among infants and toddlers in Canada during 1991-98 and to nation-wide drowning prevention activities of the Canadian Red Cross Society in the mid 1990's.

II. INTRODUCTION

Between 1991-1994 and 1995-1998, drowning rates in Canada fell by 79% among infants and by 38% among toddlers. This improvement coincided with the release in 1998 of a report on infant and toddler drowning and the consequent revision and introduction of water safety programs by the Canadian Red Cross Society across the country.

Near drowning occurs when a drowning victim is resuscitated and survives to reach the hospital. As risk factors are similar, prevention of drowning might be expected to prevent near drownings, and a lower incidence of the latter could also be observed. However in Canada, between 1970 and 1990, the rate of hospitalization for near drowning had increased as the death rate due to drowning decreased (*The Canadian Red Cross Society, 1994*).

We compared the trends in drowning to those in near drowning between 1991-1994 and 1995-1998 among infants and toddlers to verify whether there was a parallel decrease in incidence of near drownings across Canada. We also compared the incidence for near drowning hospitalizations to those for other injuries. Available determinants for hospitalizations for near drowning and other injuries among infants and toddlers were assessed, including sex, regional distribution and external cause of injury of the incidents. Finally, we examined in-hospital mortality and duration of stay in hospital of near drowning hospitalizations in comparison to other injuries.

III. METHODS

This study assessed of the incidence of near drowning and of risk factors for near drowning among infants and toddlers in Canada, for fiscal years 1994-95 through 1997-98, in comparison to other injuries. All intentional and unintentional injury hospitalizations among infants and toddlers that took place between April 1, 1994 and March 31, 1998 were included in this study.

The incidence and risk factors for hospitalization were obtained from the Canadian Institute for Health Information (CIHI) databases. The CIHI is an independent national, non-profit organization responsible for coordinating the development and

maintenance of the country's integrated health information. The CIHI manages the National Trauma Registry, which includes information on hospitalisations that occur in Canada. This database is created using the Hospital Morbidity Database at CIHI. Sources of data for this database include CIHI's Discharge Abstract Database for all provinces with the exception of Quebec and Manitoba, which do not submit 100% of inpatient discharge abstracts. For these provinces, data are submitted from the hospitals to the provincial Ministries of Health, which then are forwarded for CIHI. In this database, province reflects province of hospitalization rather than of residence. Deaths pronounced at the scene or in the emergency department are not included in this database, as these individuals are not admitted to the hospital. It was not feasible to obtain detailed data from before 1994, year the CIHI was established and took over from Statistics Canada the reporting of hospitalizations. Hence, for assessment of long term trends in incidence, we obtained near drowning rates from published reports (*The Canadian Red Cross Society, 1994, 1996b*). As data for 1993-94 was not available at time of preparation, the average incidence of 1992-93 and 1994-95 was used in the analyses.

Two datasets were used in these analyses. The first, used for near drowning analysis, included all hospitalizations coded with nature of injury code N994.1 *Accidental submersion* or with the *International Classification of Disease, 9th version (ICD-9)* codes E830 (other unintentional submersion or drowning in water transport), E832 (accident to watercraft causing submersion) and E910 (unintentional drowning and submersion). No observations were excluded because of missing data but seven observations were excluded because their external cause of injury indicated probable coding mistakes. The final dataset contained 62 infant and 440 toddler hospitalizations for near drowning.

For the analysis of other injury hospitalizations, a second dataset was created excluding all observations with the nature of injury code N994.1 in children less than 5 years old. No observations were excluded due to missing data. Sixty observations were excluded because they also had the ICD-9 codes E830, E832 or E910. Among children 0-4 years old, no iatrogenic incidents (E-codes E870-E879 and E930-949) were

reported in this period. The final dataset contained 7,895 infant and 34,397 toddler hospitalizations.

Risk factors studied were sex, region of hospitalization and external cause of injury. Due to the low numbers of events in these less populated provinces, Newfoundland, Prince Edward Island, Nova Scotia, and New Brunswick were considered together as the Atlantic provinces, and Manitoba, Saskatchewan and Alberta, as the Prairies. The Northwest Territories and Yukon were considered together and included what is now known at the Nunavut.

Hospitalization rates were calculated using national census data published by Statistics Canada. We used 1991 census data for fiscal year 1994-95 and 1996 census data for 1995-96, 1996-97 and 1997-98, because the true population for 1995-96 is probably closer to the 1996 census than to the 1991 census. The census in Canada is taken every five years and intercensal projections overestimated the population of 0-4 years old between the 1991 and 1996 census.

External causes of near drowning were categorized based on the ICD-9 codes as follows: E830, E832 Boating transport, E960-969 Assault/Neglect, E800-829, E833-848 Transport (land and air), E910 All other unintentional near drownings. The other injury categories were: traffic injuries (E800-807, E833-848), poisonings (E852-858, E860-869), falls (E880-888), choking (suffocation) (E911-915), fire/burns (E890-899 and E924), and injuries due to assault/neglect of the child (E960-969) and E904. The "Other" category was created to includes injuries due to natural and environmental factors (E900-909), late effect of injury (E929), those classified under Other accidents (E916-928) and injuries undetermined whether accidentally or purposely inflicted (E980-989).

In-hospital case-fatality rates were calculated as the proportion of admissions with a discharge status of dead to the total number of admissions for a specific injury. The significance of changes was tested by chi-square tests for trend. An α error of 0.05 was used to determine statistical significance.

IV. RESULTS

A. Incidence of hospitalizations among infants and toddlers for near drownings and other injuries

-Near drowning-

Among *infants*, near drownings constituted 1% of injury hospitalizations in Canada during 1994-98, but caused 5% of in-hospital injury deaths. Among *toddlers*, near drownings also constituted 1% of injury hospitalizations but caused 28% in-hospital injury deaths in that period (Fig. 3.1). The average rate of near drowning hospitalization in Canada for fiscal years 1994-98 was 4.1 per 100,000 person-years for *infants* (n=62) and 7.1 for *toddlers* (n=440) (Table 3.1).

Rates of near drowning among infants and toddlers combined were 5.4 per 100,000 person-years in 1970-71, 8.6 in 1975-76, 11.7 in 1980-81, 9.6 in 1985-86, 10.4 in 1990-91 and 8.7 in 1995-96 among *males* and 3.0, 3.6, 3.9, 5.6, 5.9 and 5.7 among *females* (*The Canadian Red Cross Society, 1994*, Fig. 3.3a)). Among *males aged 0-4*, rates were 10.4 for 1991-92 (n=101), 7.3 for 1992-93 (n=74), 8.2 for 1994-95 (n=81), 8.7 for 1995-96 (n=85), 7.1 for 1996-97 (n=70) and 6.1 for 1997-98 (n=60) (Fig. 3.3b)). Among *females aged 0-4*, rates were 5.9 for 1991-92 (n=55), 6.2 for 1992-93 (n=60), 5.6 for 1994-95 (n=53), 5.7 for 1995-96 (n=53), 5.3 for 1996-97 (n=50) and 5.3 for 1997-98 (n=50). The rate of near drowning hospitalization among *children aged 0-4* (males and females combined) decreased by 17% for all Canada, from 7.2 per 100,000 person-years in 1991-94 to 6.0 in 1995-98 ($p<0.0005$ by χ^2).

Using CIHI data, available only from 1994-95 to 1997-98, we found that among *infants*, for both sexes together, the rates were 4.0 per 100,000 person-years in 1994-95 (n=16), 4.1 in 1995-96 (n=15), 3.0 in 1996-97 (n=15) and 5.5 in 1997-98 (n=20) ($p>0.25$ by χ^2 for trends). The rates among *toddlers* were 7.7 per 100,000 person-years in 1994-95 (n=118), 7.9 in 1995-96 (n=123), 7.0 in 1996-97 (n=109) and 5.8 in 1997-98 (n=90), a statistically significant improvement of 25% from 1994-95 to 1997-98 ($0.025<p<0.05$ by χ^2 for trends, Fig. 3.4).

The most frequent source of near drowning among *infants* was non-boating related incidents (93%, n=59, Fig. 3.5). Among *toddlers*, 92% of near drownings were

non-boating related incidents (n=416), while 3% were boating- (n=11), 2% land or air transport- (n=10) and 1% assault/neglect-related (n=3).

-All injuries-

Some 7,957 *infants* and 34,837 *toddlers* were hospitalized for injuries in Canada from 1994 to 1998. The average hospitalization rates of 1994-98 for all injuries were 529.2 per 100,000 person-years among *infants* and 563.2 among *toddlers* (Table 3.2). The most common injuries among both age groups were falls: the rates were 245.0 per 100,000 person-years (46%, n=3,684) among infants and 207.1 (36%, n=12,806) among toddlers.

The hospitalization rates for all injuries among *infants* were 537.3 per 100,000 person-years in 1994-95 (n=2,169), 554.1 in 1995-96 (n=2,031), 522.2 in 1996-97 (n=1,915) and 502.3 in 1997-98 (n=1,842), a statistically significant decrease of 7% ($0.005<p<0.01$ by χ^2 for trends). Among *toddlers,* the corresponding rates were 639.7 in 1994-95 (n=9,201), 567.3 in 1995-96 (n=8,800), 537.4 in 1996-97 (n=8,335) and 509.4 in 1997-98 (n=7,901), a statistically highly significant total reduction of 20% ($p<0.0005$ by χ^2 for trend).

B. Incidence of hospitalization by region for near drowning and other injuries among infants and toddlers

-Near drowning-

Among *infants*, the proportion of injury hospitalizations due to near drowning was 1.2% in British Columbia (n=12), 1.0% in Quebec (n=17), 0.7% in Ontario (n=18), 0.7% in the Prairies (n=13), and 0.3% in the Atlantic provinces (n=2), while the same proportion for all of Canada was 0.8% (n=62). There were no hospitalizations for near drowning in the Northwest Territories/Yukon region.

Among *toddlers*, the proportion of injury hospitalizations due to near drowning was 1.7% in Quebec (n=128), 1.4% in British Columbia (n=62), 1.2% in Ontario (n=138), 1.2% in the Prairies (n=94), 0.8% in the Northwest Territories/Yukon (n=2), and 0.5% in the Atlantic provinces (n=16), while the proportion for all of Canada was 1.3% (n=440) (Fig. 3.6). Near drowning hospitalization rates were higher among males than females both for infants and toddlers (Fig. 3.7).

The rates of near drowning hospitalization among *infants* were 6.6 per 100,000 person-years in British Columbia, 4.8 in Quebec, 4.7 in the Prairies, 3.1 in Ontario and 1.8 in the Atlantic provinces, while the national average was 4.1 (Table 3.1). Among *toddlers*, the hospitalization rates for near drowning were 8.8 per 100,000 person-years in Quebec, 8.4 in British Columbia, 8.3 in the Prairies, 6.3 in the Territories, 5.9 in Ontario and 3.4 in the Atlantic provinces, while the national average was 7.1.

In British Columbia, among both infants and toddlers, hospitalization after near drowning associated with boating was proportionally more frequent than in the rest of Canada (Table 3.3). Hospitalizations after near drowning due to land and air transport incidents were more frequent among the Atlantic region toddlers than those in other provinces.

-All injuries-

The rates of hospitalization after all injuries among *infants* were 676.6 per 100,000 person-years in the Prairies (n=1,862), 674.0 in the Northwest Territories/Yukon (n=52), 541.2 in British Columbia (n=979), 522.9 in the Atlantic provinces (n=580), 503.3 in Quebec (n=1,779) and 470.1 in Ontario (n=2,705) (Table 3.4). Among *toddlers*, the same rates were 717.7 per 100,000 person-years in the Prairies (n=8,187), 615.4 in the Northwest Territories/Yukon (n=249), 643.0 in the Atlantic provinces (n=3,007), 615.4 in British Columbia (n=4,552), 517.3 in Quebec (n=7,570) and 481.3 in Ontario (n=11,272) (Table 3.4).

The most important improvement over time was in the Atlantic provinces. *Infant* hospitalization rates in that region were 564.3 in 1994-95 (n=180), 577.1 in 1995-96 (n=152), 482.2 in 1996-97 (n=127) and 459.4 in 1997-98 (n=121), a statistically significant decrease of 19% ($0.025<p<0.05$ by χ^2 for trends), and *toddler* rates for the same periods were 724.9 (n=917), 685.9 (n=780), 589.2 (n=670) and 562.8 (n=640), a statistically highly significant decrease of 22% ($p<0.0005$ by χ^2 for trend).

C. In-hospital mortality of hospitalization for near drownings among infants and toddlers

From 1994-1997 in Canada, there were 77 in-hospital deaths among *infants* hospitalized after an injury and 189 among *toddlers* (Fig. 3.1). Of the *infant* in-hospital deaths, 28% had been hospitalized for assault/neglect (n=21), 26% for choking (n=20),

17% for traffic injury (n=13), 5% (n=4) for near drowning and 24% for all other injuries (n=19). Of the *toddlers* in-hospital deaths, 34% had been hospitalized for traffic injury (n=66), 28% among those in after near drownings, 13% among those in after choking incidents (n=24) and 24% for all other injuries (n=45).

1. In-hospital case-fatality ratio for near drowning compared to other injuries

The highest in-hospital case-fatality ratio of all injuries was for near drownings with 6.5% (4/62) mortality among hospitalized *infants* and 11.8% (52/440) among *toddlers* (Fig. 3.8). The next highest in-hospital case-fatality ratio was for traffic injuries, with 4.9% (13/267) mortality among hospitalized infants and 2.2% (67/3,067) mortality among hospitalized toddlers.

Among *infants*, near drownings after boating incidents had a case-fatality ratio of 33.3% (1/3), while non-boating incidents had a case-fatality ratio of 5.1% (3/59, Fig 3.9). Among *toddlers*, the case-fatality ratio was 33.3% (1/3) for assault/neglect incidents, 11.8% (49/416) for non-boating incidents, 10.0% (1/10) for land and air transport incidents and 9.1% (1/11) for boating incidents.

2. In-hospital case-fatality ratio for near drowning by region

Near drowning accounted for 5.2% of the *infant* in-hospital deaths during injury hospitalization in all of Canada (4/77), for 10.0% in Quebec (1/10), for 7.1% in Ontario (2/28), for 4.6% in British Columbia (1/22) (Fig. 3.10). Near drowning accounted for 28.6% of *toddler* in-hospital deaths after injury hospitalization in all of Canada (54/189), for 38.3% in Quebec (18/47), 37.1% in British Columbia (13/35), 33.3% in the Atlantic (3/9), 27.5% in the Prairies (11/40) and 17.3% in Ontario (9/52).

Among *infants*, the 1994-98 in-hospital case-fatality ratio after near drowning hospitalization in Canada was 6.5% (4/62). but was 11.1% in Ontario (2/18), 8.3% in British Columbia (1/12) and 5.9% in Quebec (1/17) (Fig. 3.11).

Among *toddlers*, the 1994-98 in-hospital case-fatality ratio of near drowning hospitalizations was 11.8% for all Canada (52/440), 19.4% in British Columbia (13/65), 18.8% in the Atlantic region (3/16), 14.1% in Quebec (18/128), 11.7% in the Prairies (11/94) and 5.8% in Ontario (9/138). There were no toddler in-hospital deaths after near drowning in the Northwest Territories/Yukon region during the study period. There was

no significant change in the national case-fatality ratio from fiscal year 1994-95 to 1997-98 (data not shown)

D. Duration of stay in hospital for hospitalization due to near drownings and other injuries

For near drownings and other injuries, the most frequent duration of stay in hospital was 1 day (Fig. 3.12). Among both *infants* and *toddlers*, assault/neglect and fire/burns led to longer hospitalizations than other injuries.

Near drownings had a slightly higher proportion of 2-day stays among *infants* and of >50-day stays among *toddlers* compared to the other injuries (Fig. 3.13). The average length of stay after near drowning hospitalization was 2.6 days for *infants* and 3.6 days for *toddlers* (Fig. 3.15). Among *infants*, near drownings not associated with boating had a longer average length of stay (2.7 days, n=59) than non-boating incidents (1.7 days, n=3). For *toddlers*, near drownings after assault/neglect led to the longest average duration of stay in hospital (11.7 days, n=3), followed by non-boating near drownings (3.6 days, n=416).

V. DISCUSSION

Trends in incidence of infant and toddler near drowning hospitalization in Canada

Between 1970-71 and 1990-91, the rates of hospitalization due to near drowning for children aged 0-4 years old in Canada almost doubled. This may be due to a gradual improvement in reporting and/or a real increase in the rate of near drowning incidents in and around the home, where cardiopulmonary resuscitation can be rapidly initiated. Increase use or success of resuscitation and ambulance services are other possibilities, such that a decrease in the death rate could be accompanied by an increase in the hospitalization rates (*The Canadian Red Cross, 1994*).

The national rate of hospitalization for near drowning among *children aged 0-4* (males and females combined) decreased by 30% from 1991-92 to 1997-98 ($0.01<p<0.02$ by χ^2 for trends). However, in infants from 1995-95 to 1997-98, rates of hospitalisation for near drowning did not decrease significantly. This is very different from the abrupt decrease in drowning rates that occurred between 1994 and 1995, when national infant drowning rates fell from 1.2 to 0.0, and were maintained at an average 0.3 until 1998. Rates of hospitalization for near drowning among *toddlers* decreased by

25% ($0.025<p<0.05$ by χ^2 for trends) between 1994-95 and 1997-98. This progressive decrease is also very different from the abrupt decrease that occurred between 1994 and 1995 in toddler drowning rates, when rates decreased by 47% from 3.0 to 1.6, and were maintained at an average of 2.0 until 1998.

The decrease in incidence of drowning that was observed nationaly during 1991-98 does not seem to have been paralleled by a similar reduction of near drowning rates. It is possible that increased awareness of the parents and other caregivers, and a shift to drownings in bodies of water in and around the home would increase the speed of detection and thus decrease the severity of the immersion incident, causing a shift from drowning to near drowning. In that case, incidence of near drowning would not be reduced and could even be increased. It is unlikely that a drop in drowning rates had no impact on the incidence of near drowning.

Incidence of infant and toddler injury hospitalization in Canada

The rate of hospitalization after all injuries among *infants* decreased by 7% ($0.005<p<0.01$ by χ^2 for trends) between 1994-95 and 1997-98. Among toddlers, the corresponding rate decreased by 20% ($p<0.0005$ by χ^2 for trends). The reduction in near drowning hospitalization incidence among infants and toddlers is thus similar to the decrease in incidence of hospitalization due to all other injuries among the same age groups. This reduction is also consistent with the general decrease in the incidence of unintentional injury hospitalization and death that has been observed in Canada for every age group and for nearly all causes of injury: the total number of injury admissions for all ages declined by 12% from 1994-95 to 1998-99 *(CIHI, 2001).*

The Prairies had injury hospitalization rates higher than the other Canadian provinces for both infant and toddlers. Reasons that could explain differences in hospitalization rates between provinces include 1) an increased incidence of injury, 2) a lower volume of incidents and 3) the admission of children who would be sent home ("treated and released") in other regions. Even if injured infants and toddlers from the Northwest Territories and Yukon are transferred to larger trauma centres in British Columbia and the Prairies, it is unlikely that the small numbers of such cases in the Territories would significantly inflate the hospitalization rates of these provinces.

Canada in comparison to other high-income countries regarding infant and toddler near drowning and injury hospitalizations

Canada's rates of near drowning hospitalization were 4.2 per 100,000 person-years among infants and 7.0 among toddlers. These rates were lower than the rates reported from Australia in 1996-97, which were 16.1 for infants and 29.7 for toddlers among the male population, and 11.3 for infants and 17.4 for toddlers among the female population (*AIHW, 1998*). Canadian rates of hospitalization for near drowning among toddlers were also lower than the 1991 Finland rate of 7.6 per 100,000 person-years, than the 1992 New Zealand rate of 26.8 and than the 1992 United States rate of 21.4 (*The Canadian Red Cross Society, 1994*).

The 1994-1998 hospitalization rate for injuries other than near drowning among Canadian infants was 529.2 per 100,000 person-years for both sexes combined. This is higher than in Australia where the rates were 123.0 for male and 99.0 for female infants. However, Canada's rates of injury hospitalization among toddlers of 563.2 for both sexes combined were lower than the equivalent Australian rates which were 900.0 per 100,000 population among males and 675.0 among females in 1996-97 (*AIHW, 1998*). Injury hospitalization rates in Canada are higher than in the United States where rates are around 270.0 per 100,000 for children aged 0 to 4 (*Grossman, 2000*).

In-hospital mortality of infant and toddler near drowning hospitalizations compared to other injuries in Canada

Among *infants*, during 1994-98, the proportion of injury hospitalization caused by near drowning was 0.8% for Canada, while British Columbia and Quebec were the regions with the highest proportions with 1.2% and 1.0% respectively. Among *toddlers*, the national proportion was 1.3%, while Quebec had the highest proportion with 1.8% of its hospitalizations due to near drowning.

Among *infants*, near drownings thus constituted approximately 1% of the injury hospitalizations in Canada between 1994 and 1998, but caused 5% of the in-hospital injury deaths. Among *toddlers*, near drownings also constituted 1% of the injury hospitalizations between 1994 and 1998 but caused 28% of in-hospital injury deaths in that period. The highest proportion was in Quebec, where 38.3% of in-hospital deaths after injury hospitalization were due to near drownings.

Nationally, the case-fatality rate following hospitalization for injury was highest when the hospitalization was for near drowning: 6.5% mortality among infants and 11.8% among toddlers. In California in 1990, the in-hospital case-fatality rate among hospitalized victims aged 0-19 was 15% (*Wintemute, 1990*).

Among *infants*, the highest case-fatality rate for near drowning admissions was in Ontario with 11.1%, followed by British Columbia with 8.3%. Among *toddlers*, the highest case-fatality rate was in British Columbia and in the Atlantic regions with 18.8% for each region. Thus, the fact that the highest proportion of injury in-hospital deaths due to near drownings in Quebec cannot be solely due to a poor survival rate as the case-fatality ratio is 5.9% among infants, which is lower than the Canadian average, and 14.1% among toddlers, which is only slightly higher than the average for Canada. The ratio of in-hospital deaths vs. survivors in Quebec was 1:6.1. This is lower than the ratio of 1:7.5 for all Canada. This ratio was 1:16.3 in Ontario, 1:7.6 in the Prairies, 1:4.3 in the Atlantic and 1:4.2 in British Columbia.

This lower ratio is consistent with the fact that there are many home pool immersion incidents in Quebec and that these are known to have better survival rates than drownings in other types of bodies of water such as rivers or lakes (*Quan et al, 1989*). The difference is probably due to the proximity of the telephone and to a smaller period during which the child was in the water before his/her fall in the water was noticed, and the initiation of cardiopulmonary resuscitation sooner after the incident (*Nixon et al, 1986*). Factors that could explain variation in case-fatality ratios are differences in the type of body of water in which the drownings occur, the health care system, the time to reach the hospital, or the hospitalization of cases with different levels of severity.

The number of delayed deaths from near drowning has been reported to approach the number of deaths from drowning (*Peterson, 1977*). In California, in 1990, the in-hospital case-fatality ratio among hospitalized victims was as high as 15% (*Wintemute, 1990).* It was reported in Australia that 69% of near drowning victims of all ages will have complete neurological recovery, 28% will suffer some selective deficit and 3% will survive in a permanent vegetative state (*Fenner, 2000*). In the United States, some authors estimated that 93% of near drownings made a full recovery, 1%

suffered moderate brain damage, and 6% were left with severe brain damage (*Zamula, 1987; Hazinski et al, 1993*), while others found the consequences of near drowning to be bimodal, with most of the cases either completely recovering or staying severely disabled due to permanent brain damage (*Wintemute, 1990*). In the United Kingdom, it was reported that 5% of children admitted for near drowning sustained severe neurological deficit (*Kemp and Sibert, 1992*).

Even if the outcome of a near drowning can be improved by cardiopulmonary resuscitation initiation immediately at the scene, some studies report that every patient that required CPR developed permanent brain damage and that delayed deaths from near drowning approach the number of deaths from drowning (*Peterson, 1977*).

Duration of stay in hospital of infant and toddler near drowning hospitalizations

The majority of infants and toddlers who required hospitalization after an injury between 1994 and 1998 stayed in the hospital for 1 day. Longer lengths of stay were associated with poorer survival rates. The average length of stay in hospital after a near drowning was 2.6 days for infants and 3.6 days for toddlers. In Australia, in 1996-97, the average length of stay after a near drowning was 2.0 days for infants and 1.8 days for toddlers (*AIHW, 1998*).

Assault/neglect and burns were associated with a long duration of stay in the hospital. Severe burns have longer convalescence than other injuries and assault/neglect may lead to prolonged hospitalization due to both the severity of injury but also to a longer stay in the hospital protective environment to give time for criminal investigations.

Limitations

Limitations of this study include the possibility of coding errors in the reporting of the cause of injury. Variations in the reporting of ICD-9 codes have been observed in some provinces. It is recommended that patient abstracts coded with ICD-9 injury codes also have accompanying E-codes but this is not always the case. Since E-codes are the basis for inclusion in the NTR database, these omissions may result in some underreporting of trauma. However, a review of the data by CIHI suggested that there is only minor underreporting (*CIHI, 2001*). Moreover, the province coded in the database was the province of hospitalization and not necessarily the province where the incident

took place or of residence of the child. That could cause some bias in the reported incidence of events in some regions. This may be particularly important in the Northwest Territories and Yukon where patients are sometimes hospitalized in other provinces.

While near drownings have the worst in-hospital survival among toddlers, their incidence is relatively small as compared to other injuries. Some of the rates in certain regions were thus based upon small numbers subject to random variation, and must thus be interpreted cautiously. It was not feasible to obtain detailed data from before 1994, the year the CIHI was established and took over from Statistics Canada the reporting of hospitalizations.

The 1996 census population was used as denominator for the calculation of rates for year 1995 as it was believed to be a better approximation of the true population than the 1991 census population. However it is possible that the 1996 census would have been a better approximation of the true population for year 1994 as well. This is unlikely to have had a significant impact on any of the findings even if it would statistically bias the results towards the null hypothesis among infants and away from it among toddlers, as the population of infants decreased between 1991 and 1996, while the population of toddlers increased.

Recommendations for prevention and future research

Self-closing, self-latching gates around home swimming pools have been proven to be highly effective in preventing toddler pool drownings and near drownings (*Wirtz et al, 2001; Blum and Shield, 2000; Deal et al, 2000; Fergusson and Horwood, 1994; Fergusson et al, 1984; Nixon et al, 1986; Grossman, 2000; Pitt and Balanda, 1991; Geddis, 1984; Milliner et al, 1980; Lawson and Oliver, 1978; Logan et al, 1998; Hazinski et al, 1993; Kemp and Sibert, 1992; Pearn and Nixon, 1977*). In 1991, only 3% of swimming pool drownings in Canada occurred in pools that were reported to be equipped with self-closing, self-latching gate and fence (*The Canadian Red Cross Society, 1994, 2001*). In Quebec, more than 95% of swimming pools were not equipped with self-closing/self-latching gates (Régie Régionale de la Montérégie, unpublished data).

Many near drownings in Canada would be eliminated by installing self-closing and self-latching gates as well as fences around every home pool. Canada should follow Australia and New Zealand in implementing legislations that require the installation of self-closing, self-latching gates and of isolation fences for every newly constructed and for existing swimming pools. At the least, incentive methods such as discounts on the purchase of adequate locks should be distributed to home owners. Pool buyers should be informed about and offered the devices by pool vendors. In addition, a lowering of the home owner's insurance prime could be an effective way to increase the use of adequate fences and gates.

Primary prevention should be the principal objective of drowning and near drowning prevention efforts. Parents, adults of parenting age, grandparents, caretakers and other community members need to become more aware of risk factors for drowning and near drowning among infants and toddlers. Parents have to be taught that to prevent infant bathtub drowning, they must remain with their child throughout bath times. They should be educated about the importance of constant monitoring of children when a pool is in proximity, to remove toys from pool after use and the value of cardiopulmonary resuscitation training for adults and older children residing in homes with swimming pools to decrease the incidence of toddler drowning. And it should also be realised that children themselves play a very important preventive role in immersion incidents. A study conducted in Australia in showed that child bystanders or the victims' playmates are responsible for raising the alarm in one quarter of cases, and that they themselves were responsible for initiating or continuing resuscitation in a sixth of the incidents (*Pearn and Nixon, 1977*).

Future research should include an ongoing follow-up of infant and toddler near drowning incidence in Canada. In Canada, the incidence and risk factors of drownings are monitored through the Canadian Surveillance System for Water-Related Fatalities. Near drownings should also be systematically reported, as drowning fatalities portray only a part of the immersion incident story in Canada.

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Table 3.1 Numbers and rates of hospitalization due to unintentional near drowning for infants and toddlers by region, Canada, 1994-1998

a) Infants (n=62)

Numbers	94-95	95-96	96-97	97-98	94-98
Atlantic	0	0	2	0	2
Quebec	3	5	3	6	17
Ontario	5	4	4	5	18
Prairies	5	2	1	5	13
British Columbia	3	4	1	4	12
NWT+Yukon	0	0	0	0	0
Canada	16	15	11	20	62
Rates					
Atlantic	0.00	0.00	7.59	0.00	1.80
Quebec	3.09	5.85	3.51	7.02	4.81
Ontario	3.33	2.82	2.82	3.53	3.13
Prairies	6.44	3.04	1.52	7.59	4.72
British Columbia	6.65	8.84	2.21	8.84	6.63
NWT+Yukon	0.00	0.00	0.00	0.00	0.00
Canada	3.96	4.09	3.00	5.45	4.12

b) Toddlers (n=440)

Numbers	94-95	95-96	96-97	97-98	94-98
Atlantic	3	6	4	3	16
Quebec	31	42	33	22	128
Ontario	34	41	30	33	138
Prairies	30	23	21	20	94
British Columbia	20	10	21	11	62
NWT+Yukon	0	1	0	1	2
Canada	118	123	109	90	440
Rates					
Atlantic	2.37	5.28	3.52	2.64	3.42
Quebec	8.76	11.35	8.92	5.95	8.75
Ontario	6.02	6.92	5.06	5.57	5.89
Prairies	9.91	8.23	7.52	7.16	8.24
British Columbia	11.34	5.33	11.18	5.86	8.38
NWT+Yukon	0.00	12.48	0.00	12.48	6.26
Canada	7.70	7.93	7.03	5.80	7.11

Note: The rates are expressed in number of events/100,000 person-years. The denominators are based on the national census data; 1991 for 1994 and 1995, and 1996 for 1996 and 1997. Atlantic refers to Newfoundland, Prince Edward Island, Nova Scotia and New Brunswick, Prairies refers to Saskatchewan, Alberta and Manitoba. Infants are <1 year old; toddlers are aged 1-4.

Table 3.2 Numbers and rates* of hospitalization for infants and toddlers by injury, Canada, 1994-1998

A-Infants (n=7,958)

Numbers	94-95	95-96	96-97	97-98	94-98
Fall	1,064	927	876	817	3,684
Choking	269	281	248	300	1,098
Assault/neglect	203	192	199	198	792
Poisoning	153	132	136	125	546
Fire/Burn	135	161	139	110	545
Traffic incident	69	60	69	69	267
Near drowning	**16**	**15**	**11**	**20**	**62**
Other	260	263	237	203	963
All injuries	2,169	2,031	1,915	1,842	7,958
Rates					
Fall	263.56	252.79	238.88	222.79	244.98
Choking	66.63	76.63	67.63	81.81	73.01
Assault/neglect	50.28	52.36	54.27	53.99	52.67
Poisoning	37.90	36.00	37.09	34.09	36.31
Fire/Burn	33.44	43.90	37.91	30.00	36.24
Traffic incident	17.09	16.36	18.82	18.82	17.75
Near drowning	**3.96**	**4.09**	**3.00**	**5.45**	**4.12**
Other	64.40	71.72	64.63	55.36	64.04
All injuries	537.28	553.85	522.22	502.31	529.12

B- Toddlers (n=34,851)

Numbers	94-95	95-96	96-97	97-98	94-98
Fall	3,649	3,148	3,043	2,966	12,806
Poisoning	1,818	1,739	1,552	1,376	6,485
Traffic incident	855	759	717	736	3,067
Choking	773	670	634	627	2,704
Fire/Burn	564	563	498	475	2,100
Assault/neglect	171	172	172	171	686
Near drowning	**118**	**123**	**109**	**90**	**440**
Other	1,853	1,626	1,610	1,460	6,549
All injuries	9,801	8,800	8,335	7,901	34,837
Rates					
Fall	238.14	202.95	196.18	191.22	207.03
Poisoning	118.65	112.11	100.06	88.71	104.84
Traffic incident	55.80	48.93	46.22	47.45	49.58
Choking	50.45	43.19	40.87	40.42	43.71
Fire/Burn	36.81	36.30	32.11	30.62	33.95
Assault/neglect	11.16	11.09	11.09	11.02	11.09
Near drowning	**7.70**	**7.93**	**7.03**	**5.80**	**7.11**
Other	120.93	104.83	103.80	94.13	105.87
All injuries	639.63	567.33	537.35	509.37	563.19

*Note: Other includes accidents due to natural and environmental factors, due to animals and due to drugs, medicinal and biological substances adverse effects as well as other injuries. Denominators are based on the national census data; 1991 for 1994-95, and 1996 for 1995-96, 1996-97 and 1997-98. Injuries were ranked using 94-98 rates. *Rates are number of deaths per 100,000 person-year. Infants are <1 year old; toddlers are aged 1-4.*

Table 3.3 Hospitalizations for near drowning among infants and toddlers by region and by external cause, Canada, 1994-1998

a) Infants (n=62)

	Atlantic	Quebec	Ontario	Prairies	British Columbia	NWT+Yukon	**Canada**
Non-boating	2	17	18	12	10	0	59
Boating	0	0	0	1	2	0	3
All causes	2	17	18	13	12	0	62

b) Toddlers (n=440)

	Atlantic	Quebec	Ontario	Prairies	British Columbia	NWT+Yukon	**Canada**
Non-boating	12	121	135	92	54	2	416
Boating	1	1	3	1	5	0	11
Transport	3	6	0	0	1	0	10
Assault/Neglect	0	0	0	1	2	0	3
All causes	16	128	138	94	62	2	440

Note: Boating transport drownings (E830-E832); Assault/neglect (E960-969); Transport (land and air)(E800-829, E833-848); Non-boating (All other unintentional near drownings) (E910). Infants are <1 year old; toddlers are aged 1-4.
Source: Canadian Institute for Health Information, 2000

Table 3.4 Numbers and rates* of injury hospitalization for infants and toddlers by region, Canada, 1994-1998

a)Infants (n=7,958)

Numbers	94-95	95-96	96-97	97-98	94-98
Atlantic	180	152	127	121	580
Quebec	457	439	454	429	1,779
Ontario	720	708	664	613	2,705
Prairies	533	476	438	415	1,862
British Columbia	258	246	224	251	979
NWT+Yukon	21	10	8	13	52
Canada	2,169	2,031	1,915	1,842	7,957
Rate					
Atlantic	564.26	577.07	482.16	459.38	522.90
Quebec	470.65	514.50	530.87	501.64	503.31
Ontario	480.00	499.29	468.27	432.30	470.11
Prairies	686.86	722.64	664.95	630.03	676.57
British Columbia	572.06	543.41	494.81	554.45	541.15
NWT+Yukon	1050.00	524.93	419.95	682.41	674.01
Canada	537.28	554.12	522.22	502.31	529.19

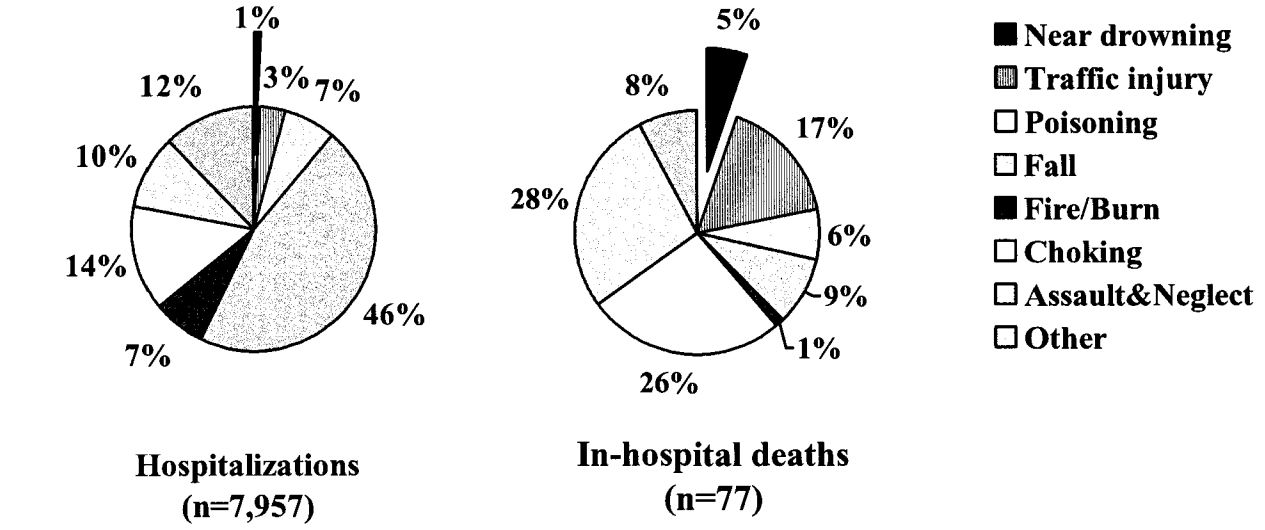
b)Toddlers (n=34,851)

Numbers	94-95	95-96	96-97	97-98	94-98
Atlantic	917	780	670	640	3,007
Quebec	2,041	1,869	1,842	1,818	7,570
Ontario	3,157	2,943	2,702	2,470	11,272
Prairies	2,412	2,037	1,944	1,794	8,187
British Columbia	1,208	1,096	1,132	1,116	4,552
NWT+Yukon	66	75	45	63	249
Canada	9,801	8,800	8,335	7,901	34,837
Rate					
Atlantic	724.90	685.90	589.17	562.79	642.99
Québec	576.88	505.27	497.97	491.48	517.25
Ontario	558.66	496.81	456.13	416.97	481.25
Prairies	797.09	729.18	695.89	642.19	717.74
British-Columbia	684.81	583.71	602.88	594.36	615.39
NWT+Yukon	835.44	936.33	561.80	786.52	779.83
Canada	639.63	567.33	537.35	509.37	563.19

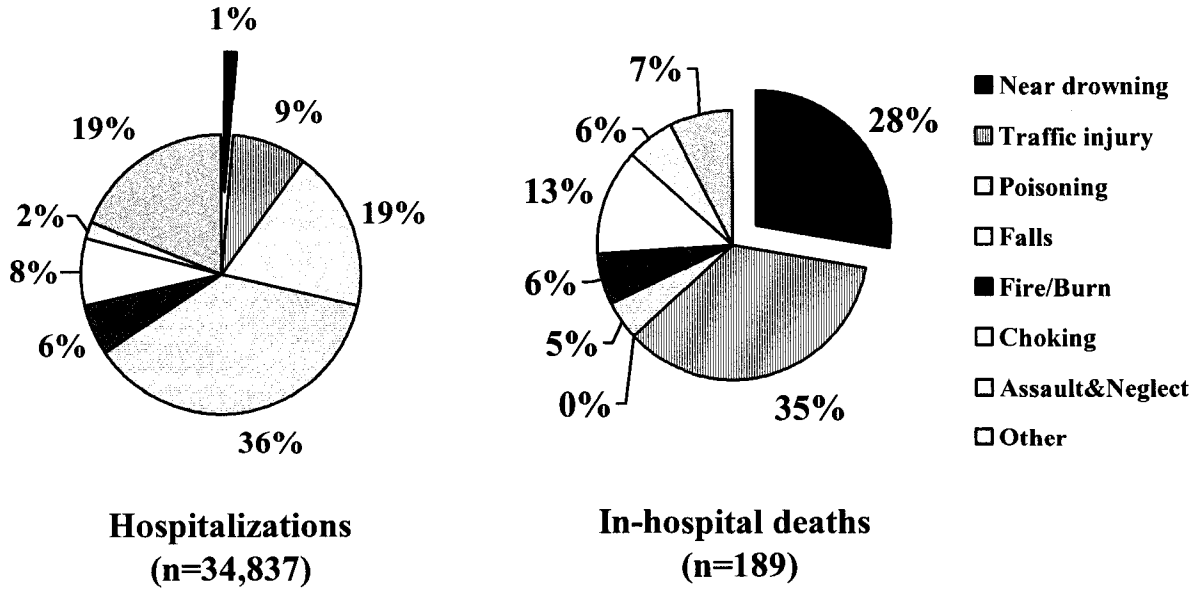
*Note:*Rates are expressed in number of events/100,000 person-years. Denominators are based on census data of 1991 for 1994-95, and of 1996 for 1995-96, 1996-97 and 1997-98. Atlantic refers to Newfoundland, Prince Edward Island, Nova Scotia and New Brunswick, Prairies refers to Saskatchewan, Alberta and Manitoba. Infants are <1 year old; toddlers are aged 1-4.*

Figure 3.1 Hospitalizations and in-hospital deaths for injury among infants* and toddlers* by cause, Canada, 1994-1998

A-Infants (n=7,957)



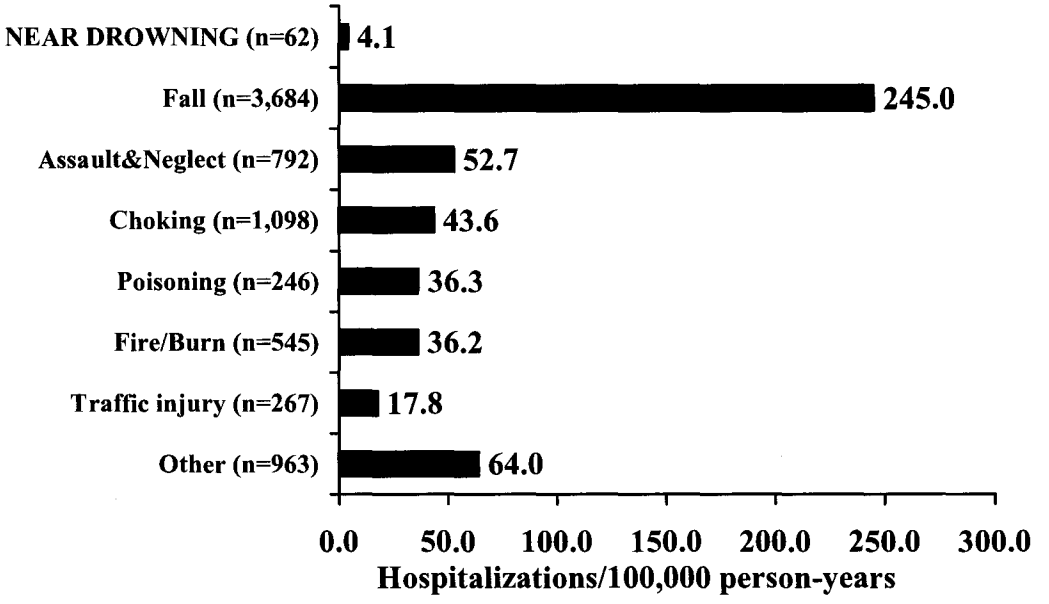
B-Toddlers (n=34,837)



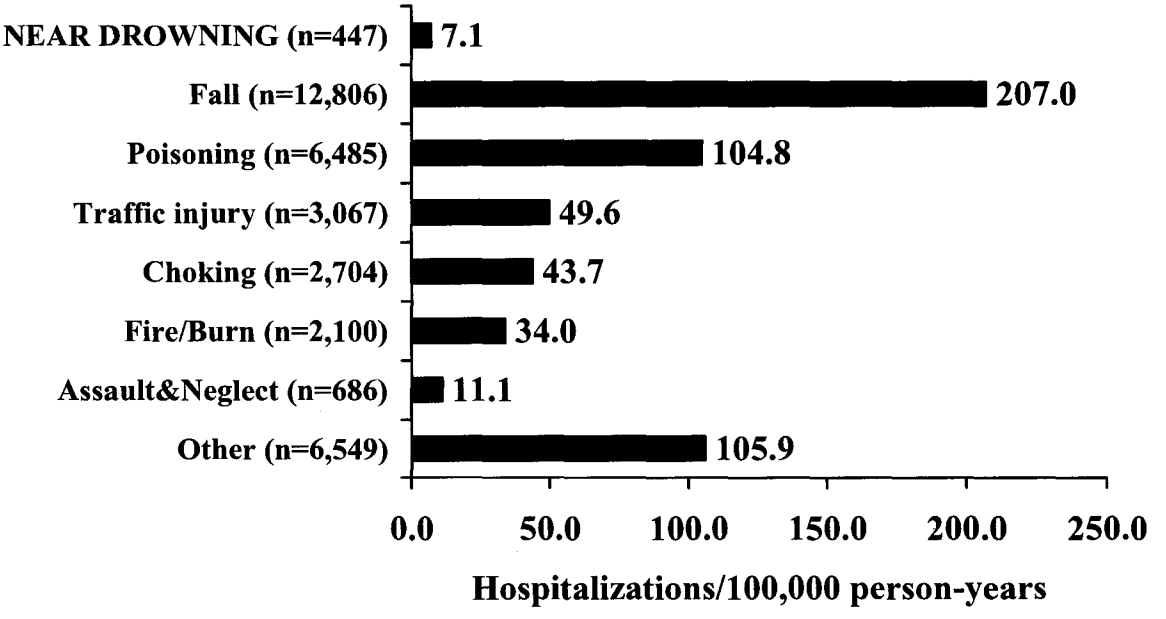
**Infants are children less than 1 year old; Toddlers are aged 1 to 4 years old.*
Source: Canadian Institute for Health Information, 2000

Figure 3.2 Rates* of hospitalization for injury by cause among infants and toddlers, Canada, 1994-98

A-Infants (n=7,957)



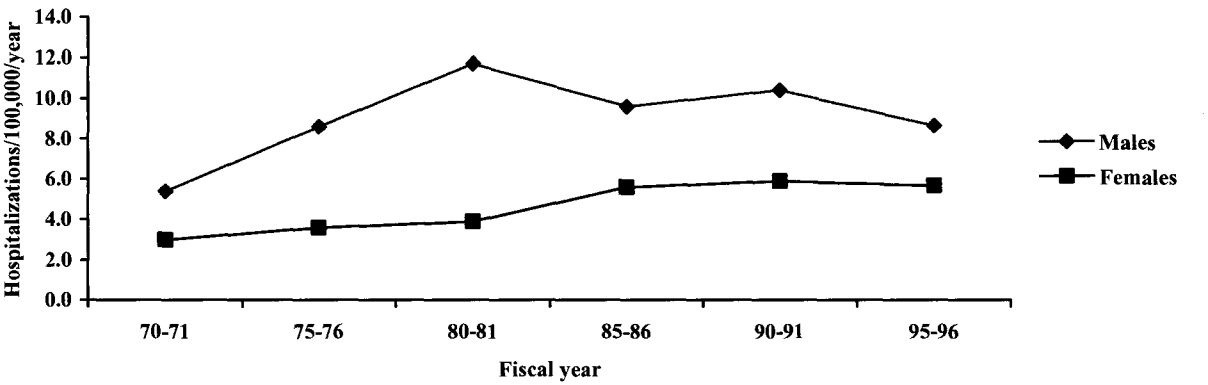
B-Toddlers (n=34,837)



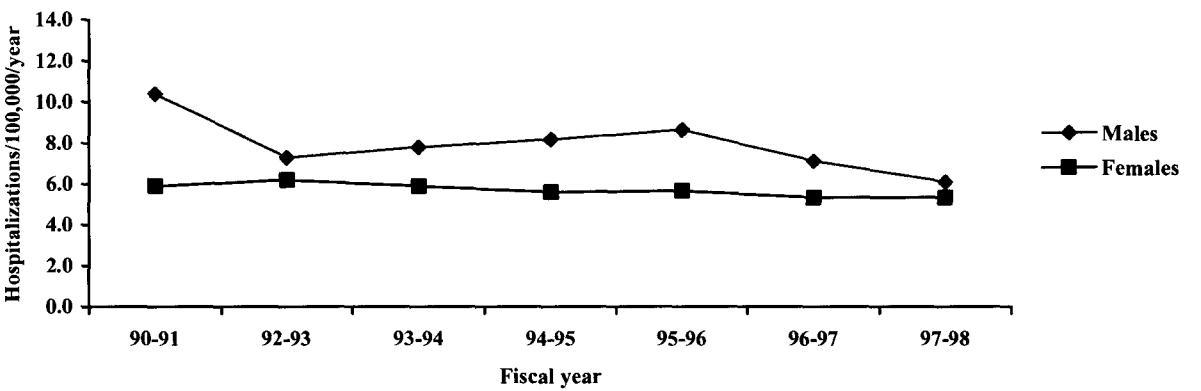
*Note: Average for all injuries (Infants: 529.12 (n=7,957), Toddlers 563.19 (n=34,837)) Infants are <1 year old; toddlers are aged 1-4. *Rates are averages for 1994-1998.*
Source: Canadian Institute for Health Information, 2000

Figure 3.3 Rate of near drowning hospitalization among infants and toddlers (0-4 yrs) by sex , Canada, 1971-98

a) From 1970-71 to 1995-96, by 5-year intervals

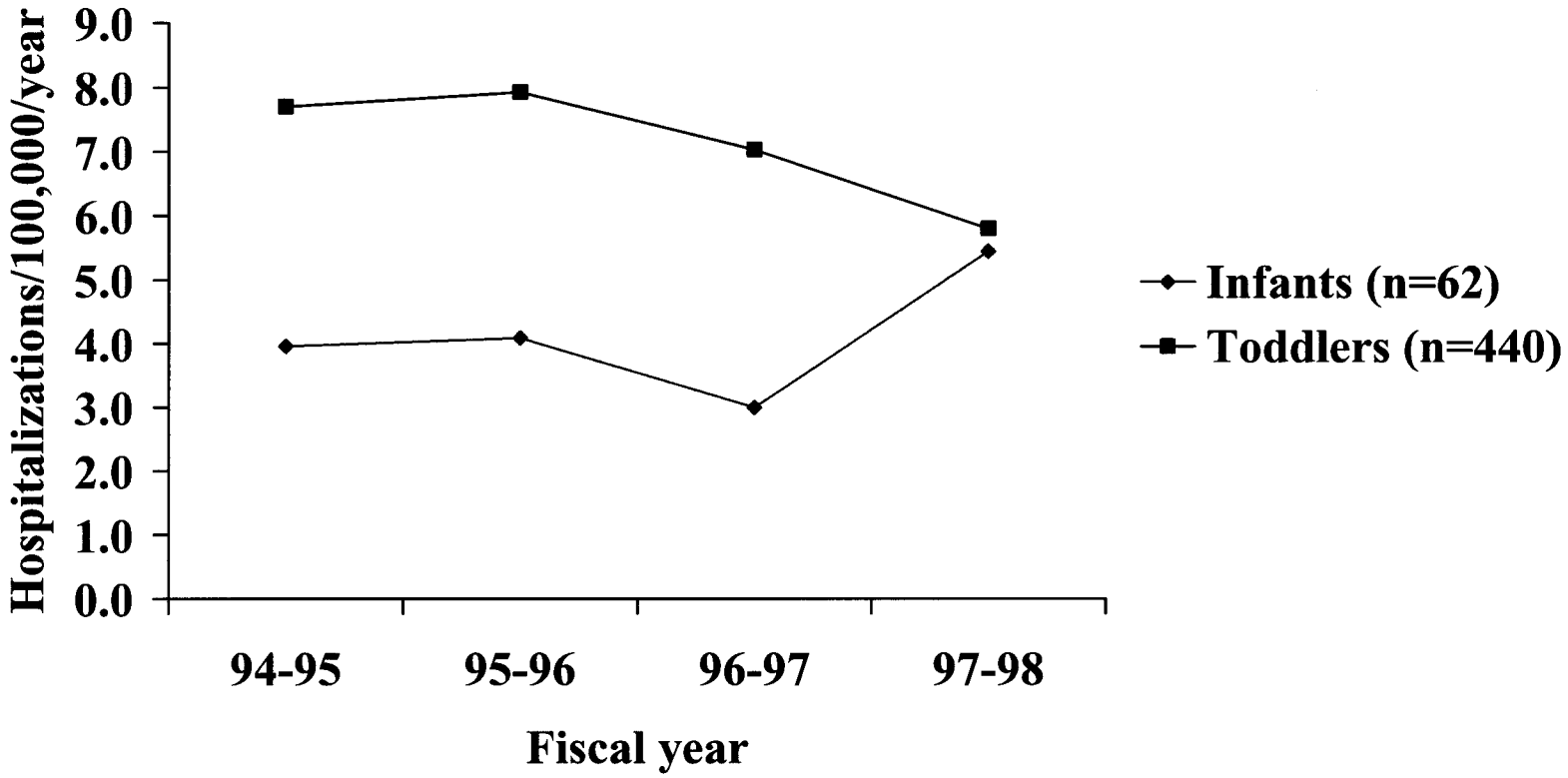


b) For 1990-91 to 1997-98, by 1-year interval



Note: Years are fiscal years from 1 April to 31 March. Adapted from Canadian Red Cross Society, 1994
Source: Statistics Canada, 1971-1991 and Canadian Institute for Health Information, 2000

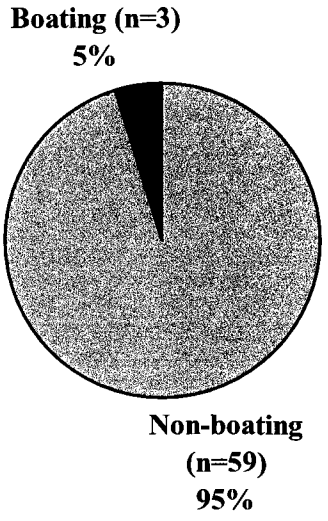
Figure 3.4 Rate of hospitalization for near drowning among infants and toddlers, Canada, 1994-1998



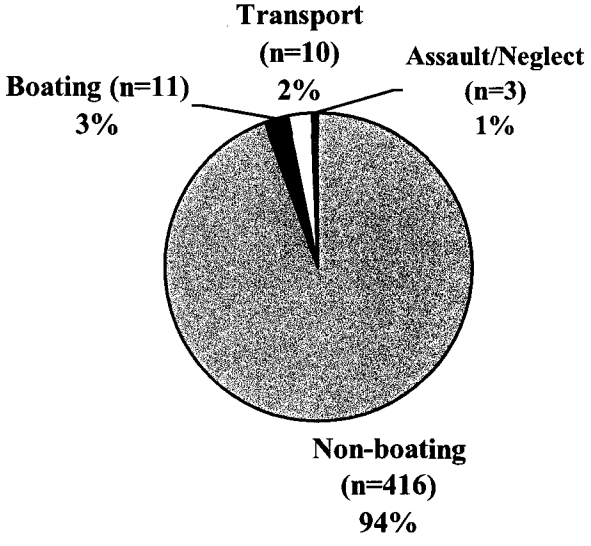
Note: Years are fiscal years from 1 April to 31 March. Infants are <1 year old; toddlers are aged 1-4.
Source: Canadian Institute for Health Information, 2000

Figure 3.5 Major external causes* of near drowning hospitalizations among infants and toddlers, Canada, 1994-1998

A-Infants (n=62)

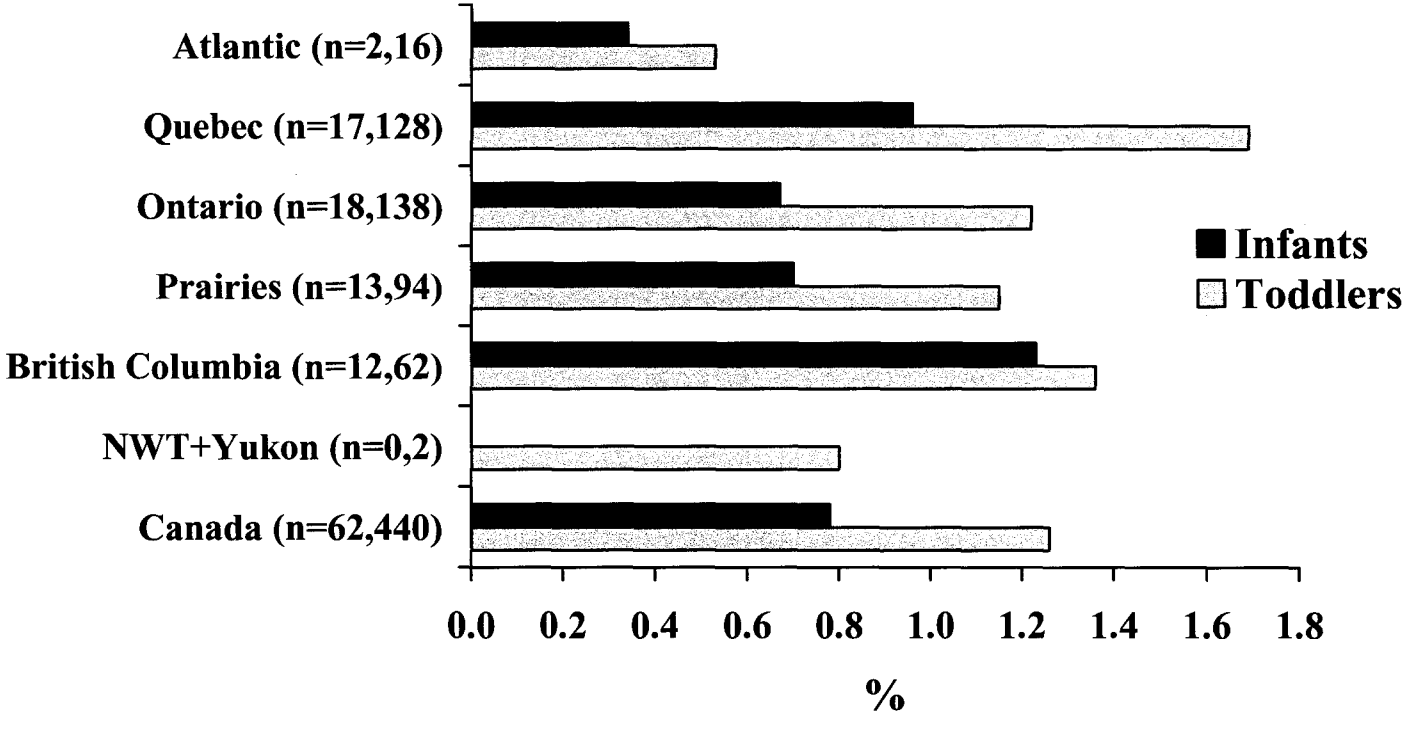


B-Toddlers (n=440)



*Note: *E830,E832 Boating transports; E960-969 Assault/Neglect; E800-829, E833-848 Land and air transport (land and air); E910 All other unintentional near drownings(= non-boating). Infants are <1 year old; toddlers are aged 1-4.*
Source: Canadian Institute for Health Information, 2000

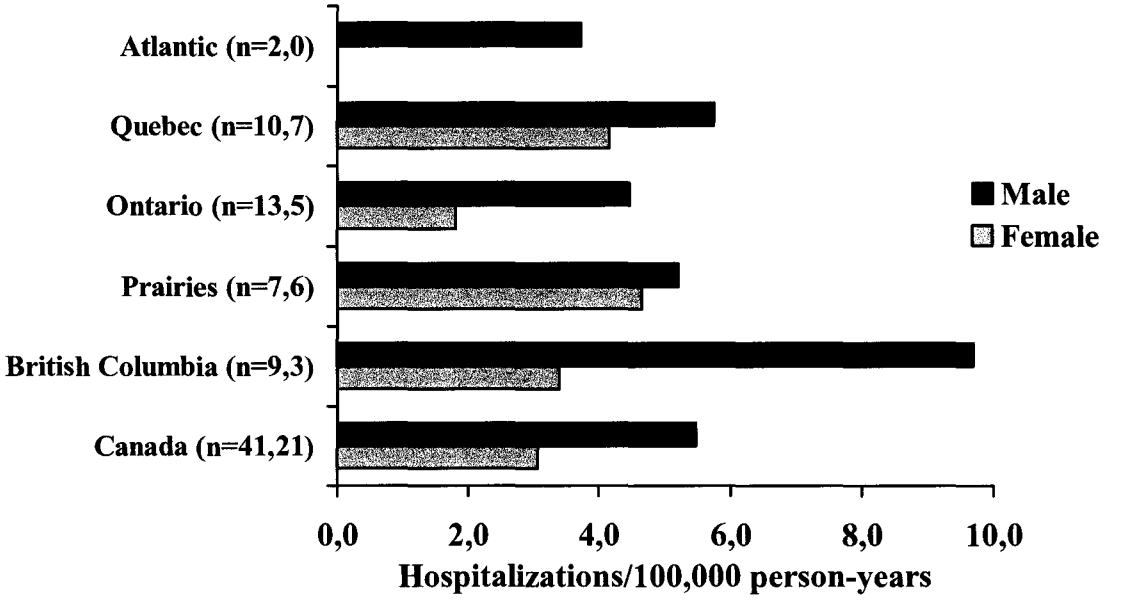
Figure 3.6 Percent of hospitalizations for all injuries due to near drownings among infants and toddlers, by region, Canada, 1994-1998



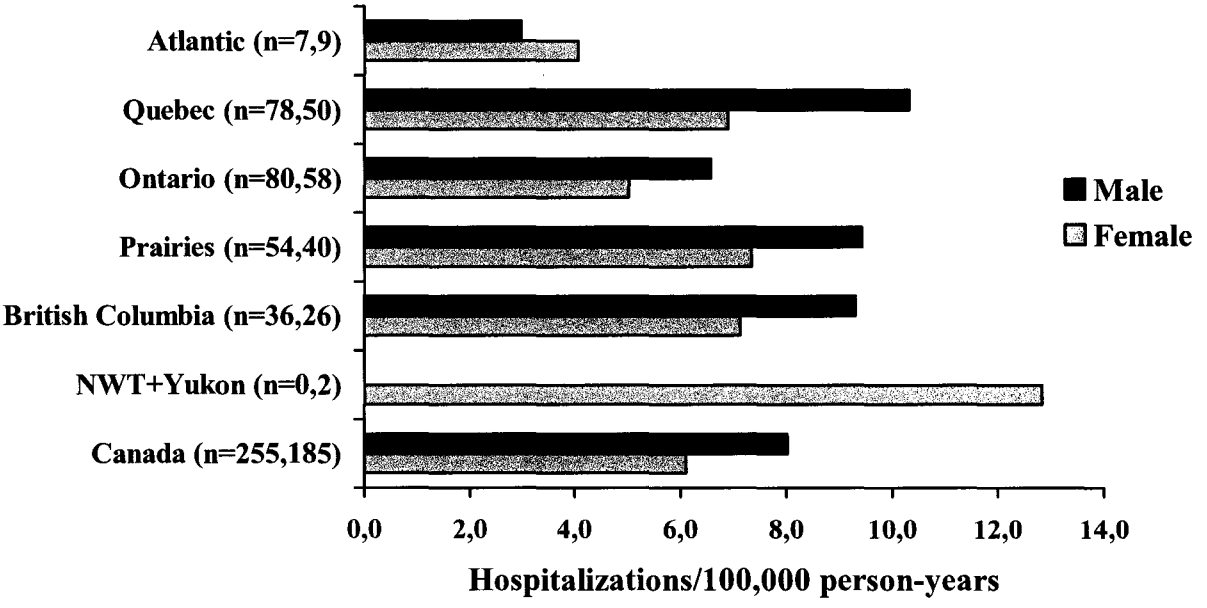
Note: Infants are <1 year old; toddlers are aged 1-4.
Source: Canadian Institute for Health Information, 2000

Figure 3.7 Rate* of near drowning hospitalization among infants and toddlers by region and by sex, Canada, 1994-98

A-Infants (n=62)



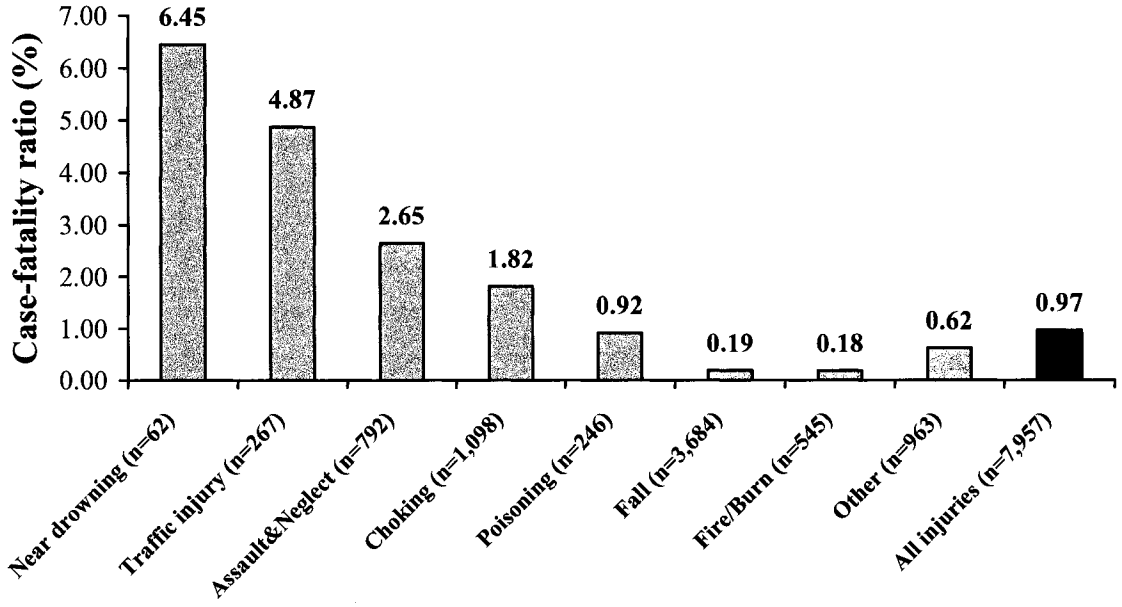
B-Toddlers (n=440)



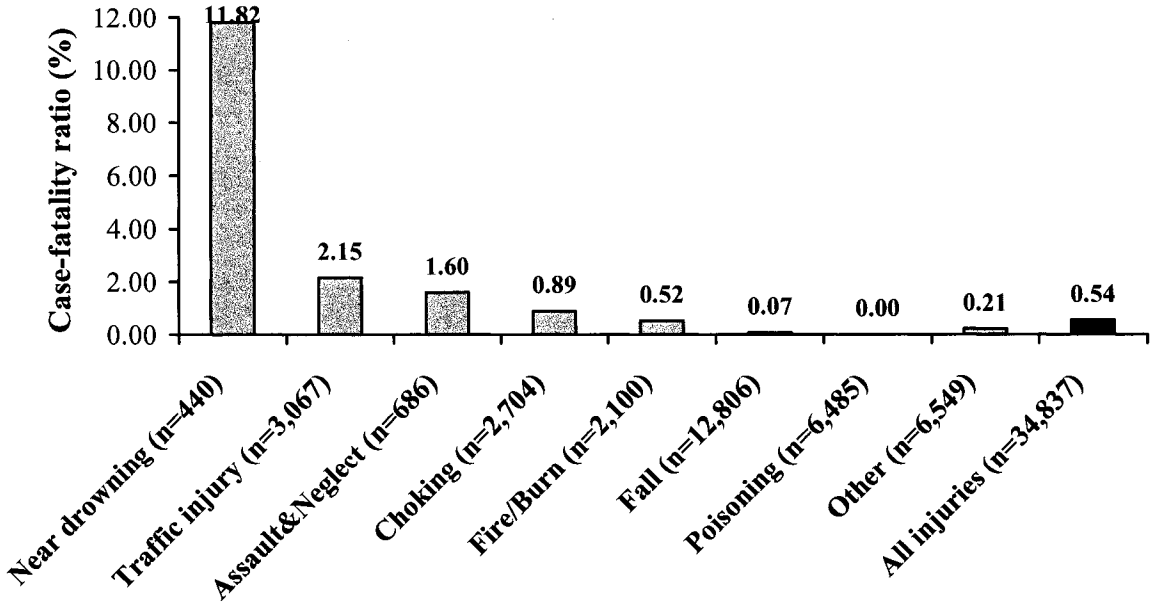
*Note: *Rates are average for 1994-1998. Infants are <1 year old; toddlers are aged 1-4.*
Source: Canadian Institute for Health Information, 2000

Figure 3.8 In-hospital case-fatality ratio during injury hospitalizations by type of injury among infants and toddlers, Canada, 1994-1998

A-Infants (n=7,957)



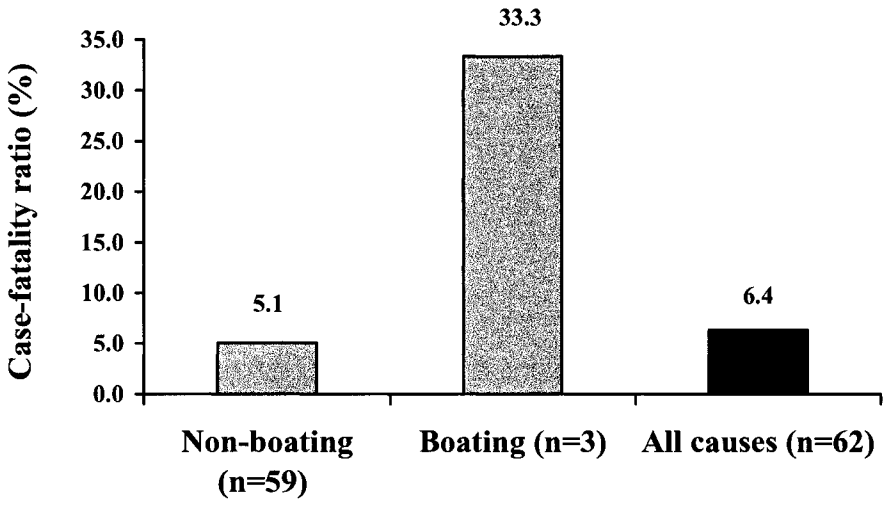
B-Toddlers (n=34,837)



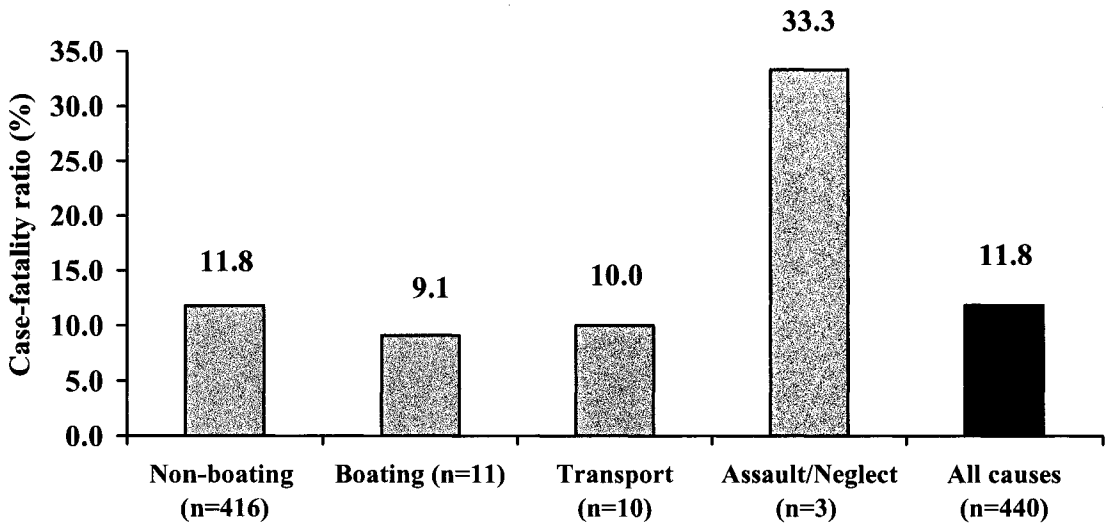
Note: Infants are <1 year old; toddlers are aged 1-4.
Source: Canadian Institute for Health Information, 2000

Figure 3.9 In-hospital case-fatality ratio during near drowning hospitalization by cause among infants and toddlers, Canada, 1994-1998

A-Infants (n=62)

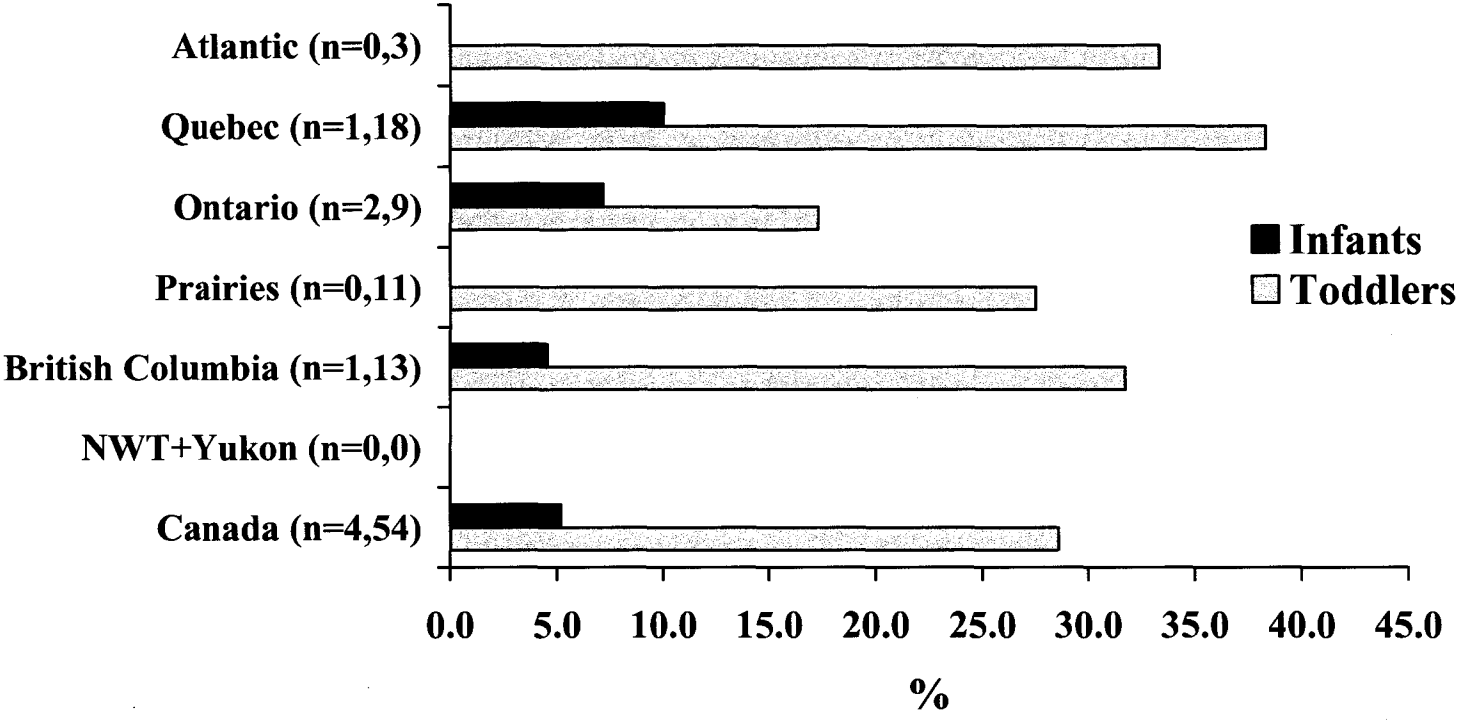


B-Toddlers (n=440)



Note: Boating transport drownings (E830-E832); Assault/neglect (E960-969); Transport (land and air)(E800-829, E833-848); Non-boating (All other unintentional near drownings) (E910). Infants are <1 year old; toddlers are aged 1-4.
Source: Canadian Institute for Health Information,2000

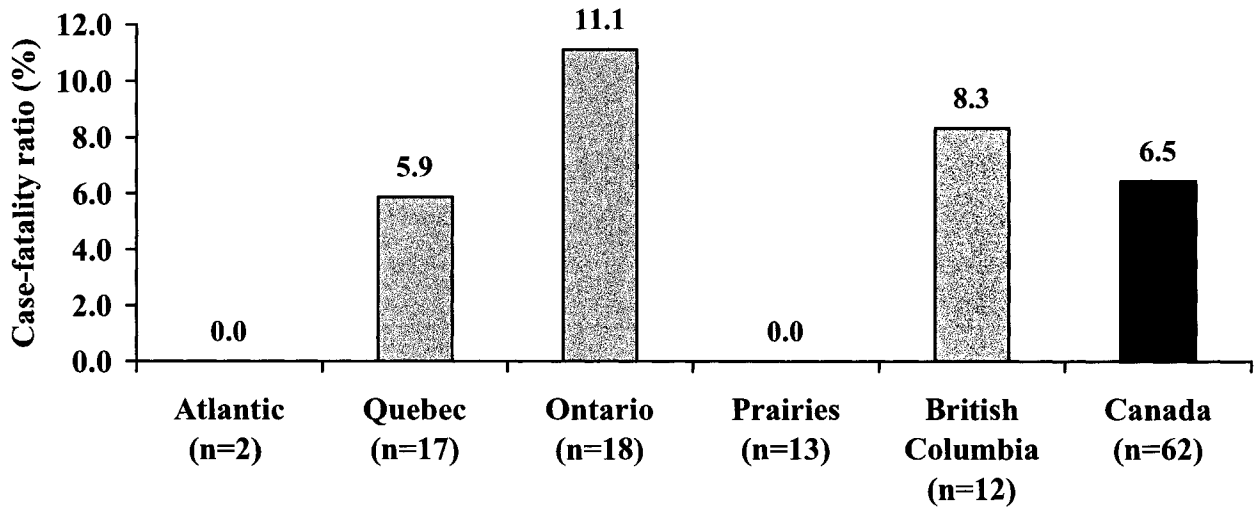
Figure 3.10 Percent of in-hospital injury deaths due to near drownings among infants and toddlers, by region, Canada, 1994-1998



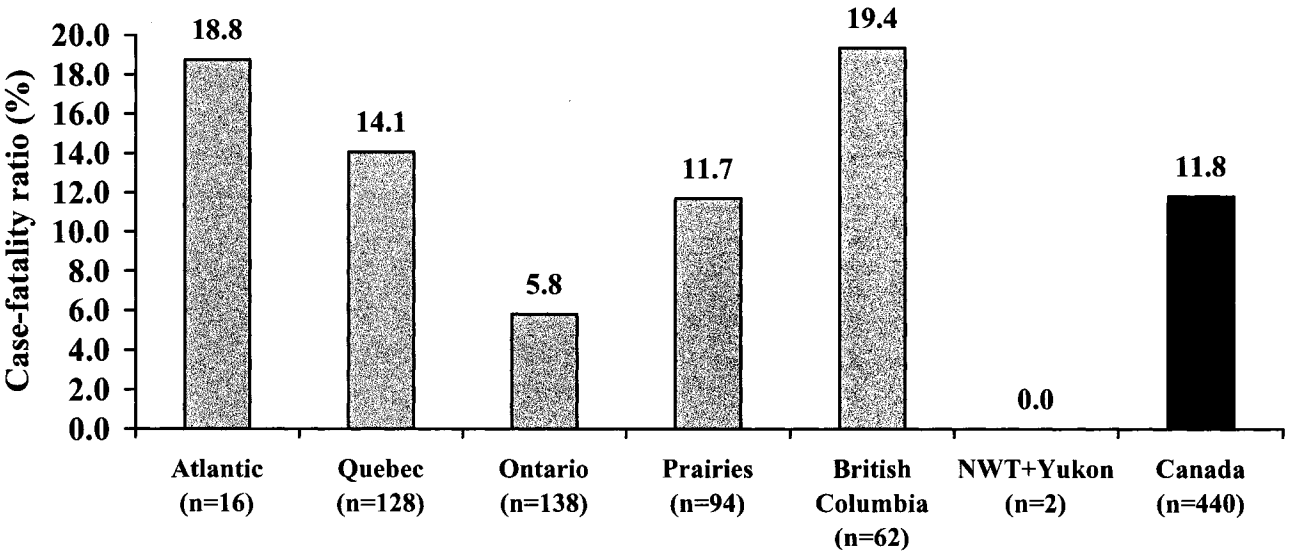
Note: Infants are <1 year old; toddlers are aged 1-4.
Source: Canadian Institute for Health Information, 2000

Figure 3.11 In-hospital case-fatality ratio of near drowning hospitalization among infants and toddlers, by region, Canada, 1994-1998

A-Infants (n=62)

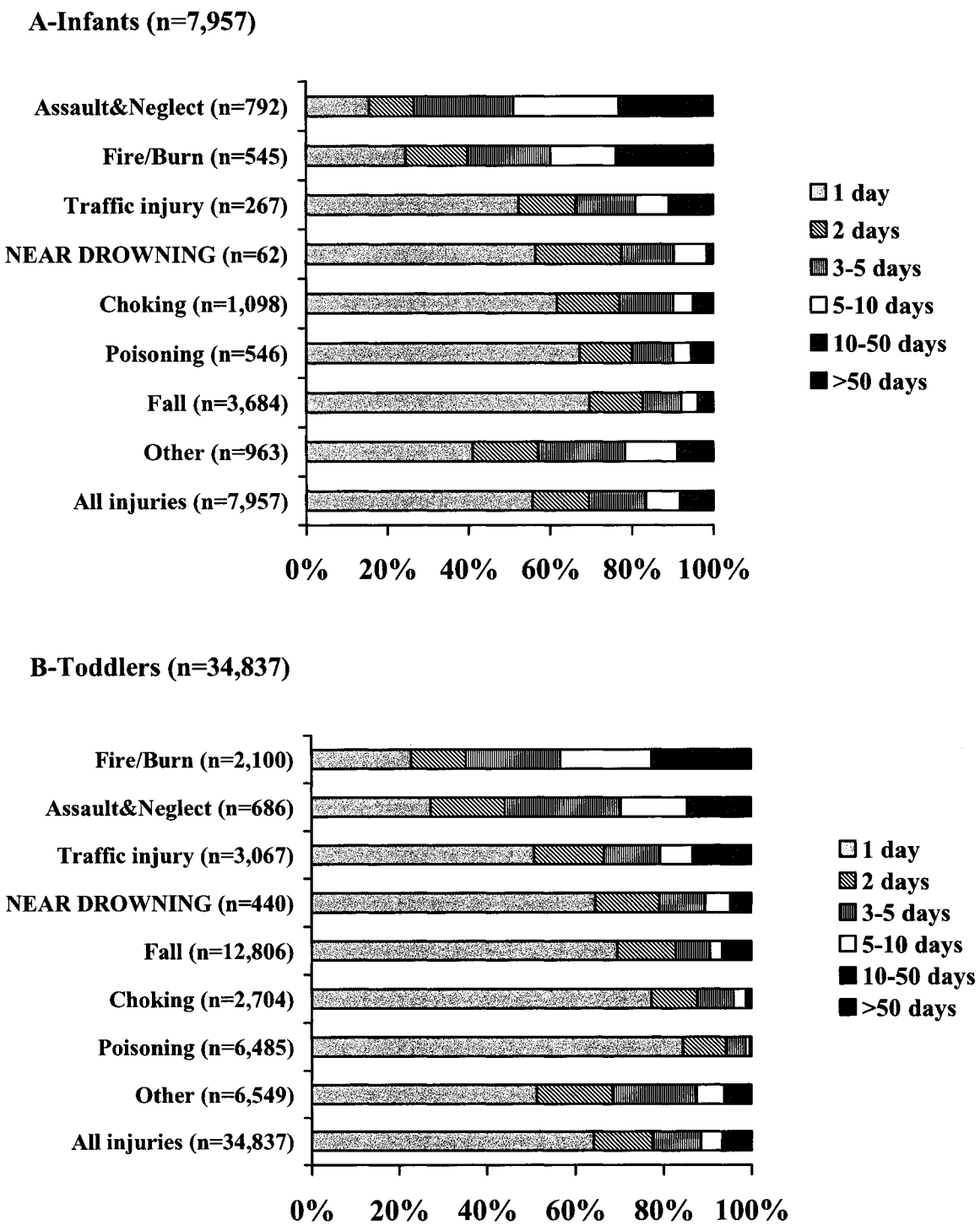


B-Toddlers (n=440)



Note: Infants are <1 year old; toddlers are aged 1-4.
Source: Canadian Institute for Health Information,2000

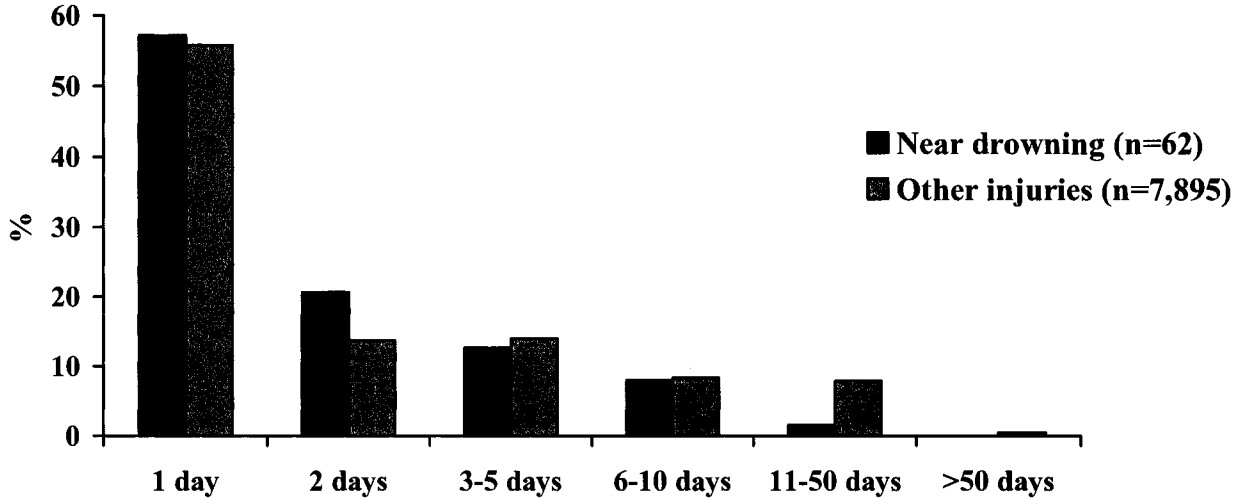
Figure 3.12 Length of stay in hospital by type of injury among infants and toddlers, Canada, 1994-1998



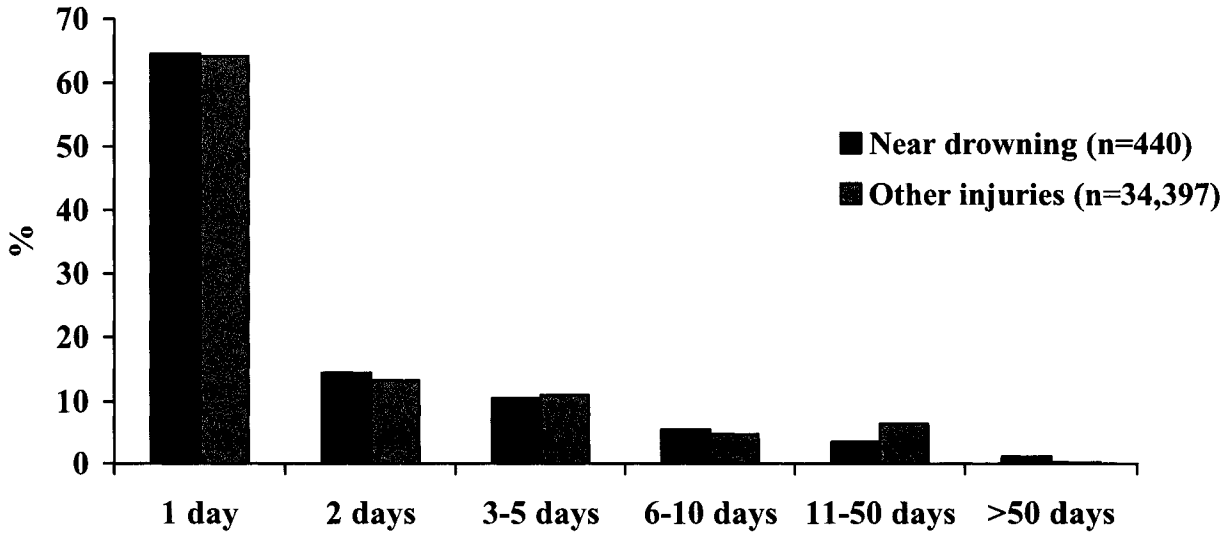
Note: Infants are <1 year old; toddlers are aged 1-4.
Source: Canadian Institute for Health Information, 2000

Figure 3.13 Percent of hospitalization per length of stay in hospital among infants and toddlers, Canada, 1994-1998

A-Infants



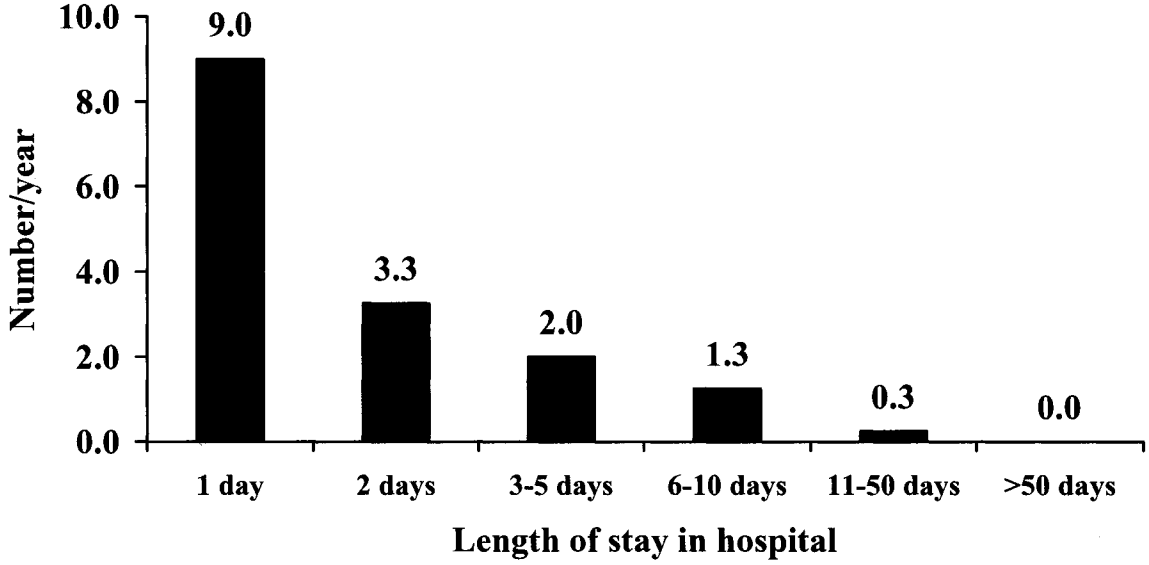
B-Toddlers



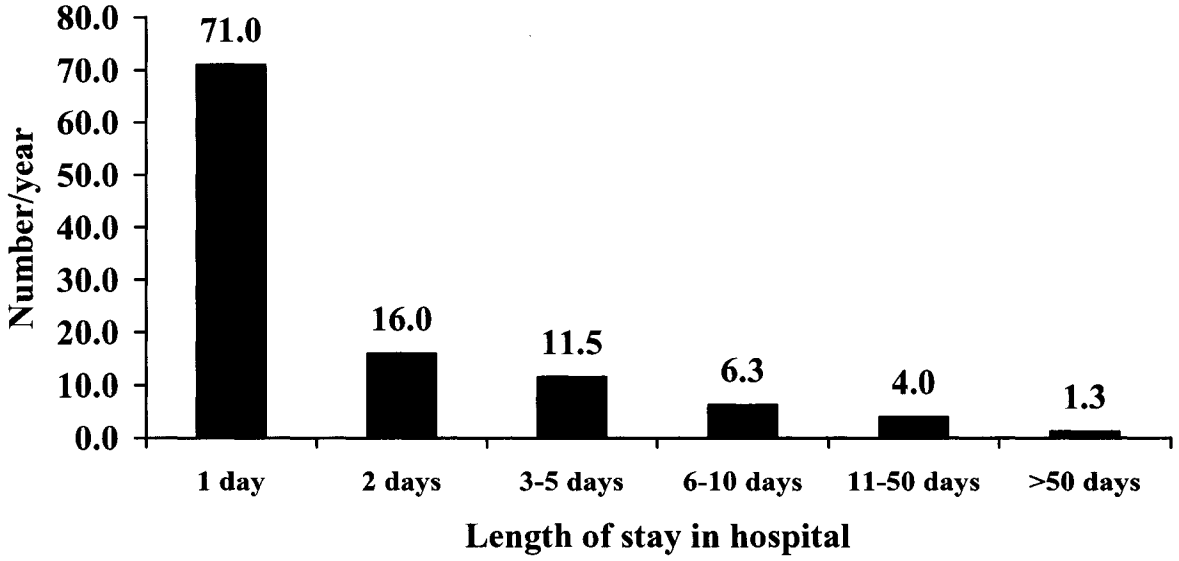
Note: Infants are <1 year old; toddlers are aged 1-4.
Source: Canadian Institute for Health Information , 2000

Figure 3.14 Average length of stay in hospital after near drowning hospitalization among infants and toddlers, Canada, 1994-1998

A-Infants (n=7,957)



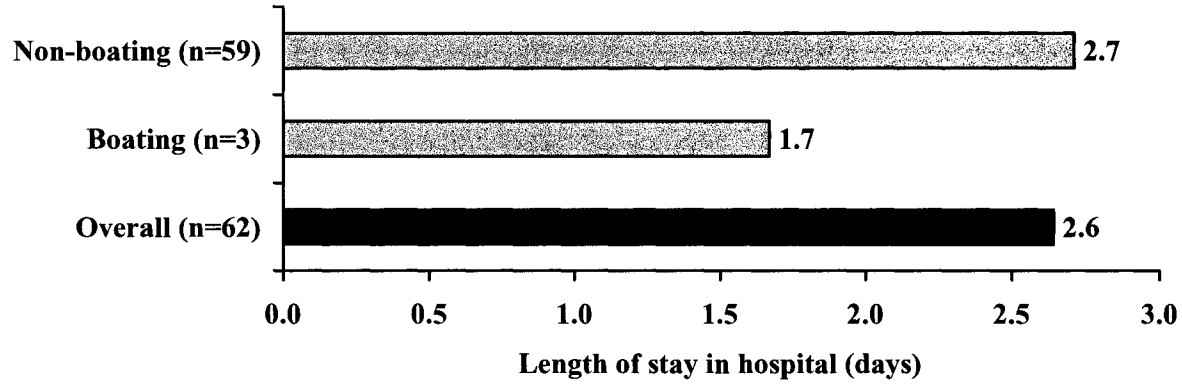
B-Toddlers (n=34,837)



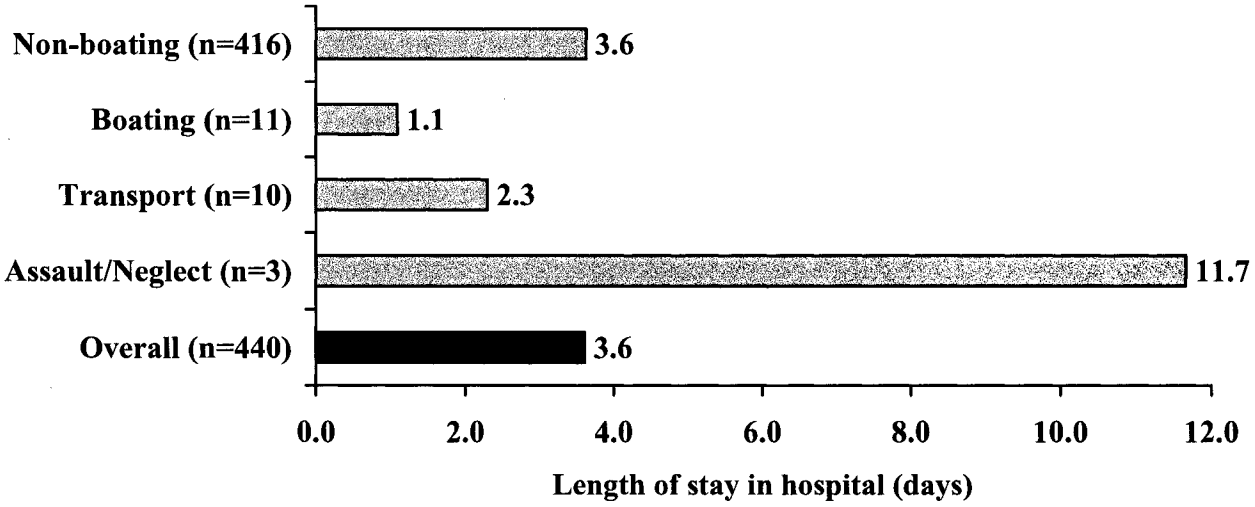
Note: Infants are <1 year old; toddlers are aged 1-4.
Source: Canadian Institute for Health Information, 2000

Figure 3.15 Average length of stay in hospital of hospitalizations due to near drowning among infants and toddlers, by type of drowning, Canada, 1994-1998

A-Infants (n=62)



B-Toddlers (n=440)



Note: Boating transport drownings (E830-E832); Assault/neglect (E960-969); Transport (land and air)(E800-829, E833-848); Non-boating (All other unintentional near drownings) (E910). For infants, there were 4 in-hospital deaths from near drowning including 3 non-boating and 1 boating; for toddlers, there were *54 in-hospital deaths including 49 non-boating, 1 boating, 1 transport and 1 assault/neglect. Infants are <1 year old; toddlers are aged 1-4.*
Source: Canadian Institute for Health Information, 2000

CHAPTER 4: General conclusion

A- Summary

The principal objective of this thesis was to assess the trends in incidence and risk factors of drowning among infants and toddlers in Canada from 1991 to 1998, using data from the Canadian Surveillance System for Water-Related Fatalities. In order to determine whether the trends seen in drowning were specific to this type of injury, the incidence of death due to other injuries as reported by Statistics Canada vital statistics was also assessed. Moreover, as it is likely that any intervention that had an impact on the incidence of drowning would have affected the incidence of near drowning as well, the incidence and risk factors of near drowning among infants and toddlers in Canada were also assessed and compared to other injuries, using hospitalization data from the Canadian Institute for Health Information.

Chapter 2 demonstrated that between 1991 and 1997, drowning was the fourth most common cause of injury death among infants and second among toddlers. Between 1991 and 1998, there were 28 infant and 321 toddler drownings in Canada. The average rate of drowning for 1991-98 was 0.9 per 100,000 person-years for infants and 2.6 for toddlers. Canadian infant drowning rates fell by 79% between 1991-1994 and 1995-1998, while toddler drowning rates fell by 38%. On the other hand the average mortality rate due to injuries other than drowning only decreased by 13% among infants and by 21% among toddlers. Thus, the decrease in drowning incidence in the mid 1990's was not paralleled by a similar decrease in the incidence of other injury deaths in the same period in Canada. Other high-income countries did not report such a decrease.

Bathtubs were the setting for 74% of the infant drownings in Canada from 1991 to 1998. Infant bathtub drowning rates decreased by 73% between 1991-94 and 1995-98. Swimming pools were the setting for 34% of the toddler drownings from 1991 to 1998. Ontario's rate of pool drowning among toddlers decreased by 45% and Quebec's by 29%. Of the Canadian pool drownings, 47% occurred in Quebec. In Quebec, 62% of toddler drownings occurred in swimming pools, as compared to 38% in Ontario. Quebec's toddler swimming pool drowning rate was 1.8 per 100,000 person-years while

the national average was 0.9. From 1993-98, 46% of the pool drownings in Canada occurred in above ground pool, 27% in inground pools and 27% in pool of unspecified type. In Quebec, 48% of the drownings occurred in above ground, as compared to 18% in Ontario. However, in 61% of the incidents in Ontario and in 39% of those in Quebec, the type of pool was unspecified.

Chapter 3 demonstrated that, among *children aged 0-4*, in Canada, the rate of near drowning hospitalization decreased by 33% from 1991-94 to 1995-98. The rate of hospitalization for all injuries among infants decreased by 7% and among toddlers by 20% from 1994-95 to 1997-98. The gradual reduction in near drowning hospitalization incidence among infants and toddlers is similar the decrease in the incidence of hospitalization due to all other injuries among the same age groups. It is also consistent with the general decrease in injury hospitalization and deaths among all ages reported by the Canadian Institute for Health Information (CIHI, 2001).

The decrease in drowning incidence among infant and toddlers that was previously seen in Canada in the mid 1990's was not accompanied by a reduction of similar magnitude in near drowning rates. It is possible however that there was a reduction in near drowning incidence but that it was masked by a shifting of the fatal drowning cases to less severe near drownings. It is unlikely that a fall in drowning rates had no impact on the incidence of near drowning.

Previous experience has shown that a decrease in the drowning rate is not necessarily paralleled by a decrease in the rate of near drowning. During 1970 to 1990, while the average rate in drowning deaths in Canada decreased, the rate of hospitalization for near drowning actually increased. While the reasons for dissimilar trends in drowning and near drowning are unknown, a shift to a greater proportion of drownings in and around the home may be part of the answer.

In Canada, the proportion of injury hospitalizations due to near drowning between 1994 and 1998 was 0.8% among infants and 1.3% among toddlers. Hospitalization after near drowning thus constituted approximately 1% of the hospitalizations due to injuries among both infants and toddlers; however, drowning was the cause of 5% of the infant in-hospital injury deaths, and of 28% of the toddler in-hospital injury deaths in Canada during 1994-98. In Quebec, among toddlers, 38% of

in-hospital deaths after injury hospitalization in 1994-98 were due to near drownings, which was higher than the other Canadian regions.

The in-hospital case-fatality rate of near drowning hospitalizations was the highest of all injury hospitalizations in Canada with 6.5% mortality among hospitalized infants and 11.8% among toddlers. The average length of stay in hospital after a near drowning was 2.6 days for infants and 3.6 days for toddlers.

This thesis thus showed that there was a significant decrease in the incidence of drowning among infants and toddler in Canada between 1991-94 and 1995-98, and that this decrease was not accompanied by a decrease of similar magnitude of all injury deaths. It also showed that there was a reduction in near drowning incidence, but that this decrease was not of the same magnitude as the decrease in drowning deaths.

B. Conclusion

The identification of risk factors and the study of the variations in the incidence of injuries between populations and over time are the basis of injury epidemiology and an essential element in any attempt to reduce the incidence or severity of injury. A major impediment to the development of successful injury prevention strategies is the lack of sound and systematic injury surveillance systems for epidemiological research. As Deal et al suggest, the most important task today may not only be to conduct more research on risk and protective factors for injury, but also to conduct rigorous trials of intervention strategies and to translate new and existing research findings into effective prevention programs *(Deal et al, 2000)*. A comprehensive surveillance system to monitor both fatal and non-fatal injuries is a necessity to focus the prevention efforts on the most important problems, as well as to evaluate whether they are successful. Unfortunately, Health Canada reported that as of the year 2000 (*Mackenzie and Herbert, 2000*), the Canadian Surveillance System for Water-Related Fatalities is the only national population-based surveillance system that provided comprehensive data on risk factors for injuries.

Regarding drowning prevention, parents, adults of parenting age, grandparents, babysitters and other caregivers and other community members need to become more aware of risk factors for drowning and near drowning among infants and toddlers. Parents have to be taught that to prevent infant bathtub drowning, they must remain

with their child throughout bath times, and not leave even for a moment. They should be educated about the importance of constant monitoring of children when a pool is in proximity and the value of cardiopulmonary resuscitation training for adults and older children residing in homes with swimming pools.

Canada should follow Australia, New Zealand and some US states in implementing legislations requiring and enforcing the installation of self-closing, self-latching gates and of appropriate isolation fences around every existing and new home swimming pool. Almost all swimming pool drownings of toddlers in Canada, thus one third of all toddler drownings from 1991 to 1998, could have been eliminated by self-closing, self-latching gates and isolation fences around every home pool. During 1991-99, 118 toddler drownings could have been prevented.

The three keys to success in preventing child injury, according to Sweden's experience, are the development of an adequate statistical data base for fatal and nonfatal injuries, the courting and nurturing of an injury prevention coalition to carry the word within their own organizations, and "infinite patience" (*Bergman and Rivara, 1991*). The Canadian Surveillance System for Water-Related Fatalities and the associated prevention programs is an important step towards a goal that Canada, as all industrialized countries, should aim at: to reach Sweden's rate of child injury death, currently the lowest in the world.

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