A DESCRIPTIVE STUDY OF TRAUMATIC HEAD INJURY DISCHARGES IN NEWFOUNDLAND AND LABRADOR, 1985-1998

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A Descriptive Study of Traumatic Head Injury Discharges in Newfoundland and Labrador, 1985-1998

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A thesis submitted to the

School of Graduate Studies

in partial fulfillment of the

requirements for the degree of

Master of Science

Division of Community Health
Faculty of Medicine
Memorial University of Newfoundland

March, 2002

St.John's Newfoundland

Abstract

Background: In the last decade the number of traumatic head injuries (THIs) admitted to Newfoundland's main neurosurgical referral centers has noticeably declined, particularly those resulting from motor vehicle accidents (MVAs). **Objectives:** To describe the epidemiology of THIs over the period 1985-98 and to assess any relationship between the incidence of THIs and use of helmets, seatbelts and alcohol. To determine the occurrence of these preventative measures. **Methods:** The charts of 2,739 patients from the greater eastern area of Newfoundland were reviewed. Other etiological factors affecting the incidence of THIs such as animal attacks, fall, brawls, sports/play, abuse, pedestrians, moose-MVAs, plane crashes, explosions, suicide attempts, being struck with a foreign object and work injuries were also examined. Sex, age, dates of injury and admission, ICD codes assigned, physiological outcome, hospital outcome and geographic location of injury were also collected. **Results:** Falls accounted for 31.2 percent of all THIs; MVAs, the second most common cause, accounted for 27.4 percent of all THIs. Most injuries were incurred by people ages 15 and younger (26 %). They were typically male and lived in the urban eastern area of Newfoundland. Enforcement and legislation on helmet and seatbelt use and drinking and driving were temporally associated with the observed decline in THIs. A great deal of safety education and public awareness, however, is still needed.

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Acknowledgements

I would like to say much thanks to my family and friends for their continued patience, encouragement and support throughout the entire Master's program. They could really appreciate how much completion of this program meant to me.

I would like to extend sincerest gratitude to my supervisor, Dr. George Fox, for his patience, guidance, support and interest through this process. His expertise in research and academics have helped me tremendously. I would like to thank very much the other members of my thesis committee, Dr. Sharon Buehler, Division of Community Health and Dr. Falah Maroun, Chief of Neurosurgery, Surgery Program, Health Sciences Center, for their interest, kindness, support and professionalism.

Finally, many thanks, as well, go out to the entire faculty and staff in the Division of Community Health for their administrative support and professionalism and also to Heather Cook of the Alcohol Drug and Dependency Commission and Pat Reid of the Newfoundland Brain Injury Association. As well, I would like to commend the medical record personnel of all health care institutions included in this study, in particular, Linda Byrne and Ricky Fisher of the Health Sciences Center and Eileen Hatch of the Janeway Hospital.

Chapter 1

Introduction

When someone experiences any kind of trauma, it has the potential to significantly affect the individual who incurred the injury, as well as one's family and society in general. The experience of a head injury is the most serious type of trauma. Traumatic head injuries (THIs) are a leading cause of mortality and morbidity (Cooper, 1993; Gronwall, Wrightson and Waddell, 1990).

A THI is any injury to the head/brain that occurs as a result of some foreign force being applied to it. There are various types of traumatic head injuries, these include ones such as open, closed and crushing (Beare & Myers, 1990; Gronwall et al., 1990). An open head injury occurs when the scalp gets lacerated and the skull fractured thus the brain matter becomes exposed and/or damaged (Gronwall et al., 1990). A closed head injury occurs when the head is accelerated, decelerated, or rotated and the brain is forced to follow the movement of the skull. The soft, jelly-like substance of the brain gets twisted and distorted in the process, which stretches and damages the nerve fibers (Gronwall et al., 1990). Finally, a crushing head injury is the crushing of the head between two foreign objects so that the base of the skull and the nerves that run out through it are damaged (Gronwall et al., 1990). Beattie (1997) points out that although the external evidence of injury can often be minimal when an injury occurs, the potential for underlying problems within the skull can be high.

In the province of Newfoundland and Labrador, a decrease in both the incidence and severity of THIs has been observed over the past 15 to 20 years. Maroun (1989) found, from 1977 to 1986, that pediatric head injuries significantly declined. These observations primarily come from the province's main neurosurgical referral centres, the Health Care Corporation of St. John's (HCCSJ), which includes adult and pediatric populations. The Carbonear General Hospital was also included. All hospitals are located on the Avalon Peninsula of the province. While the spectrum of THIs is quite varied, the neurosurgeons perceive that the decline overall in THIs is mostly a result of a decline in injuries resulting from motor vehicle accidents (MVAs) and bicycle accidents.

THIs are a major public health concern and prevention continues to be of paramount importance (National Institutes of Health [NIH], 2000). Many strategies can be and have been taken in an effort to help reduce both the incidence and severity of THIs. Primary prevention is aimed at individuals who have not yet suffered from injury (Mausner & Kramer, 1985). Intervention at this stage is intended to change conditions that put the individual at risk for injury (Riegelman & Povar, 1988). Due to the high rates of mortality and/or morbidity that often accompany head injuries, primary preventative devices/strategies such as seatbelt and helmet use and

not drinking and driving are important steps in minimizing the number/severity of head injuries.

The leading cause of THI varies across provincial, national, and international levels. For Newfoundland, unintentional falls are the most frequent reported cause of THI, making up 31.2 percent of total head injuries (National Trauma Registry [NTR], 2001). At the national level, THIs were also primarily caused by unintentional falls (44%) (NTR, 1999). In the United States, however, in 1999, injury resulting from MVAs takes the lead, accounting for 53 percent of all THIs (Centers for Disease Control [CDC], 2001).

The incidence of THIs continue to decline. In Newfoundland and Labrador, for example, there were 752 hospitalized admissions for THI in 1985 compared to 1999 where only 467 cases of THIs were admitted (Newfoundland and Labrador Centre for Health Information, 2000). Nationally, for Canada, there were 21,163 THI admissions in 1999 compared to 37,684 reported in 1985 (Statistics Canada, 2001). For the United States, the census for 2000 suggests that approximately 1.5 to 2 million people were reported to have incurred a THI. This has declined significantly from that reported for 1985 (NIH, 2000). In addition, the rates of hospitalization for people with THI in the United States has declined

nearly 50 percent since 1980 (Thurman, Alverson, Dunn, Guerroro & Sneizek, 1999).

For Newfoundland and Labrador, there were some identifiable factors that were felt to have had some impact on the decline of THIs and their severity. Most factors were preventative devices or strategies that involve the operation of motor vehicles, such as the wearing of a seatbelt or helmet when operating a motorcycle, ATV, skidoo, or pedal bicycle, and not drinking alcohol and driving. Although compulsory seatbelt usage was introduced in the early 1980's, it was not strictly enforced until the early 1990's when the demerit point system was introduced (Newfoundland Department of Justice, 1995). Also, in December 1994, the provincial government of Newfoundland revised the impaired driving law, enforcing a stricter 0.05 mmol of alcohol per litre of blood as opposed to the previously allowable level of 0.08 mmol (Newfoundland Department of Justice, 1995). Similarly, for the usage of bicycle helmets, four of the province's densely populated municipalities, three of them on the Avalon Peninsula, imposed compulsory bicycle helmet usage in 1994. Compulsory helmet usage for motorcycle riders was enforced provincially at a much earlier time in 1973 (Newfoundland Department of Government, Services and Lands, 1996).

Given the observations by clinicians and the many prevention-focused laws introduced into the province of Newfoundland and Labrador in the last

decade or so, one could hypothesize that this legislation had a significant influence on the declining incidence and severity of THIs.

It was the purpose of this research to investigate and confirm these clinical observations through a retrospective chart review of the hospital records of residents of Newfoundland and Labrador who incurred a THI and who were admitted to the main neurosurgical referral centres during the years 1985 to 1998. Other etiological factors and their association with THIs will also be explored.

Chapter 2

Literature Review

There is considerable research on THI prevention. Many interventions decrease both the frequency and severity of THIs. Primary prevention, in particular, is the most important. Intervention at this level is intended to change conditions that put the individual at risk for injury (Riegelman & Povar, 1988). Due to the serious nature of outcomes that often accompany THIs, it is in the population's best interest to prevent them.

THIs have a significant impact on mental, physical, psychological, and social well-being. THIs can affect one's financial status, quality of life, loved ones, and society in general. The U.S. NIH has suggested that under-diagnosed and, consequently, inadequately treated head injuries are likely to create a substantial burden on society (NIH, 2000).

Overall, the primary cause of THIs is falls. The second most common cause is MVAs, followed by bicycling injuries. Consequently, these are the focus of this study. For MVAs and bicycling, there are clearly preventative devices and behaviours that one can use to help prevent injury. Other factors also have the potential to induce THIs. Abuse, assault, animal attacks, sports/play, explosion, suicide attempts, plane crashes, work, brawls, being struck with foreign objects, and being a pedestrian all contribute to THIs. Beattie (1997) suggests that it is very important to determine the exact mechanisms of injury so as to be able to anticipate the probability of

significant injury. The various etiologies of THIs will be discussed in the next section.

2.1 MVAs

Head injuries attributed to MVAs are primarily due to: 1) non-use of seatbelt safety restraints; 2) drinking alcohol and driving; and 3) non-use of helmets by motorcyclists/pedal cyclists. This includes such vehicles as car/trucks, ATVs, skidoos, moose-MVAs, and motorcycles. Much research has been completed to illustrate this. As a randomized control trial would be both unethical and illegal to implement (Mausner & Kramer, 1985; Sackett, Haynes, Guyatt & Tugwell, 1991), the study designs used to evaluate safety measures were primarily retrospective in nature and were deemed best suited for this type of study.

2.1.1 Seatbelt Usage

It is felt that seatbelts offer the greatest protection for car/truck occupants. Seatbelt usage was found to be associated with a significant decrease in head injuries (Anderson, McLellan, Pagliarello & Nelson, 1990; Pratt, Richardson, & Yeoh, 1973). The evidence to support the usage of seatbelts in preventing the occurrence of head injuries is overwhelming. Decreased incidence of head injuries following implementation of compulsory seatbelt legislation has been found at the provincial (Clarke, 1999), national (Anderson et al., 1990), and international levels (Pratt et al.,

1973; Allen, Barnes & Badiwala, 1985; Rutledge, Lalor, Oller, Hansen, Thomason, Meredith, Foil & Baker, 1993; Thomas, 1990). However, some research suggests that seatbelts have no significant impact on decreasing head injuries (Marine, Kerwin, Moore, Lezotte & Baron, 1994; Swierzewski, Feliciano, Lillis, Illig & States, 1994).

In a 1986-1988 study of 383 patient accidents admitted to Sunnybrook Medical Centre, Toronto, Ontario, seatbelt use decreased fatalities in collisions by as much as 45 percent (Anderson et al., 1990). Here, belted occupants had a lower mean length of stay (LOS) ($p< 0.05$) and also a significantly lower ($p< .01$) injury severity score. Pratt et al. (1973) similarly found for Australia that seatbelt use significantly reduced injury for the 18,000 cases reviewed ($p< 0.01$). Many other studies have found that compulsory seatbelt legislation is associated with an increased use of seatbelts and decreased incidence of head injuries in particular.

In a British prospective study published in 1985, 611 car drivers and front seat passengers were followed for four months before and after seatbelt legislation was initiated (Allen et al., 1985). With legislation, the incidence of all injuries dropped significantly as compared to the four months prior to legislation. In particular, there was a significant decrease in face and skull injuries ($p < .05$).

In addition, Rutledge et al. (1993) looked retrospectively at 3,396 patients listed in the North Carolina trauma registry and cross-matched injury type with seatbelt use. The patients wearing seatbelts had significantly fewer, shorter hospital stays and less time requiring mechanical ventilation in the ICU. The most significant difference was noted in injuries sustained to the head/neck region ($P < .0001$).

In a prospective England study reported in 1990, 95 injuries incurred one year before legislation were compared with 85 injuries incurred one year after legislation (Thomas, 1990). The only type of injury that significantly decreased as a result of compulsory seatbelt legislation was that sustained to the head region ($p = .048$).

For the province of Newfoundland and Labrador, Clarke (1999) also found a significant decrease in THI admissions after compulsory seatbelt legislation became enforced. In a retrospective chart review of 201 patients at the Health Sciences Centre who had incurred head injuries as a result of an MVA, the results were consistent with the previously reviewed literature. This study found a significant increase in the number of people using the seatbelt when it was available for their use ($p< 0.05$). This was most noticeable in 1993-1994, when compulsory seatbelt legislation was more strictly enforced. Thus, it was surmised that enforcement of seatbelt legislation in Newfoundland likely played a significant role in the decline of

head injuries. Similar statistics about increased seatbelt use over this time period were also noted (Canadian Council of Motor Transport Administrators [CCMTA], 1997). A report generated by the Royal Canadian Mounted Police (RCMP) noted that seatbelt charges decreased from 3,513 in 1985 to 927 in 1999 (RCMP, 2000).

In contrast, a retrospective study from 1994 in Colorado on 256 MVA crash victims suggested that seatbelt usage had no significant impact on decreasing the incidence of injuries (Marine et al., 1994). The investigators suggest that other factors such as crash severity, type of vehicle, and type of impact all play important roles. While finding that seatbelt use was not a significant factor in decreasing injuries, this study is criticized for the known lack of reliability of restraint use information in the United States. As the laws and the degree of their enforcement vary across states, accuracy of such results is questioned. Swierzewski et al. (1994) similarly found that the fatalities incurred for those restrained were no different than those who were not restrained. A total of 118 victims were assessed from New York and the incidence of major head injury was the same.

2.1.2 Alcohol Usage

There is a considerable amount of research that shows an association between the incidence of head injuries and drunk driving and, in particular, a reduction of THI with a decrease in drinking and driving (Honkanan &

Smith, 1991; Cherpital, 1993; Waller, Stewart, Hansen, Stutts, Popkin & Rodgman, 1986). Some authors, however, have suggested that alcohol use may have no effect on THI or, paradoxically, may even have a protective effect on the occurrence of or severity of a head injury (Maio, Portnoy, Blow & Hill, 1994; Ward, Flynn, Miller & Blaisdell, 1982).

The literature on alcohol and THIs, however, does not specifically address the incidence of THI before and after drunk driving legislation was implemented. The studies, instead, are of a general nature, associating the use of alcohol with an increased incidence of injuries.

From a retrospective Finnish study reported in 1991, a trauma registry was reviewed for 14,920 patients who had MVAs and head trauma (Honkanan & Smith, 1991). The investigators found, as did Clarke's preliminary study, that those who suffered head injuries were eight times more likely to be intoxicated as opposed to those that were driving sober (OR=8.3; 95% CI=7.6-9.1). Head injury was found in 64.1 percent of people who were drinking and driving, as opposed to only 17.6 percent found in those driving and sober (Honkanan & Smith, 1991). Even amongst those operating motorcycles, there was a fourfold greater incidence of alcohol intoxication in nonhelmeted motorcyclists than in sober ones (Johnson, McCarthey, Miller & Peoples, 1995). Drinking and driving, they suggest, significantly increases one's risk of incurring a head injury.

In a retrospective study published in 1986 out of North Carolina, medical record data on more than one million people who were involved in MVAs was assessed (Waller et al., 1986). Once the effects of seatbelt use, age, speed, vehicle type and vehicle weight were adjusted for, it was concluded that the drinking driver was more likely to suffer serious injury or death than the non-drinking driver ($p < .05$). Drinking and driving, they also suggest, significantly increases one's risk of incurring a head injury.

Johnson (1989) and McKenzie and Single (1997) suggest that while impaired driving is a major cause of mortality and morbidity in Canada, alcohol consumption is, in fact, declining. Locke (1991), in her research from the Canadian national summary statistics, has found that drinking and driving charges and injuries incurred have decreased as a result of legislation being introduced. She has found that those fatally injured from drinking and driving had decreased from 52 percent in 1981 to 36 percent in 1989.

Johnson (1989) similarly has found that, even from 1981 to 1987 in the United States, the incidence of impaired driving has declined by 21 percent, going from 162,000 in 1981 to 128,000 in 1987. McKenzie and Single (1997) present some Canadian statistics that have also found alcohol consumption to be declining. They found that 72.3 percent of Canadians reported drinking in 1994 compared to 79 percent in 1990 and also that 45

percent of those who were fatally injured in MVAs had some alcohol in their blood.

Young people are most often the ones to be found drinking and driving. Cherpital (1993) reported the age group most likely to incur such an injury from drinking and driving was 18-49 years. Honkanan and Smith (1991) recognized a broader age range of 15 to 64 year old males to be most susceptible.

Males, in particular, young males, are most often found to be the ones drinking and driving and incurring a THI as a result. Cherpital (1993) found in her Californian study of 1,150 people 18 years and older, that males (56 %) who were drinking (45 %) were most likely to engage in high risk behaviour such as drinking and driving and to incur a THI as a result of it. Ward et al. (1982) also note that in their Texan study of 1,198 patients, 32 percent had consumed alcohol prior to the injury, thus engaging in risky behavior. This occurred especially for young males (36 %) as opposed to females (20 %). Finally, Honkanan and Smith (1994) in their Finnish study of 108 patients admitted to the emergency room of a local hospital found that head injury was more common among the intoxicated (64.1 %) than among the sober (17.6 %), particularly among males (19.7 %) as opposed to females (9.5 %).

Many reasons have been put forth as to why people continue to drink and drive. As Ward et al. (1982) have found, males are much higher risk takers than females. Also, there exists the perception among drinkers that they won't get caught because they are only going short distances, and the distorted perception, derived from alcohol consumption, that they are able to drive (Waller et al., 1986).

Contrary to popular belief, some studies suggest that alcohol has a protective effect on the brain once an injury is sustained. Mortality is significantly decreased in those intoxicated drivers compared to those not intoxicated (Maio et al., 1994; Ward et al., 1982). However, the survivors had a greater incidence and severity of head injuries compared to the non-intoxicated people. Ward et al. (1982) found that the total mortality in the intoxicated group was significantly less than in the group with no detectable alcohol level ($p < 0.01$). Maio et al. (1994) similarly found in their retrospective study out of Michigan on 176 cases that injury and length of stay was no more significant for those drinking and driving than it was for those who were not ($p > 0.05$). These studies suggest that due to the increased levels of circulating catecholamines caused by the presence of alcohol, the body is better prepared physiologically to withstand injury. Hyper-metabolism is one of the body's metabolic responses to injury.

Catecholamines, which increase metabolism, are the mediators (Ward et al., 1982).

The argument for increased catecholamine levels, however, is not without criticism. One group disputes the notion of alcohol's protective effects (Waller et al., 1986), and suggests that alcohol may increase cerebral edema and thus exacerbate injury. As a result, intoxicated people presented to emergency rooms with THIs may be misclassified as being more seriously injured than they actually are. As a result, their apparent quicker recovery from a presumably more serious injury may skew the data in a positive fashion. Additionally, if drunk drivers are pronounced dead at the scene, this would bias the sample of patients presenting to the hospital as a less severely injured group.

In Newfoundland and Labrador, the results are similar to those reported in the literature. An earlier study by Clarke (1999) found a declining trend in drinking and driving over the period of 1992 to 1998. This trend was most notable from 1994 onwards.

In a report by the RCMP (2000), the number of impaired driving charges decreased from 1,850 in 1985 to 1,306 in 1999. It may be surmised that the decreased use of alcohol before driving was positively associated with the decreasing incidence of head injuries. This finding parallels the

results found on the national scene for the whole of Canada in the years 1987-1995 (CCMTA, 1997).

2.1.3 Helmet Usage

The usage of helmets either on motorcycles or pedal bicycles has been found to significantly reduce THIs. But these findings, as well, are not without criticism. Bicyclists who wear helmets will reduce their risk of sustaining a head injury by 88 percent (Ontario Neurotrauma Foundation, 1998). In a Texas study on the whole of the United States data base, non-helmeted riders are 14 times more likely to be involved in a fatal crash than the bicyclists wearing a safety helmet (Winslade, 2001). Henderson (1995), in his Australian review of bicycle helmet effectiveness, has similarly suggested that bicycle helmets substantially reduce the risk of head injury in a crash by minimizing brain tissue distortion that occurs on impact.

According to many, bicycle helmets have been found to significantly decrease the incidence and severity of THIs (Sosin, Sacks & Webb, 1996; Guohua, Baker, Fowler & DiScala, 1995; Thompson, Rivera & Thompson, 1996; Linn, Smith & Shepps, 1998; Zentner, Franken & Lobbecke, 1996). This was particularly observed, when compulsory helmet legislation was implemented (Linn et al., 1998; Robinson, 1996). Vulcan and Lane's (1998) summary article from Australia adds that bicycle helmets, when properly

worn, are a proven intervention and the injury prevention community should play its part in ensuring that they become widely used.

In a descriptive Canadian study, data on helmet usage was collected on 1,462 injured bicyclists in British Columbia over a five-year period (Linn et al., 1998). Head and facial injuries were found to be most prevalent, particularly for those who did not use a helmet (OR=1.55; 95% CI=1.18-2.04). With compulsory helmet usage just being introduced, the authors postulated a decrease in the number and severity of head injuries.

In a prospective study, 3,390 head-injured bicyclists admitted to central and eastside hospitals of Seattle were analyzed, comparing injuries before and after the introduction of compulsory bicycle helmet legislation (Thompson et al., 1996). Bicycle helmets provided substantial protection against head injuries for cyclists of all ages (OR = 0.32; $p < 0.05$), including those involved in motor vehicle crashes (OR = 0.31; $p < 0.05$). A decrease of THIs of between 69 to 74 percent was found for bicyclists in the post- versus pre- legislation period.

Similarly, in another retrospective study, the charts of 140,247 injured bicyclists from across the United States were analyzed (Sosin et al., 1996). It was determined that 33 percent of all deaths as a result of head injuries could have been prevented had the bicyclists worn helmets. Sosin et al. (1996) found that bicycle helmets reduced head injury between 74 and 85

percent. They suggest that implementation of compulsory bicycle helmet legislation does have a significant impact on decreasing THIs incurred from bicycling. Guohua et al. (1995), also in a retrospective chart review of 2,333 children ages 0-14 years old from Maryland, found that 54 percent of all head injuries sustained were the result of bicycling and that over one-half of these could have been avoided had the bicyclist worn a helmet.

Finally, a German study from 1987-1995 was conducted on 159 patients admitted for bicycling injuries (Zentner et al., 1996). Of these, 52 percent suffered head trauma as a result of not wearing a helmet. They found that a bicyclist's risk of head injury is decreased between 33 to 56 percent by wearing a helmet.

Traumatic head injuries incurred from bicycling most often occur for people aged 0-15. Henderson (1995), in his study, has found that the age group 5-16 years old is most susceptible to bicycling injuries. Sosin et al. (1996) support this notion for children less than 19 years of age, as does Loubeau (2000), who, in her study of 31 New York children, found those between 5-14 year olds as most susceptible to THIs as a result of not wearing a bicycle helmet.

For motorcycles, in particular, the literature reveals that it is mostly young adults who are most likely not to wear a helmet (Skalkidou, Petridou, Papadopoulos, Dessypris & Trichopoulos, 1999; Johnson et al., 1995).

Skalkidou et al. (1999) have found persons under 30 years old are most likely to not wear helmets and to incur THIs as a result of this behaviour ($p < 0.001$). In their July to August 1998 Greece study, a total of 982 motorcycle riders got stopped and interviewed. The four year study of Johnson et al. (1995) similarly found the average age at which one incurred injury from not wearing a helmet to be 29.8 years. When they assessed the helmet status of 331 patients admitted to an Illinois hospital after having a motorcycle accident and incurring a THI, 254 (77 %) of them did not wear a helmet.

Also, males more often than females have been known to incur more THIs as a result of not wearing a helmet. Linn et al. (1998) found that 13.8 percent of boys admitted with a head injury incurred that injury as a result of not wearing a bicycle helmet compared to 10.2 percent of girls. Skalkidou et al. (1999) similarly found that girls complied with helmet use significantly more often than did males ($p < 0.001$). Johnson et al. (1995) also found that girls (89.7%) more so than boys (10.3 %) complied with helmet use ($p < 0.01$). Rourke (1994) in her Ontario study of 250 5-14 year olds found that helmet compliance was significantly greater for females than for males ($p = 0.002$). Morris, Trimble & Fendley (1994) similarly found in their two-year Ontario study of 851 cyclists that of the 197 females, 31 wore helmets (15.7 %) compared to the boys, where only 53 of the 654 (8.1 %) wore a helmet.

Henderson (1995) found that 85 of the 102 that were seriously head injured or killed were males (83.3 %).

Much of the research has found little compliance with helmet use. Many have discussed why this may be so. Many reasons have been identified as to why people may not be compliant with helmet use, even when there is legislation in place. Henderson (1995) suggests that cost, peer pressure, and the perception that helmets are not "macho" may play a role. Alcohol use also seemed to be a factor regarding failure to use helmets (Johnson et al., 1995). Sosin et al. (1996) also add the absence of an appropriate adult role model to the list. As well, parental inconsistency in enforcing helmet use contributes to this belief (Rourke, 1994). A degree of fear and misunderstanding about the benefits of head protection was also noted (Loubeau, 2000). Loubeau (2000) reported that in spite legislation in an urban New York city and the knowledge that helmets help decrease injury, only 9 of the 31 children were wearing them. Using focus groups, Loubeau (2000) found that discomfort and the perception of looking dumb had attributed to such noncompliance.

Another point of emphasis should be the proper fit of the helmet. Henderson (1995) suggests that in order to get optimal protection afforded by a helmet, it must be fitted properly, placed properly, and have the chin straps fastened. Otherwise, he suggests, neither the helmet nor the laws

requiring its use can reach their full effectiveness. Rivara, Astley, Clarren, Thompson & Thompson (1999) found that a sample of 126 children from the state of Colorado wearing helmets still sustained a head injury that was likely due to the poor fit of the helmet, and suggested that a poorly fitted helmet may be associated with an increased risk of head injury.

2.2 Other MVA Forms

In Newfoundland, many people frequently utilize skidoos. Beilman, Brasel, Dittrick, Seatter, Jacobs & Croston (1999) found in their Minnesota study of 274 charts that head injuries affected 33.6 percent of the population studied as a result of skidoo accidents. Ethanol use (44 %) and non-use of helmets (35 %) were the main contributing factors. Additionally, in an 18-year review of snowmobile use in Newfoundland and Labrador, Hamdy, Dhir, Cameron, Jones & Fitzgerald (1988) discovered that the head was one of the most commonly injured areas (27.6 %) and less than 10 percent of patients were wearing helmets at the time of the accident. In their summary article on snowmobiling accidents, the American Academy of Pediatrics (2000) commented that head injuries were the leading cause of injury and death from accidents on snowmobiles. Most deaths and injury occurred, they suggest, as a result of striking fixed objects, such as a tree, cable wire or another vehicle.

The rugged terrain of the province brings with it the increased use of all-terrain-vehicles (ATVs). This is particularly so in rural areas of the province. As they are sometimes used as recreational toys, ATVs have the potential to induce head injuries to those availing of these vehicles.

Head injuries have also been found to be a result of ATV accidents. Boswell, Boyd, Schaffner, Williams & Frantz (1996) in their study from two Georgian hospitals on 69 fatalities, found that two deaths resulted from riding ATVs without a helmet. Cvijanovich, Cook, Mann and Dean (2001) in their Utah pediatric study, found that 32 of the 788 people in ATV-related accidents (25 %) suffered damage to their central nervous system. Gibbs, Lawrence and Reilley (1997) similarly found head injuries to be the most common injury type incurred during ATV accidents in Louisiana (13 %). They suggest that ATVs have produced many deaths and serious injuries since their introduction to the marketplace.

Somewhat unique to Newfoundland and Labrador is the moose as a cause of head injury. This animal, which roams the rugged terrain and wooded areas of the province, can be somewhat of a menace to motor vehiclists, frequently wandering out into the roadways and causing accidents, particularly at night. Hence, it has the potential to cause head injuries to the passengers/driver of the vehicles. Ratty and Turner (1991) found this to be so for injuries in general in Newfoundland MVAs in only

two years, 1987-1988, where 661 injuries were caused by moose-MVAs. No other research was found directly relating moose MVAs, and head injuries.

2.3 Newfoundland Legislation

For the province of Newfoundland and Labrador, legislation has only been passed in recent years regarding compulsory seatbelt use (Government of Newfoundland Department of Justice, 1990), stricter drinking and driving laws (Newfoundland Department of Justice, 1995), and compulsory bicycle helmet use (City of Mount Pearl, 1994; City of St. John's, 1994; Town of Paradise, 1992; City of Corner Brook, 1994).

Compulsory seatbelt use was passed and enforced July 1, 1982 (Newfoundland Department of Justice, 1995). It stated that a person who operates on a highway a vehicle in which a seatbelt assembly is provided for the driver shall wear the complete seatbelt assembly in a properly adjusted and securely fastened manner (Newfoundland Department of Government, Services and Lands, 1996).

However, it was not until the demerit point system was introduced in Newfoundland in 1990 that a very high compliance rate in seatbelt use was noticed. The demerit point system attached a point value plus a fine to any seatbelt violations (Newfoundland Department of Justice, 1995). For not wearing a seatbelt, one could receive a fine from 45 to 500 dollars and/or imprisonment for 2-25 days, plus two demerit points. The accumulation of

demerit points increases the difficulty and cost with which one is able to get their vehicle registered and driver's licence renewed (Newfoundland Department of Government, Services and Lands, 1996).

Similarly, the revision of the drunk drinking legislation, enacted and enforced in December 1994, set a blood alcohol concentration level to 0.05 mmol/L as opposed to the previous level of 0.08 mmol/L (Newfoundland Department of Justice, 1995). The law states that a criminal offence is committed by any one who operates a motor vehicle while impaired by alcohol or a drug or who has consumed alcohol in such a quantity that the concentration in the person's blood exceeds 80 milligrams (50 for Newfoundland) of alcohol in 100 millilitres of blood (Greenspan & Rosenberg, 2001). The penalty for first-time offenders is at least a one-year suspension of their driver's licence accompanied by a six to eight hundred dollar fine. Repeat offenders face substantial fines plus the serving of intermittent time in prison (Newfoundland Department of Justice, 1995).Compulsory motorcycle helmet use was passed and enforced in May 1973 (Newfoundland Department of Government, Services and Lands, 1996). The law generally states that no one shall ride on or operate a motorcycle, ATV, or skidoo unless that person is wearing a helmet and that failure to do so may result in a maximum fine of 500 dollars (Newfoundland Department of Government, Services and Lands, 1996).

The implementation and enforcement of bicycle helmet legislation has only recently been introduced as municipal by-laws. Only four known municipalities, St. John's (City of St. John's, 1994), Mount Pearl (City of Mount Pearl, 1994), Paradise (Town of Paradise, 1992), and Corner Brook (City of Corner Brook, 1994), have implemented the helmet by-law so far. Generally, the law states that no person shall ride on or operate a bicycle on a street unless that person is wearing a bicycle helmet that is designed for bicycling use and is approved by the Canadian Standards Association.

St. John's passed the by-law in April 1994 and enforced it in June 1994 and imposes a 20 to 45 dollar fine for not adhering to this by-law (City of St. John's, 1994). Mount Pearl passed a similar by-law in May 1994 and it came into effect June 1994 where they impose a maximum 20 dollar fine (City of Mount Pearl, 1994). Paradise passed and enforced their helmet by-law in September 1992 where a set fine of 25 dollars is imposed (Town of Paradise, 1992). Finally, Corner Brook passed their helmet by-law in July 1994 to be enforced effective August 1994 for a maximum fine of 25 dollars (City of Corner Brook, 1994). The helmet law enforcing authorities in these communities have been lax in proposing punitive measures, such as fines, confiscation of property, and issuing of warnings primarily due to lack of human resources.

The literature, thus, supports the notion that seatbelts, helmets, and not drinking alcohol before driving are contributing factors that are associated with the declining incidence and severity of THIs.

2.4 Falls

Besides these most common ways of incurring THIs and trying to prevent them through the usage of seatbelts, helmets, and not drinking and driving, head injuries may be incurred from a variety of other methods. As was mentioned earlier, mechanisms such as falls, abuse, assault, explosions, pedestrians, sports/ play, moose, work relatedness, suicide attempts, animal attacks, and being struck with an object can all contribute to head injury. While some research has been found on falls, abuse, assault, pedestrians, sports/play, and suicide, very little has been found on work-related injuries, animal attacks, explosions, and being struck with a foreign object.

Falls is the most common cause of THIs (NTR, 1999). In Canada, falls were the number one cause of THIs, making up 44 percent of all head injuries reported (NTR, 1999), particularly for the age group less than 15 years old (46 %). Falls were similarly the most frequent cause of head injury for people aged 35-64 years old in Canada (44 %) and for those aged 65 and over (85 %) (NTR, 1999). These findings differ from the United States, however, where MVAs took the number one position for causing THIs, with falls being second (NIH, 2000).

Falls have been an identified primary cause of THI in both children (Reece & Sege, 2000; Beattie, 1997; Adesunkanmi, Oginni, Oyelami & Badru, 1998) and the elderly (Ebersole & Hess, 1994). Whether it is due to a child's not fully developed sensory system (Sin & Ullman, 1999) or to the elderly's decreased sensory functioning, respectively, these two populations are very susceptible to injury from falling (Ebersole & Hess, 1994; Luukinen, Viramo, Koski, Laippala & Kivela, 1999; Kannus et al., 1999).

Beattie (1997), in her U.S. review article, found that falls were the most common injury for children. While they typically fall short distances, their head injuries were most often not severe. Beattie (1997) has discovered that most falls in children are usually from short heights or from running on level surfaces. As children are typically energetic, playful, and curious, this finding is not unusual. They were typically found to be falling off beds and furniture (Betz, Hunsberger & Wright, 1994). Reece and Sege (2000) in their retrospective review of 287 medical records of children admitted to an Ohio hospital, found that 80 of these were the result of falling (27. 9%), 6.3 percent of which occurred while the child was in a walker, and often down over a flight of stairs. Adesunkanmi et al. (1998) found that 25 percent of all childhood injuries were the result of falling. Of the 1,471 Nigerian children that were presented at the emergency department, 305 of them were injured from falling. Finally, Sin and Ullman (1999), in their

U.S. summary article, suggest that due to the active growing nature of the nervous system of children, it is therefore most susceptible to incurring injury.

As already stated, the elderly, as well, were found in the literature to be very susceptible to incurring a THI from falling. Many natural and pathological factors have been identified for this happening. The elderly are more likely to suffer from osteoporosis, decreased sensory perception, and forgetfulness (Ebersole & Hess, 1994). They may forget where they placed things, and with decreased visual and auditory perception, tend to fall more frequently, incurring injuries, including head injuries. The National Institutes of Health (2000) also note that risk factors for falls among the elderly include alcohol use, medications, and osteoporosis. Likewise, Kannus et al. (1999) found the incidence of falls among Finland's elderly population to be increasingly high. Of the 750 elderly people that were presented to the emergency department 554 (73.9 %) of them were injured as a result of a fall. Luukinen et al. (1999) similarly found in their Finland study that of the 588 charts reviewed, cognitive decline was positively associated with elderly people falling.

2.5 Pedestrians

Being struck by a motor vehicle while walking along the roadside is another well-recognized cause of head injury. Much research to date has

found the head to be the most frequent site of injury as a result of motor vehicle-pedestrian accidents (Patrick, Bensard, Moore, Partington & Karrer, 1998; Hill, Delaney & Duflou, 1996). Hill et al. (1996) found that of 101 pedestrians that were presented to an Australian emergency department, the most severe of their injuries was to the brain ($p < 0.004$). Children are found quite frequently to incur a THI as a result of a pedestrian accident. Given the energy level and spontaneity so often exhibited in children, it is not unusual to see children running out into the streets or playing in the streets (Betz et al., 1994). Also, their attention span is so short that they often times may forget where they are. Patrick et al. (1998), similarly, found 527 children to have suffered from pedestrian accidents. Of the 527 children admitted to two of Denver's medical centres over a seven year period, 37 percent suffered from head trauma and 51 children (10%) were struck in the driveway of their own home.

2.6 Sports/Play

Sports/play are a well-recognized form of experiencing a THI (Bailes & Cantu, 2001; Buechner, Speare, Hamel & Fontes, 2000; Baker, Fowler, Warner & Dannenberg, 1994). In all forms of sport, from soccer and baseball to hockey, the occurrence of a head injury is quite common (Bailes & Cantu, 2001). In Bailes and Cantu's (2001) summary article of sport related head injuries, they have stated that the incidence and severity of head

injury incurred during sports in the U.S. depends greatly on the sport being played. They have found that 9.1 percent of injuries sustained from recreational activities involve some form of head injury, with 20 percent of these resulting from football.

Buechner et al. (2000) found sports and recreation, in general, to be a major cause of THI, particularly among males aged 14 and younger. Of the 1,378 Rhode Island residents that sustained a THI during the years 1996-97, 43 (3.1 %) were sports related. Baker et al. (1994) found in their sample from the U.S. consumer product safety commission surveillance that of the 464.000 persons younger than age 25, 58.480 of them received a THI as a result of sports/play (12.6 %).

The National Institutes of Health (2000) found that only three percent of hospitalized patients with head injury occurred as a result of play and/or sports; approximately 90 percent of sports-related head injuries are mild and may go unreported. The largest concentration of THIs incurred from sports and play are in the age group 0-15 years. Baker et al. (1994) have similarly found a high incidence of traumatic head injuries in children resulting from sports and recreation. THI constituted 15 percent of all injuries associated with playground equipment, 20 percent of injuries from children's vehicles, and six percent of injuries from skateboards and roller skates. Informal

recreation activities, as a result, constituted 32 percent of head injuries in children less than 15 years old (Baker et al., 1994).

2.7 Abuse

Deliberately inflicted injury is a frequent cause of serious head trauma in young children. Betz et al. (1994) identify that childhood is a very critical time for one's physical, intellectual, emotional, social, and psychological development, all areas where abuse may have serious long-term and short-term ramifications. Prevention around this issue could primarily be done through education, but also through role modelling and early identification of the risk factors.

Dashti, Decker, Razzaq & Cohen (1999) found that intentional head trauma was inflicted onto children in 38 of the 405 cases (9.4 %) received in a New York emergency department. Head injury is a major cause of morbidity and mortality in the abused child. In the study conducted by Reece and Sege (2000), 19 percent of head injuries occurring in children were from abuse. Similarly, Duhaime, Alario, Lewander, Schut, Sutton, Seidl, Nudelman, Budenz, Hertle & Tsiaras (1992) found in a Pennsylvanian study that of 100 children admitted to a hospital emergency department, 32 of them (32 %) experienced a THI as a result of abuse and/or neglect.

Also, DiScala, Sege, Guohoa & Reece (2000) found in a 10-year Baltimore study of the National Pediatric Trauma Registry from 1988-1997 that 10.6 percent of all blunt trauma to patients younger than 5 years was the result of abuse. Recently, a condition known as Shaken Baby Syndrome has been identified as a very common form of abuse inflicted on children (Barlow & Minns, 2000). Barlow and Minns (2000) in their 15-year retrospective Scottish study found that child abuse occurs at an incidence rate of 24.6/ 100,000 in children under 1 year old.

2.8 Other Etiological factors of THIs

Assault has also been identified as a source of THI. Gilthorpe, Wilson, Moles & Bedi (1999) in their British study, found that assault made up a significant percentage of THIs in their study. In this study of 25,300 patients, 3.756 were head injured as a result of assault, with females aged 15-44 years the most likely victim (O.R.=2.38). Langley, Chalmers and Fanslow (1996) also found head injury to be the most common-occurring injury as a result of an assault in New Zealand. Most assaults that occurred involved people under the influence of alcohol (Brickley & Shepherd, 1995; Langley et al., 1996). Brickley and Shepherd (1995) in their United Kingdom study of 242 patients found that assault caused a THI in 48 percent of the people seen in hospital, where alcohol was a factor 100 percent of the time. Most of these injuries incurred here were the result of gunshot wounds.

Brawls have also been found to to be associated with a high incidence of THI. Hussein, Wijetunge, Grubnic & Jackson (1994) found brawls to play a significant role in causing THI. Of the 950 patients seen at a London hospital emergency department, 225 had received craniofacial trauma as a result of a brawl. Of those 177 cases that involved alcohol, young males were more often the ones to engage in a brawl. Hussein et al. (1994) found that interpersonal violence mostly involved young males and also that fights occurred mainly between strangers who had consumed excessive amounts of alcohol (Cherpital, 1993). Strauch, Wirth, Taymoorian and Geserick (2001) also found in their Berlin study that of the 36,274 autopsies performed on people that died between 1980-87, 152 of them had died from head injury incurred from fighting.

Suicide attempts are also another, less popular way in which THIs occur. Gunshot wounds have been the most commonly identified cause for THIs to occur. More males than females use a lethal means of suicide attempt (Johnson, 1989). Hussein et al. (1994) found that only 3 of the 950 cases (0.003 %) at one of London's emergency departments were seen to be a result of a suicide attempt.

Animal attacks are another means by which head injuries result. Not much, however, has been found in the literature. A small number of people have been found to experience THI from dogbites (Hussein et al., 1994).

Hussein et al. (1994) found that only 25 of the 950 cases (2.6 %) seen in London's hospital were because of receiving a dogbite. Adesunkanmi et al. (1998) found snake and dog bites, in particular, to be a frequent form of injury in children where head injury was also common. Of the 1,471 Nigerian children admitted to hospital with trauma, 108 of them (7.3 %) were bitten by either a dog or snake. Curiosity and inquisitiveness are very characteristic of children and certainly may contribute to their interactions with animals in a manner disruptive to the animal (Betz et al., 1994).

Being struck with a foreign object such as a rock or falling tree is another manner in which head injuries are incurred. As children are very characteristically playful and curious, they are the ones to most likely incur a head injury from this method (Betz et al., 1994). Most research found on this topic was in the areas of sports and play, covered in a separate section of this report.

Many people incur head injuries in the workplace. Hussein et al. (1994) have found that while work place injuries only make up a small proportion of all head injuries, they are most often the result of a fall or being struck with an object or piece of equipment. Only 31 of the 950 (3.3 %) injury cases received into London's hospital were seen as the result of a work-related craniofacial injury.

2.9 Outcome

The outcome of a THI varies, depending on the degree of severity of the injury. As a result, people may spend varying lengths of time in hospitals or other institutions. Beattie (1997) states that children are discharged home after a minor head injury as long as their level of consciousness is normal and there is no clinical or radiological evidence of a skull fracture.

The tool typically used in the assessment of the outcome of the head injury is the Glasgow Coma Outcome Scale. This scale has five categories to reflect the different degree of brain damage incurred from injury: good recovery; moderate disability; severe disability; vegetative state; and death. This is a highly respected tool that has reliably and validly reflected the true level of injury in different situations (Hall, Cope & Rappaport, 1985; Snoek, Jennett, Bond & Brooks, 1981). To survive a THI with good recovery means that normal life activities may be resumed even though there may exist a minor neurological or pathological deficit (Hall et al.,1985).

Many studies highlighted already have found that good recovery was the most common outcome. Zentner et al. (1996) found that of those that injured their head bicycling, 70 percent made a good recovery. The NIH (2000) suggests that 90 percent of sports-related injuries are often mild and may even go unreported. Beattie (1997) admits that even for children

incurring THI from falling, the injuries are frequently not severe. The National Institutes of Health (2000) suggests that the significant increase in recent years of people surviving from head injuries and enduring fewer sequelae as a result of it may be attributed to faster and more effective emergency care, quicker and safer transportation to specialized treatment facilities, and advances in acute medical management.

However, as Harmon (1999) points out, even something as simple as a concussion could produce long-term sequelae for the person. Once a person experiences a mild concussion, they are at four to six times more increased risk of sustaining a second concussion that, over time, could produce long-term cognitive, physical, psychological, and social ramifications for the patient. Although Beattie (1997) found that the incidence of acute sequelae in children is much less than that found in adults, this may not always be the case.

One may also be left moderately disabled as a result of their THI. Snoek et al. (1981) suggest that this type of person is independent but disabled in some aspect of their functioning. This person can look after him/herself at home, go out, go shopping, and travel. Hall et al. (1985) say the disabling feature here is most often related to memory deficits and personality changes. NIH (2000) adds that although the head injury may

result in physical impairment, the more problematic consequences involve cognition, emotional functioning, and behaviour.

Persons left with a severe disability as defined by the Glasgow Coma Outcome Scale are conscious but disabled. They are dependent on others for fulfilment of their activities of daily living (Hall et al., 1985). Snoek et al. (1981) add that physical and mental disability usually go hand in hand because when there is physical disability after a head injury, there is almost always considerable mental deficit. Although most complications become apparent in the first few days, some may not surface until months later, depending on the severity of the trauma (NIH, 2000). Many of those sustaining head injury recover to the point where they no longer require hospital care, but can be cared for in some manner at home with help from others. Caring for the head-injured person can create much strain and distress on the family. This arises not so much from the person's physical ailments but from his/her cognitive and psychological changes (O'Neill & Carter, 1998).

Persons left in vegetative state typically showed no evidence of meaningful responsiveness (Snoek et al., 1981). They may open and close their eyes and sleep, but there is no evidence of any cognitive processes occurring.

When death results from the THI, all brain function obviously ceases (Snoek et al., 1981; Hall et al., 1985). This may occur upon immediate arrival at hospital or, often times, may occur at the scene of the accident.

2.10 Preventative Programs

Many traumatic head injuries can be prevented. Much research has shown that educational programs, advertising, and the media can be effectively utilized to promote safety in one's home and community.

Shah (1990) says that healthy public policy aims at mobilizing many segments of the community to reduce the adverse effects on humans that may result from deleterious environmental/man-made exposure. Bolen, Sacks & Bland (1999) suggest that people need only to engage in simple behaviours to help prevent injury from occurring. Simple things like fastening up your seatbelt and helmet and not drinking and driving go a long way in prevention. Bolen et al. (1999) admit, however, that many people still do not avail of preventative measures, for reasons of peer pressure, cost issues, or the desire to be "macho". The National Institutes of Health (2000) highlights how safety features such as safety belts, helmets, air bags, infant/child car seats, as well as changes in the speed limits, road design, and traffic control have reduced motor-vehicle-related THI and could reduce it further. Martin (2001) provides an educational outline on the proper usage of

the seatbelt to prevent injury, adding that those simple behaviours of fastening up the seatbelt properly would help to reduce injury.

Imposed legislation also seems to have an effect on reducing traumatic head injuries. Bolen et al. (1999) have found in the U.S. that states with behaviour relevant legislation have the highest level of associated safety practices for alcohol-impaired driving, occupant restraint use, and bicycle helmet use. The Think First Foundation of Canada (2001) has currently underway in Canada a community-based educational program to assess for all forms of injury prevention in children.

For drinking and driving, however, little research has been done on the positive impact that not drinking and driving has on injury. This is promoted in our communities, mostly through advocacy groups. Organizations, such as the popularly known Mothers Against Drunk Drivers (MADD), still campaign today in an effort to increase public awareness of the consequences of doing so. They advocate for stiffer sentencing, increased police enforcement, and vehicle seizure (MADD, 2001).

SADD (Students Against Drinking and Driving) is another well-known advocacy group that campaigns in the community for a similar purpose. They propose that not drinking and driving decreases injury (SADD, 2001).

Much research supports the passing of laws to enforce the usage of helmets. Burdett (1998) found that helmet usage had increased significantly as a result of the helmet law in Ontario. Winslade (2001) highlights how an oil company offered a subsidy for bicycle helmets to schoolchildren to help reduce injury, which turned out to be a success. Gilchrist, Schieber, Leadbetter and Davidson (2000) suggest how helmet usage went from 0 to 45 percent as a result of a police-enforced helmet program for children. Sosin et al. (1996), however, found those studies of educational campaigns and legislative approaches have demonstrated increased bicycle helmet use and subsequent reductions in head injuries. A subsidized helmet cost program, according to one researcher, found that helmet usage increased by up to 45 percent (Vulcan & Lane, 1998).

Rourke (1994), however, found that in spite of an intensive education campaign on the importance of helmet usage, helmet use did not dramatically change. While it did increase 17-fold, there were still 87 percent of children still not wearing a helmet. Mandatory bicycle helmet usage was not in place at this time but was enforced two years following this study.

Education that addresses other aspects of safety, such as that encountered for pedestrians, assault, and falls, are also present, albeit more so at the local level (Newfoundland and Labrador Safety Council, 2001).

For falls in particular, there have been some changes in the design of walkers, strollers, and shopping carts to help prevent falls among young children (NIH, 2000). For the elderly, the American Brain Injury Association (2001) recommends a medication review for the person, the wearing of safe shoes, and the conduction of a home safety check to help prevent injury.

For violence-related injuries, standards of prevention have also been examined. Programs to prevent street violence and suicide are being strengthened, especially through legislation, to control the use of handguns and to increase their safety (NIH, 2000).

For snowmobiles, in particular, Hamdy et al. (1988) recognize the need for prevention. They state that human factor was indeed responsible for the majority of the injuries incurred, but that with the enforcement of legislation, and the intensification of public education about the hazards of driving snowmobiles, these injuries could be minimized. Beilman et al. (1999) suggest that efforts at prevention of snowmobile injuries should be targeted at rider education and enforcement of alcohol restrictions.

As for pedestrian safety, American Brain Injury Association (2001) highlights points for parents to be teaching their children so as to reduce the potential for injury, i.e., look both ways before crossing the street. Durkin, Laraque and Barlow (1999) add that pedestrian-associated injuries decreased

substantially by 45 percent after a pedestrian educational program was implemented.

Sports/play also have preventative issues that may be assessed. A protective coating on playground equipment helps reduce risk of serious head injury. Having an adult present is also important (American Brain Injury Association, 2001). Education, good training and coaching techniques, improved equipment and rule changes, and enforcement can all help curb sports-related head injuries (Baker & Patel, 2000).

Chapter 3:

Methods

3.1 Study Objectives

The goals and objectives of this study are outlined (Exhibit 3.1). These goals and objectives were used to guide the design of the study and the formulation of the data extraction form, as shown in Appendix A.

Exhibit 3.1 Study Goals and Objectives

1. To assess the overall epidemiology of THIs in Newfoundland and Labrador from 1985-1998 in terms of sex, age, geographical location of injury, safety mechanisms/practices utilized, hospitalization outcome, and physiological outcome.
2. To describe the possible relationship that bicycle/motorcycle helmet usage, seatbelt usage, and stringent drinking and driving legislation may have had on the declining incidence and severity of THIs.
3. To comment on the need for road safety education, and improved legislation on preventative equipment/strategies.

3.2 Study Setting and Population

The setting for this study is the Canadian province of Newfoundland and Labrador. It has a population of approximately 512,930 (Newfoundland and Labrador Centre for Health Information, 1998). Its unique geography has communities, towns, and cities dispersed throughout the province. The province's capital, St. John's, is located on the

northeasterly portion of the Avalon Peninsula. This city has a population of approximately 150,000. St. John's contains the main neurosurgical referral center, the Health Sciences Centre, which caters to the health needs of the majority of the province's population located on the greater Avalon Peninsula. Recent health care restructuring has now enabled this centre to receive both adult and pediatric neurosurgical referrals from around the island of Newfoundland and Labrador.

For the rest of the province, there are 28 health care facilities. They receive and then refer traumatically head injured patients to the main neurosurgical referral centre in St. John's. It is recognized that the hospitals in rural centers of the province primarily refer the more severe of the head injuries and this pattern of referral is not significantly different amongst these centers. Also, the overall population changes for Newfoundland for the years 1985 and 1998 were not significantly different, and therefore, would not impact on the number of admissions.

The investigator chose to include the three health care institutions serving the Avalon Peninsula: The Health Sciences Centre, the Janeway Children's Hospital, and the Carbonear General Hospital. These institutions typically maintain a very high occupancy rate, particularly the neurosurgical unit at the Health Sciences Centre, where there are specialized neuro-diagnostic imaging equipment and subspecialty health care professionals.

Most head injuries admitted to the Health Sciences Centre are assessed first by a neurosurgeon or emergency physician. For the outlying regions of the province, a neurologist, general practitioner, nurse practitioner, or surgery resident would be the first health care professional to assess a head-injured patient. The more severe of THIs would be referred and transported by air to St. John's. St. Clare's Mercy Hospital, the only other acute care hospital on the Avalon Peninsula, was not included, since all THIs were brought directly to or referred to the neighbouring neuro-specialized Health Sciences Centre.

3.3 Ethical Considerations

The study protocol was approved by the Human Investigations Committee (HIC) of the Faculty of Medicine, Memorial University of Newfoundland. A significant emphasis was placed by the investigator on protecting the identity of each patient through the use of numerical coding; no names were used on paper files. Every pertinent patient chart was examined in the confines of the medical record department and replaced on the day of data collection so as to ensure no misplacement of the patient's record. Any questions or uncertainties regarding the patient charts were addressed with medical record personnel in privacy. Pledges of confidentiality were signed by the investigator for each of the health care

institutions where charts were reviewed. All paper files were kept in locked storage.

3.4 Recruitment of Institution

For each of the health care facilities in the province where charts were reviewed, the hospital administration was contacted initially by telephone, followed by a mailed hard copy, to inform them of the study. Copies of the chart abstract form and an information package were mailed to each of the institutions to the assigned director of the medical records department, as well as to the Chief Executive Officer of each of the relevant health care boards, the Health Care Corporation of St. John's Board and the Avalon Healthcare Institutions Board. These documents included a cover letter, a copy of ethical approval, a copy of ethical approval amendment, an abstract and a copy of the objectives and were intended to provide an overview of the study (Appendix B).

For each of the hospitals the Chief Executive Officer was also asked to forward their support for the study to the medical record personnel who would be responsible for the selection and retrieval of patient charts. The name of this contact person was then provided to the researcher via letter or telephone. For all of the involved institutions, a confidential computer generated list of patients admitted with a THI, either as a primary or secondary diagnosis, was obtained from medical records.

3.5 Chart Selection

The study population for this retrospective chart review was determined using the applicable international classification of disease (ICD) codes for head injury. The ICD is a coding method that applies a different number to each distinctive illness/injury. Charts assigned ICD codes that involved some form of head injury for Newfoundland residents admitted to the hospitals under investigation were retrieved via two methods. First of all, the Health Sciences Centre and Janeway Hospital did not begin computer abstracting of their patient charts until 1992. Therefore, for the head injuries occurring prior to 1992, paper indices of ICD codes were reviewed. In these indices, the ICD codes were ordered numerically. However, for the THIs that occurred in the years 1992 to 1999, a more simplified computer cross-match was available. During this process, a computer search was done for all ICD codes that represented some form of head injury that resulted from trauma. This list was then given to medical records personnel to view and retrieve charts. Both methods of obtaining charts provided the first eight digits of the health insurance number as a confirmation identifier, the date of admission, and all other ICD codes assigned to that patient discharge.

With these methods, the number of charts required to be retrieved and reviewed was estimated to be around 3,500, 1,500 from the Health Sciences

Center, 1,400 from the Janeway Hospital and 600 from Carbonear General Hospital. The primary population served on the Avalon Peninsula at the involved health care institutions made up 47.5 percent of the overall population of the province of Newfoundland and Labrador.

Only patients discharged with a diagnosis of head trauma were considered for this study. All relevant ICD-9-CM (International Classification of Disease) codes were used to include all forms of THI (Appendix C). The ICD-9-CM code of 854 was most frequently found. This code represented intracranial injury of other and unspecified nature and made up nearly 40 percent of all the THIs that had to be reviewed.

Inclusion Criteria:

1)The patient admitted was a child or adult resident of Newfoundland and Labrador.
2)The THI occurred between January 1, 1985 and December 31, 1998.
3)The head injury occurred within the province of Newfoundland and Labrador.
4) The person was admitted to one of the three study acute care institutions in the province for at least 24 hours.
5) The THI was the person's primary or secondary discharge diagnosis.

Exclusion Criteria:

1) Any Newfoundland or Labrador resident who sustained a THI outside of the province of Newfoundland and Labrador.
2) Any non-resident of the province of Newfoundland and Labrador who sustained a THI while in the province.
3) Any person sustaining a head injury in another province/

country (i.e., St. Pierre et Miquelon, France) but referred to health care institutions in Newfoundland and Labrador for treatment and/or intervention.

4) Any person suffering from an acquired head injury not traumatically induced (i.e. cerebrovascular disease, brain tumours, etc.)

3.6 Abstract Form

A chart audit form was developed (Appendix A). The data collected were obtained from the admitting sheet, discharge summary, history and physical report, laboratory report, nursing progress notes, consultation forms, nursing admission assessment, emergency records, letters of transfer, and ambulance attendant reports. The data that were assessed and collected for each patient chart were as follows:

1) Patient health insurance number.
2) Patient age and sex .
3) Location of injury.
4) Injury information, including the date of injury, date of admission to hospital, and the ICD codes applicable as a result of the injury.
5) Cause of the head injury: a) Motor Vehicle Accident- car/truck; b) MVA-skidoo/seadoo/boat; c) MVA-ATV; d) MVA-motorcycle; e) Animal involvement i.e., Moose and MVA f) Fall from height; g) Slip/Fall; h) Fight/brawl; i) Sports/Play related; j) Pedestrian; k) Struck with foreign object; l) Explosion; m) Suicide attempt, i.e. gunshot; n) Abuse; o) Work related; p) Bicycling; q) Animal attack; r) Plane crash; s) Assault.
6) Physiological outcome using the Glasgow Coma Outcome scale to determine categories of a) Vegetative State; b) Severe Disability; c) Moderate Disability; d) Good Recovery; or e) Death.
7) Outcome of hospital admission: Discharged, transferred or died.

MVAs included all categories of MVA- car/truck, skidoo/seadoo/boat, ATV, motorcycle and moose-MVAs. Falls, similarly, included both falls from height and slip/falls. If an MVA was the etiological factor, the person's position in the motorized vehicle, helmet status (bicycles and motorcycles), seatbelt status (car/truck and moose MVA), and drinking and driving status were obtained. Furthermore, if drinking and driving was noted, the level and date of the blood alcohol concentration were also obtained. Alcohol may also contribute to other injury causes such as those from falls, brawls, and assault, but alcohol use was generally not noted in these charts.

A pilot study of 201 charts was carried out in 1999. The categories of causes of head injuries were developed from those encountered in the pilot study.

The Glasgow Coma Outcome Scale is a widely used measure in emergency rooms and intensive care units to assess the severity of neurological damage in terms of five categories: 1) Good recovery- resumption of normal life even though there may be a minor neurologic and pathologic deficit; 2) Moderate disability- able to resume a near normal life with slight disabilities such as memory deficits, personality change, speech difficulty (dysphasia), paralysis (hemiparesis), or balance difficulties (ataxia); 3) Severe disability- dependent for daily support by reason of

mental or physical disability, usually a combination of both (conscious but disabled); 4) Vegetative state- unresponsive and speechless for an extended period of time. Shows no sign of brain function; 5) Death- the cessation of all physiological processes that signify life (Hall et al., 1985).

3.6 Statistical Analyses

Data were entered into SPSS. Upon completion of data collection, several outcome variables were examined. First, the frequency and type of head injury cases during the study period were assessed to identify if, indeed, the number of head injuries had decreased over the time span 1985 to 1998, during which time compulsory seatbelt legislation, stricter drinking and driving legislation, and compulsory helmet usage in selected communities were implemented/initiated.

Descriptive statistics were also examined. Characteristics of the study population, i.e., age, sex, geographical location of injury, date of injury, date of admission, type of head injury incurred, etiology of injury, seatbelt status, helmet status, alcohol status, outcome of hospital admission, and physiological outcome, were all assessed for any patterns or trends. Measures of central tendency, frequencies and proportions, were all obtained as part of the statistical analyses. A regression analysis will not be performed on the data, based on the decision that the information obtained would not have been complete.

Chapter 4

Results

4.1 Study Population

4.1.0 THI Frequency

To provide some estimate of possible changes in the referral patterns over the study period, injuries were compared for the first and last years of

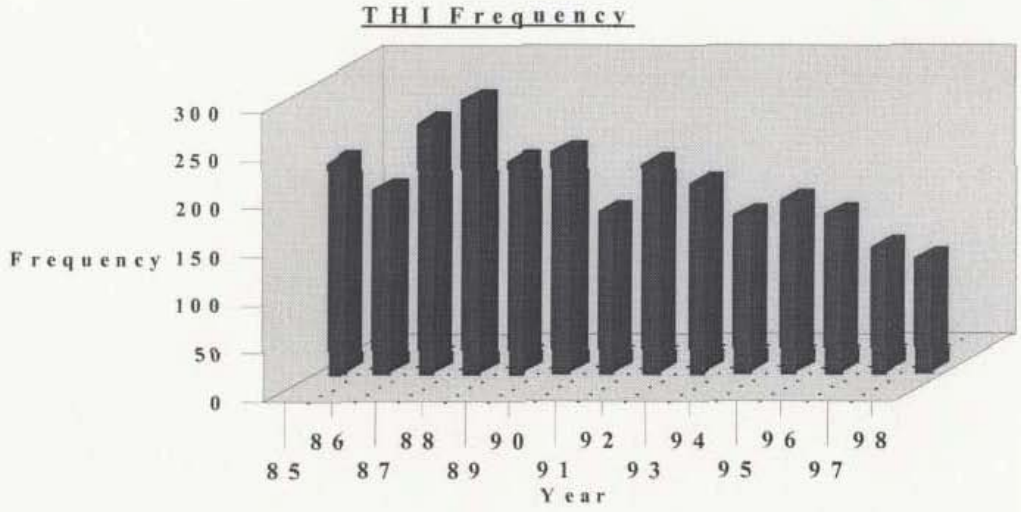


Figure 4.1 Percent of THIs in Newfoundland and Labrador, 1985-98

of the study period. Admissions for THI in the province for the years 1985 and 1998 were obtained from the Newfoundland and Labrador Centre for Health Information. The admissions to the hospitals included in this study accounted for 63 and 65 percent of total admissions for the two years, 1985 and 1998, respectively. The referral pattern has not changed significantly in this time frame.

The frequency of THIs in Newfoundland and Labrador has declined from 1985 to 1998, most notably from 1989 onwards.

4.1.1 Size of population

The size of the study population achieved during this study is shown in Table 4.1. Of the 3,231 admissions considered eligible from the computer listings provided by medical records, a total of 2,739 patient charts were reviewed from the three hospital sites involved in the study. A total of 1,033 came from the Health Sciences Hospital, 1,319 charts were reviewed from the Janeway Children's Hospital, and 387 charts were reviewed from Carbonear General Hospital. Of the total charts, 1,447 were those of children or someone 15 years of age and younger and 1,292 were those of adults. The unequal distribution of charts from the three hospitals was expected. The Janeway Hospital is the only tertiary children's hospital in the province while the Health Sciences Center and Carbonear General are two of the main tertiary adult hospitals for the province.

Four hundred and ninety-two cases did not meet the study protocol inclusion criteria: 65 people who incurred a THI were from outside of Canada; 80 were from outside of the province of Newfoundland; 255 with a discharge code of THI had no THI documented in their chart, a coding error; 26 had a THI documented in emergency but no admission documented; 32 of the head injuries were not traumatic in nature; 20 THIs were discharged prior to 1985; and 14 were charts missing required documentation, such as

the admission date and discharge date. An additional 27 charts were considered lost in storage and deemed irretrievable.

Table 4.1 Study Population by Health Care Institution

Health Care Institution	Number of THIs
Health Sciences Centre	1,033
Janeway Children's Hospital	1,319
Carbonear General Hospital	387
Total:	**2,739**

4.1.2 Patient Characteristics

Table 4.2 provides baseline characteristics for the THIs incurred by the study patients. The average age of people who had incurred a THI was 23 years, with a range of 0 to 99 years. The median was 15 with a mode of 6. Significantly more males than females incurred a THI ($p= 0.026 < 0.05$). For all etiologies of THIs, more males than females incurred a THI at an average male to female ratio of 1:3.

Table 4.2- Distribution of THIs by Age and Sex

Age	Frequency	Male	Female
0-15 Years	**1447**	**940**	**507**
16-24 Years	**462**	**351**	**111**
25-44 Years	**410**	**313**	**97**
45-74 Years	**311**	**219**	**92**
> 75 Years	**109**	**47**	**62**
Total:	**2739**	**1870**	**869**

Table 4.3 Etiology by Sex for THIs

Etiology	n	Male (%)	Female (%)	% of Total
MVAs				
Car/Truck	510	62.5	37.5	18.6
Skidoo/Seadoo/Boat	30	76.7	23.3	1.1
ATV	104	84.6	15.4	3.9
Motorcycle	67	92.5	7.5	2.4
Moose/MVA	38	71.8	28.2	1.4
Falls				
From height	472	68.0	32.0	17.2
Slip/Fall	381	63.2	36.8	13.9
Sports/Play	329	70.5	29.5	12.0
Bicycling	301	68.1	31.9	11.0
Pedestrian	231	61.9	38.1	8.4
Other				
Struck with object	102	78.4	21.6	3.7
Fight/Brawl	76	90.8	9.2	2.9
Assault	41	80.5	19.5	1.5
Suicide Attempt	14	92.9	7.1	0.5
Work Related	14	85.7	14.3	0.5
Abuse	12	58.3	41.7	0.4
Animal Attack	11	45.5	54.5	0.4
Explosion	4	100	0	0.1
Plane Crash	2	100	0	0.1
Totals	**2,739**			**100 %**

Helmet, seatbelt, and alcohol use were of particular interest. Documentation of use was not available in charts for 174 of the 500 charts (34.8 %) relevant to helmet use. Documentation was not given for 86 of the relevant 546 (15.9 %) seatbelt use charts and for 28 of the 602 (4.6 %) alcohol relevant charts. Consequently, given the remaining 326, 459, and

574, 82.5 percent of the total relevant charts, were available to assess helmet, seatbelt, and alcohol use respectively.

4.2 General Findings

In general, fewer of those incurring a THI were wearing a helmet (17.2 %) than those that did not wear a helmet (82.8 %) in motorcycle, bicycle, ATV or skidoo accidents. The majority of people who should have been wearing a helmet did not. This was a significant difference ($p<.05$).

More people incurring a THI in an MVA were not under the influence of alcohol (66 %) as opposed to being under the influence of alcohol (34 %). This was a significant difference. Through the 14 years studied, it was found that people who incurred a THI in an MVA involving cars/trucks and moose/MVAs were more often wearing a seatbelt (54.8 %) than not wearing a seatbelt (45.2 %). This was not a significant difference ($p> .05$). Males were more often the ones to drink and drive (93.3 %), to not wear a seatbelt (68.8 %), and to not wear a helmet (74 %), as opposed to females, who drove after using alcohol (6.7 %), did not wear a seatbelt (31.2 %), and did not wear a helmet (26 %). Males were also the ones to more frequently incur falls (65.9 %), incur a THI while attempting suicide (92.9 %), become involved in fights/brawls (90.8 %), and to get struck with a foreign object (78.4 %). As a result of the analysis of the data over the 14 years studied, it appears that the number of people wearing helmets, using seatbelts, and not

drinking and driving has increased. This is reflected in the proportion of people with THI with safety devices in place.

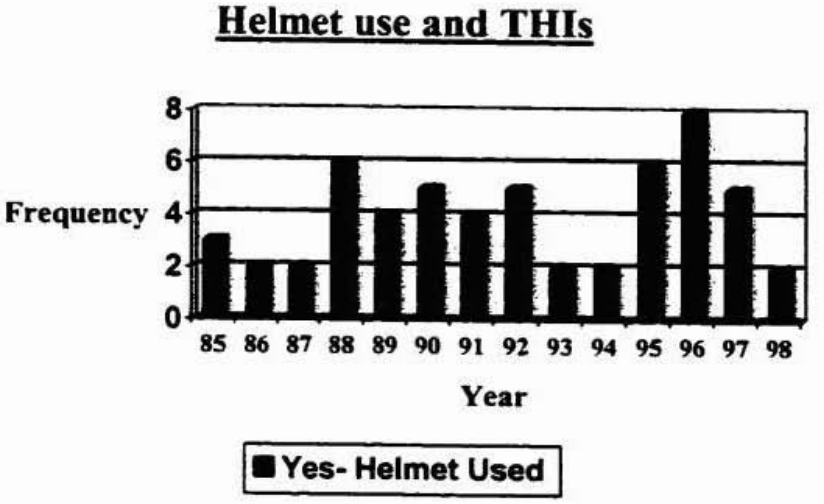


Figure 4.2- Helmet Usage in Newfoundland, 1985-1998

4.3 Helmet Use

Motorcycle, skidoo, and ATV helmet legislation was provincially enacted and enforced across Newfoundland in 1973 and bicycle helmet use was municipally enacted and enforced in four communities in 1994. Of the total number of head injuries, 500 were from accidents where a helmet should have been worn. These were accidents involving motorcycles, bicycles, ATVs, and skidoos. Helmet use or non-use was not documented in 174 cases (34.8%).

In spite of an increase of helmet usage over the years, overall, more people with injuries did not wear a helmet (82.8 %) as opposed to those that did (17.2 %). Greater compliance, however, was found for those riding motorcycles as compared to those riding ATVs, skidoos, or bicycles (Table 4.4).

Table 4.4 Helmet usage by mode of Transportation in Newfoundland

Mode of Transportation	Yes	No	Total
Skidoo/seadoo/boat	28.6 %	71.4 %	100 %
ATV	15.5 %	84.5 %	100 %
Motorcycle	59.3 %	40.7 %	100 %
Bicycling	3.4 %	96.6 %	100 %

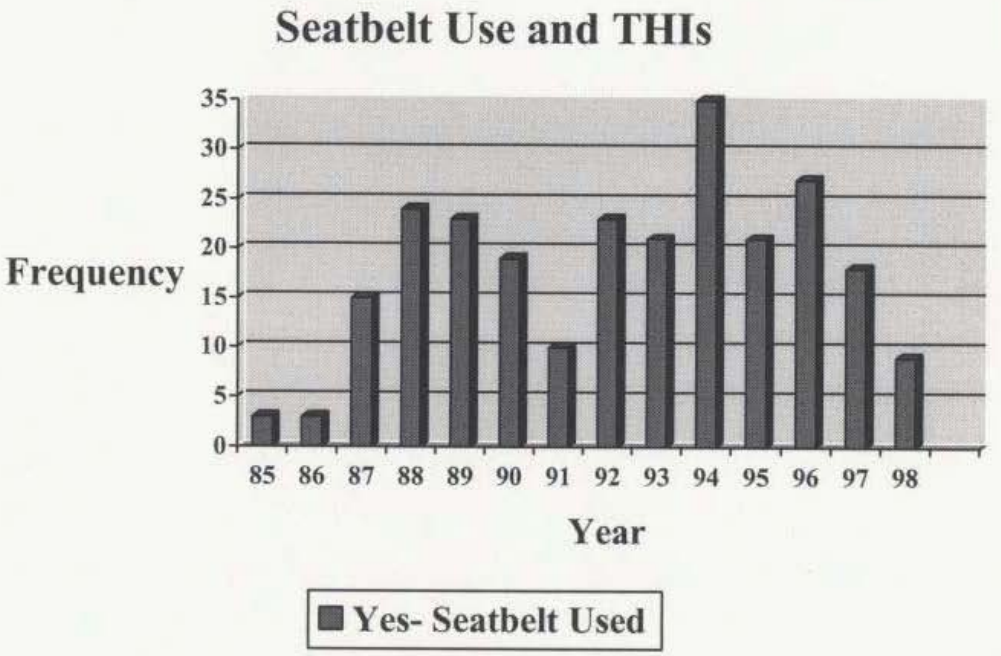
4.4 Seatbelt Use

Seatbelt legislation was enacted and implemented in 1983. It was expected that compliance would be greater when the demerit point system was introduced into the province in 1991. Of the head injuries in the study, 546 (19.9 %) were the result of an MVA accident where seatbelts are required to be worn. These were accidents involving MVA- cars/trucks and MVA and moose.

Information on seatbelt use was available for 458 (83.9 %) of the 546 relevant charts. More people were found to be using their seatbelt (54.8 %) than were not (45.2 %). This difference, however, was not significant. Seatbelt status was not documented for 16.1 percent of cases.

The frequency of people with THI, as a result of an MVA in which they were not wearing their seatbelt, seems to have decreased primarily from the early 1990's, most notably 1993 (Figure 4.3).

Figure 4.3- THI and Usage of Seatbelts in Newfoundland from 1985-98



4.5 Alcohol Use

Similarly, for alcohol use, the number of people drinking and driving has dropped from 1994 onwards. The results of the period of time leading up this point seem erratic. The decrease from 1994 may be attributed to the decreased number of cases for those years (Figure 4.4). Also, it is important

to note here that 51.3 percent of the people involved in MVAs who were under the influence of alcohol were the drivers of the motorized vehicle. The drivers had a mean blood alcohol level of .3386 mmol/L, with a range from .2-.80, a median of .34, and a mode of .38, with the accepted level at 0.05 mmol/L.

Of the total number of head injuries, 602 (21.9 %) were the result of an MVA accident where alcohol could obviously have been a factor. These were accidents involving MVA- cars/trucks, moose-MVAs, motorcycles, skidoos, and ATVs. Information on alcohol use was available for 574 (95.3 %) of them. If one looks only at the records for which there was documentation, 33.9 percent of people incurring THIs from MVAs were found to be under the influence of alcohol while 66.1 percent of people were not. Information was not available for 4.7 percent of cases.

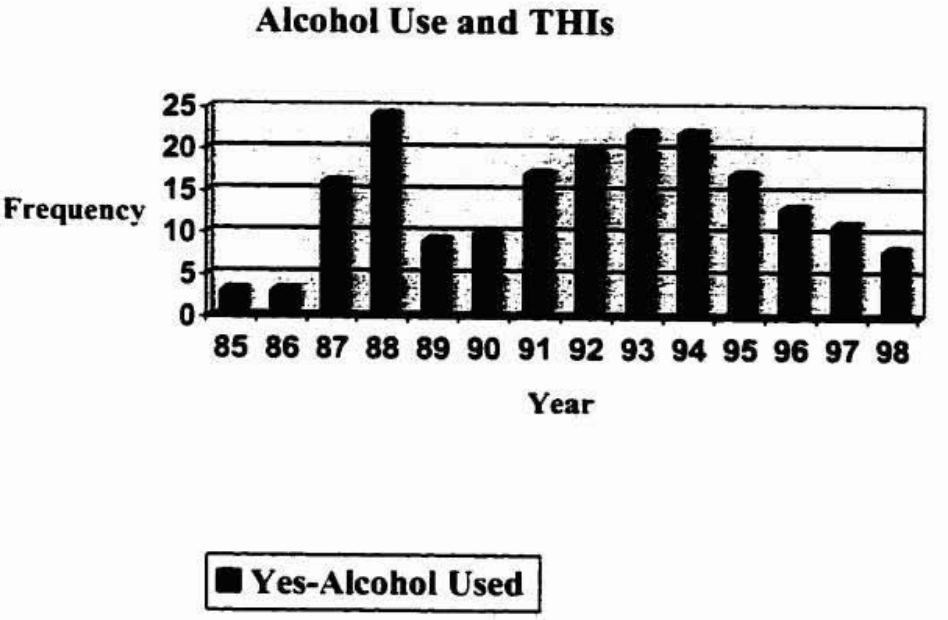


Figure 4.4- THI and Alcohol Use in Newfoundland from 1985-1998

4.6 Hospitalization

Of the 2,739 THI cases who were hospitalized from 1985-1998, the highest frequency of admissions was in the year 1988 (10.4 %) and in the month of July (11.2 %). The summer months June, July, and August were the period that most THIs occurred, accounting for 32 percent of all THIs (Table 4.5). People were also most often admitted on the same day that the THI occurred (94 %).

Table 4.5- Monthly Distribution of THIs, 1985-1998

Month	Frequency	Percentage
January	187	6.8 %
February	170	6.2 %
March	217	7.9 %
April	187	6.9 %
May	259	9.4 %
June	270	9.8 %
July	309	11.3 %
August	292	10.7 %
September	235	8.7 %
October	247	9.0 %
November	187	6.8 %
December	179	6.5 %
Total:	**2,739**	**100 %**

4.7 Length of Stay

Length of stay is defined as the time period from the first day of admission to the day of death, discharge, or transfer of the patient to another institution or discharged home. The mean length of stay (LOS) for patients who incurred a THI was 13 days. Four percent died while in hospital.

4.8 Etiology

The most common cause of a hospitalized THI from 1985 to 1998 in three large tertiary care hospitals in Newfoundland was falls (31.2 %). Falls were most often caused by falls from heights such as patio decks, furniture, fences, windows, stairs, and countertops (55.4 %) and from slipping and

falling at ground level, such as on ice, slippery flooring, and through tripping (44.6 %).

The second most common cause of a THI was motor vehicle accidents (27.3 %). Most MVAs were those involving cars and trucks (68.1 %), with ATV and motorcycle accidents accounting for 13.9 and 8.9 percent of MVA related THIs, respectively. Skidoos, seadoos, and boats accounted for only 4.0 percent of MVAs that resulted in a THI, while moose-MVAs accounted for 5.1 percent. The other factors contributing to the occurrence of a THI were quite varied (Table 4.6).

Table 4.6- The Etiology of THIs, 1985-1998

Etiology	N	Percentage
MVAs:		**27.3%**
Car/Truck	510	18.6 %
Skidoo/seadoo/boat	30	1.1 %
ATV	104	3.8 %
Motorcycles	67	2.4%
Moose-MVA	38	1.4 %
Falls:		**31.2 %**
Fall from height	472	17.3 %
Slip/Fall	381	13.9 %
Fight/Brawls	76	2.8 %
Sports/Play	329	12 %
Pedestrian	231	8.4 %
Struck with object	102	3.7 %
Explosion	4	.15 %
Suicide Attempt	14	.50 %
Abuse	12	.45 %
Work related	14	.50 %
Bicycling	301	11 %
Animal Attack	11	.40 %
Plane Crash	2	.10 %
Assault	41	1.5 %
Total:	**2,739**	**100 %**

4.9 Type of THI incurred

This study included all forms of head injury induced traumatically (Appendix D). It did not include those that were acquired such as spontaneously occurring brain tumours, cerebral bleeds, subarachnoid hemorrages and cerebrovascular accidents. The three most common types of THIs were for ICD code 854- Intracranial injury of other and/or unspecified nature (37 %), ICD code 850- Concussion (14.9 %) and ICD code 801-

Basal skull fracture (11.0 %). Because many patients experienced more than one type of head injury, the total number of head injuries (n= 3,532) incurred far exceeds the total number of patient charts in the study (n=2,739).

4.10 Location of Occurrence of THI

The majority of THIs hospitalized at the Health Sciences Centre, Janeway Children's Hospital and Carbonear General occurred in and around the greater eastern region of Newfoundland near the capital of St. John's. Almost half (47.5 %) of the residents of Newfoundland and Labrador live on the Avalon Peninsula. St. John's was the site of 35.8 percent of THIs, while 41.1 percent occurred in the general eastern region. The western region referred 5.5 percent, the central region 8.0 percent and the southern region 7.2 percent of the THIs hospitalized in St. John's. In the less densely populated regions of the province such as the Northern Peninsula and Labrador, minimal cases were referred at 0.55 percent and 1.8 percent, respectively (Figure 4.5).

Location of Injury by Health Region

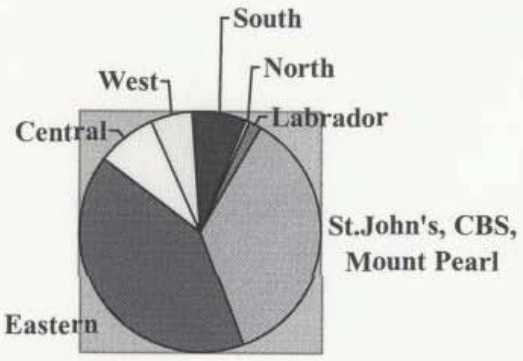


Figure 4.5- Geographical Location of THIs Hospitalized in 3 Tertiary Care Hospitals in St. John's Region from 1985-1998

4.11 Hospitalization Outcome

There were three categories of hospital outcome in this study: 1) discharge; 2) transfer; 3) death. The majority of patients who were admitted to hospital after incurring a THI were well enough to be discharged home (92.2 %). Nearly four percent (3.8 %) with a poor prognosis were transferred to another institution. They were left with some deficit and were not ready to be discharged home. Four percent died in hospital as a result of the THI that they incurred (Table 4.7).

Table 4.7- Hospital Outcome of People with THIs in Newfoundland, 1985-1998

Hospital Outcome	Frequency	Percent
Discharge	2,526	92.2
Transfer	104	3.8
Death	109	4.0
Total:	2,739	100.0

4.12 Physiological Outcome

The Glasgow Coma Outcome scale measures severity of neurological damage and degree of functioning of the brain. It consists of five main catgories: 1) good recovery; 2) moderate disability; 3) severe disability; 4) vegetative state; 5) death. In accordance with this scale, most patients had a good recovery prognosis (87.2 %) (Table 4.8). Only four percent died as a result of the THI, 0.4 percent of the patients were left in a vegetative state with no sign of brain function, and 1.4 percent were severely disabled, with such symptoms as severe memory loss, which prevented them from functioning optimally in society. Seven percent were left with a moderate disability, such as slight hearing loss, but were still able to function independently in society.

Table 4.8- Physiological Outcome of People with THIs in Newfoundland, 1985-1998

Physiological Outcome	Frequency	Percent
Good Recovery	2,388	87.2
Moderate Disability	193	7.0
Severe Disability	39	1.4
Vegetative State	10	0.4
Death	109	4.0
Total:	**2,739**	**100.0**

Chapter 5

Discussion

Injuries are a large and neglected health problem in all regions of the world, accounting for 16 percent of the global burden of disease in 1998 (NTR, 1999). As well as a large cause of human suffering, injuries are also an unquestionable major source of medical costs and losses to the economy and society (NTR, 1999). THIs in 1998 made up 11 percent of all injuries that required hospitalization in Canada, the third leading type of injury after orthopedic and superficial injuries (NTR, 1999).

THIs represent a major cause of mortality and morbidity, both nationally and provincially. For the province of Newfoundland, this study found that while there were 219 THIs experienced in 1985, there were only 118 experienced in 1998. This finding parallels statistics for the whole of Canada, where 37,684 THIs were reported in 1985, while only 22,005 occurred in 1998, a significant decrease of 58.4 percent (NTR, 1999). In Canada, in 1985, head injuries accounted for 11 percent of all traumatic injury admissions (NTR, 1999). The incidence rate of THIs in Newfoundland in 1998 was found to be 73.8/100,000, while that of Canada was just slightly below this at 73.4/100,000 (Think First Foundation of Canada, 2001). The incidence rate for the United States was found to be higher at 100/100,000 (NIH, 2000).

5.1 Age

The age bracket in which most THIs occurred for residents of Newfoundland and Labrador was 0-15 years of age; 53 percent of all the THIs that were admitted from 1985 to 1998 were in this age group. This was a somewhat surprising result as compared to other research findings. The higher proportion in this study is likely due to the inclusion in the study of the only tertiary children's hospital in the province while excluding some adult cases admitted to hospitals outside the Avalon peninsula. Statistics for Canada as a whole showed that the highest frequency of THIs occurred for people ages 15-34 years old, accounting for 30 percent of all head injury admissions (NTR, 1999). The United States reported a similar finding in a 1998 report, where they found the highest occurrence of THIs to be in people 15-24 years old. They also identified an additional peak in incidence in adults 75 years old and older and also in children ages five and younger (NIH, 2000).

For Newfoundlanders in the age bracket of 0-15 years, the most common etiology was falls, making up 32 percent of all of the THIs incurred in this age group and 54 percent of all THIs incurred from falling. Falls were also the leading cause of head injury for 0-15 year olds nationally, where 46 percent of all admissions were attributed to falls (NTR, 1999). For ages 16-24, the most common reason for someone to be admitted to hospital because

of a THI was a MVA which involved a car or truck. These accidents accounted for 42.4 percent of THIs in this age group and 38.4 percent of all THIs incurred from MVAs with car/truck involvement. For the ages 25-44, the most common reason for someone to be admitted to hospital after incurring a THI was also due to MVAs involving a car or truck (31.4 %) and 25.3 percent of all THIs incurred from MVA with car/truck involvement.

For people ages 45-74 and 75 and greater, the most frequent cause of THIs was falls. Falls made up 42.7 percent and 79.1 percent, respectively, of hospital admissions for people in these age groups. Together, these age groups account for 22.6 percent of all THIs incurred from falling. For those 75 years of age and older, apart from falling, THIs were incurred in MVAs (car/truck) and pedestrian accidents.

5.2 Sex

Males are more likely to incur THIs than females. From the research conducted in Newfoundland, males incurred significantly more THIs than females ($p = .026$) from all etiological sources. This finding is of no surprise. It is well documented in the literature that males are much greater risk takers than are females. They have a greater incidence of injuries at all ages and stages and usually suffer more severe injuries than do females (Federal, Provincial and Territorial Advisory Committee on Population Health, 1999). Similarly, the National Trauma Registry (2000) reports that approximately

54 percent of all injury admissions in Canada were males. In NIH statistics, males are twice as likely as females to experience a THI (NIH, 2000). This finding is supported by the Federal, Provincial and Territorial Advisory Committee on Population Health (1999) where, in their summary, provincial reports have found that males generally have higher morbidity and mortality rates than females.

The only category where females exceeded males in frequency of head injury, but not significantly so, was for falls at ages exceeding 75 years of age. This most likely is attributed to the fact that females often outlive males in terms of longevity. If there are more females in the age group where falls are the most predominant cause of a THI, then it only stands to reason that more females than males will incur such an injury.

5.3 Yearly Distribution

The month in which THIs were most frequently observed was July (11.2 %). This is not an unexpected finding as it is during the summer months when more people are outdoors and involved in more activities. Zentner et al. (1996) similarly found that most head injuries, especially those incurred from riding bicycles, were incurred during the summer months, with a peak observed for July.

5.4 Etiology of THIs

5.4.1 Seatbelts and THIs

Seatbelt usage in Newfoundland and Labrador still needs to be improved. In the 458 of 546 charts for MVAs which documented seatbelt use over the 15-year period, more than half of the passengers and drivers were found to be wearing their seatbelts (54.8 %). There was, however, a significant difference found between sexes. Females were reported to be wearing their seatbelt significantly more times than were males ($p < 0.05$). Anderson et al. (1990) have found, similarly, that females were more likely to use restraints and partake in health promotion activities than males.

The government of Newfoundland and Labrador made seatbelts compulsory in early 1982. The Department of Transportation, however, maintains that this was not strictly enforced and implemented until 1990 when the demerit point system was introduced to Newfoundland (Newfoundland Department of Government, Services and Lands, 1996).

In this study, in the 458 charts documenting seatbelt use in a MVA, the usage of seatbelts sharply increased up to 1988. This trend then leveled off to a plateau up to 1996, followed by a moderate decrease into the late 1990s. This finding is believed to be attributed to not as many head injuries occurring as a result of MVAs. It is felt, however, that the implementation and increasing strict enforcement of provincial legislation on the compulsory

usage of seatbelts have played roles in the notable decline in admissions with a THI as a result of a MVA. As mentioned previously, this is reflected in the fact that charges for not wearing a seatbelt by the RCMP dropped drastically from 1985 (n= 3,513) to 1998 (n= 837) (RCMP, 2000).

The findings of this study are supported by the work of Thomas (1990), Reath, Kirby, Lynch and Maull (1989), Rutledge et al. (1993) and Allen et al. (1985). They all found that the compulsory wearing of the seatbelt produced a significant decline in the mortality and morbidity of people in MVAs, particularly for facial and head injuries.

As 45.2 percent of all Newfoundlanders in this study were found to be still not wearing their seatbelt, a literature review was conducted into possible reasons for this noncompliance. Reath et al. (1989) suggested that perhaps there are many reasons why people do not wear their seatbelt. Some perceive that the wearing of a seatbelt violates one's personal liberties or civil rights. Others add, however, that the increased hospital charges for injuries suffered by unrestrained motor vehicle crash victims equally deprives citizens of their civil liberties, due to this added financial liability. Marine et al. (1994) found that infractions of such mandatory laws as seatbelt legislation carry low fines that may not distress people.

5.4.2 Alcohol and THIs

Alcohol use was documented for 574 of the 602 charts for THIs incurred as a result of driving a car/truck, ATV, motorcycle, skidoo, or moose/MVA. Drinking and driving has long been recognized as a common cause of THIs. Driving while impaired is a serious social, economic, and safety problem.

From the research conducted in Newfoundland, significantly more people did not drink and drive (66%) compared to the number that did drink and drive (34 %) ($p < 0.05$). Still, little over one-third of those studied got behind the wheel of a motorized vehicle while inebriated. Newfoundland, in 1989, had the highest per capita sales of alcoholic beverages in Canada at 138 litres (Locke, 1991). However, since the onset of stricter laws in the province of Newfoundland and Labrador in 1994, which legislated a reduction in the blood alcohol level to 0.05 mmol/L for being charged and/or fined for drinking and driving, there has been a notable decrease in the number of people who were charged with drinking and driving (RCMP, 2000).

This decrease started in 1994, where 22 of the 57 people who incurred a THI from MVAs were drinking and driving compared to 1998, where eight of 21 cases were documented. It is safe to conclude that the provincial implementation of stricter drinking and driving legislation has had an impact

on the observed decline in THIs. This is supported by the studies of Johnson (1989), McKenzie and Single (1997), Locke (1991), Waller et al. (1986), and Hankanan and Smith (1991).

In this study, males incurring THIs were significantly more likely to be drinking and driving than were females ($p < 0.05$). Of the 195 THIs in inebriated drivers, 93.3 percent were males compared to 6.7 percent of females. This significant difference in injuries by sex is consistent with what has been found in the literature (Cherpital, 1993; Honkanan & Smith, 1994). The occurrence of THIs was most often found among young males in this study in the age bracket of 16-44 years (37.3 %). This parallels the finding that Cherpital (1993) and Honkanan and Smith (1994) found for THIs and drinking and driving.

It is also significant to note that the person most often involved in drinking and driving injury was the operator of the vehicle (51.3%). The other 48.7 percent were in the following positions: 1) Frontseat passenger- 21.5 percent; 2) Backseat passenger- 22.5 percent ; 3) Other- 4.4 percent. The position of the injured person was not documented in two cases. Surprisingly, the category of "Other" involved 4.4 percent of people injured while riding in conspicuous places such as in the back of a pick up, the hood of the vehicle, and hanging out through the door/window of the vehicle.

The mean blood alcohol level found for those inebriated and involved in MVAs was .3386 mmol/L with a median of .34 and a mode of .38. This is significantly higher than the accepted provincial level of 0.05 mmol/L. Another point of interest here is that people were more likely to drink and drive when operating a skidoo/seadoo/boat (59.1 %) as opposed to the operating of a car/truck (31.7 %), ATV (48.3 %), or motorcycle (36.5 %).

Reasons for people still drinking and driving in spite of stricter enforcement of legislation may be attributed to the already discussed risk-taking behaviours and the perception that they won't get caught because they are only going short distances, as Ward et al. (1982) and Waller et al. (1986) propose, respectively.

5.4.3 Helmets and THIs

Helmet usage in Newfoundland and Labrador needs to be improved. However, the province has come a long way since 1985. For 1985, 35 of the 57 charts for the number of persons in cycling accidents revealed that they were not wearing a helmet (61.4 %), as opposed to three of the 57 people that did wear a helmet (5.3 %). Information was not available for 19 of the 57 charts (33.3 %) of those riding cycles and admitted with a THI that year. In 1998, two of the 16 cases reviewed (12.5 %) did not wear a helmet as opposed to eight of the 16 cases (50 %) that did wear one. Helmet use information was not documented for six of the 16 charts reviewed (37.5 %).

Over the duration of the study, more people were not wearing a helmet (82.8 %), than were (17.2 %), with missing helmet status for 34.8 percent of people.

Motorcycle helmet legislation in Newfoundland has been in place since 1973 (Newfoundland Department of Government, Services and Lands, 1996). Bicycle helmet legislation, however, has only been introduced in more recent years since 1994. Additionally, bicycle helmet legislation is only in effect in four municipalities across the province and applies to both pediatric and adult populations. Although these are fairly densely populated areas of the Avalon Peninsula, St. John's, Mount Pearl, Corner Brook, and Paradise, a significant portion of Newfoundland's population is excluded and not expected to implement such legislation. If such legislation was enforced in all municipalities across the province, there would undoubtedly be a higher percentage of people wearing a helmet.

From the date of implementation and enforcement of the helmet legislation, 1994-95 onwards, there has been an increase in the number of people using a helmet. Although this reflects a slight increase in THIs of people using helmets, it nonetheless, illustrates that people are increasingly engaging in the prevention practice of wearing a helmet. This increase was not significant ($p > 0.05$). The finding that people were more compliant with helmet use when riding motorcycles, as opposed to ATVS,

skidoos/seadoos and bicycles, is perhaps reflective of the notion that motorcycles are indeed the motorized vehicles used more commonly that have the potential to cause a more forceful injury on highways, for example, whereas ATVs, skidoos/seadoos and pedal bicycles are more off the road vehicles and often not found in the middle of high traffic areas.

Finding that significantly more males than females do not wear helmets ($p < .05$) is not surprising. Males, as already stated, tend to be typically high-risk takers who more often drive under the influence, speed, and not wear helmets (Federal, Provincial and Territorial Advisory Committee on Population Health, 1999). As the data suggests, this applies to both bicycle and motorcycle helmet usage. Henderson (1995) found this to be particularly so for bicycle helmet usage, where males, more so than females, did not engage in the preventative practice of wearing a bicycle helmet.

As this study has found, the beneficial effects of wearing a helmet are substantial. This finding is supported by many other authors/researchers (Ontario Neurotrauma Foundation, 1998; Winslade, 2001; Henderson, 1995; Sosin et al., 1996; Zentner et al., 1996; Thompson et al., 1996; Rivera et al., 1999).

In the current study, bicycling was the most common cause of THI amongst the age group 0-15 years. For all those aged 0-15 years admitted to

hospital because of a THI, 93.3 percent were induced from bicycling. As bicycling is a very common childhood activity, this finding is not surprising. This finding is supported by many others (Henderson, 1995; Sosin et al., 1996; Loubeau, 2000; Thompson et al., 1996). Thompson et al. (1996) add, however, that children under six years of age, in particular, need to be especially careful, even with a helmet, because of incomplete development of the brain and the relative flexibility of the skull and sensitivity of brain matter.

In the current research, more bicycling head injuries were incurred by males (75 %) than females (25 %) who were wearing a helmet in the 326 records where helmet use was recorded. This finding is consistent with what has been found in the literature, where girls use helmets more than boys and therefore incur fewer THIs from bicycling for this reason (Henderson, 1995; Morris et al., 1994; Rourke, 1994; Linn et al., 1998).

Motorcycle helmet safety is also recognized as very important. For persons in the study group, motorcycle riding was the second highest cause of THIs for people aged 16-24 (8.6 %).

As stated earlier motorcycle helmet legislation has been enacted since 1973 (Newfoundland Department of Government, Services and Lands, 1996). Realistically, it is impossible to draw any definitive conclusions as to whether or not the legislation had any effect on decreasing the incidence of

THIs in motorcycles and/or increasing the use of helmets over the period 1985-1998. The finding in Newfoundland that most THIs from motorcycle accidents occurred at ages 16-24 is consistent with other research, which has found this type of accident mostly occurring in young adults (Skalkidou et al., 1999; Johnson et al., 1995).

Males (92.5 %) were significantly more often involved in motorcycle accidents causing hospitalized THIs than females (7.5 %). This finding was consistent with that found by Johnson et al. (1995) and Skalkidou et al. (1999).

As mentioned before, there is still a large percentage of Newfoundlanders who do not wear a helmet regardless of the legislation. Numerous reasons have been provided as to why people may not wear a helmet (Henderson, 1995; Johnson et al., 1995; Loubeau, 2000; Sosin et al., 1996; Rourke, 1994).

For Newfoundland, in particular, economic hardship is faced by many. Therefore, the cost of a helmet, ranging from $20.00 to $500.00 may certainly be a potential barrier to people not wearing them. It is important to note also, that while motorcycle, ATV, and skidoo helmet use is compulsory for all of the province, only four Newfoundland municipalities implement compulsory bicycle helmet legislation.

As well, peer pressure, the image of not being macho, alcohol use, fear, and misunderstanding may all be reasons for Newfoundlanders not to wear a helmet. Finally, the older generations of Newfoundland did not have these helmet laws to abide by, and unfortunately, they may retain childhood practice. If a behavior is not promoted and reinforced by the parent, then it is often perceived as unnecessary and/or unimportant to the child (Sosin et al., 1996).

It is also noteworthy to mention here that often times the emergency casualty officer, resident, or neurosurgeon on call determined that the helmet was not strapped up properly, if at all. In order to obtain the optimal protection that a helmet is designed to provide, it must be securely and properly fashioned as Henderson (1995) advocates.

5.5 Other MVA Injuries

Motor vehicle-related issues that could potentially increase one's risk of incurring a THI include moose-involved MVAs, the operation of a skidoo, ATV, seadoo, and/or boat. In the province of Newfoundland and Labrador, more than in other provinces, people are often involved in moose-related MVAs. In this study, there were 38 THIs incurred from moose MVAs, accounting for only 1.4 percent of all THI-MVA injuries documented. These most frequently occurred in the age group of 16-24 years of age (38.5 %). Although this study did not include those who died at

the scene of the accident, there were a lot fewer than what Rattey and Turner (1991) reported for all moose-related injuries. And once again, males more often incurred a THI as a result of the accident (71.8 %) than did females (28.2 %).

Prevention strategies such as cutting back the treeline from the highway, the installation of guardrails, frequent warning signs, and increased lighting are all measures that may help keep moose off the road. Additionally, as moose frequent the highways to lick the salt off of the road, perhaps Newfoundland road-clearing authorities could use more sand instead of salt to decrease slippery road conditions. These measures have already been implemented for many regions of the province. Nonetheless, moose-MVAs are still a major concern to Newfoundlanders.

ATVs accounted for 104 cases of documented THI admissions (3.8 %). These accidents occurred particularly in children 15 years and younger (43.3 %). Most people who incurred a THI from riding ATVs were not wearing a helmet (58.8 %) and they were often under the influence of alcohol (46 %).). At least some of these THIs, therefore, were preventable. Another significant point to highlight here is that one is required to be 16 years of age or older in Newfoundland in order to operate a motorized vehicle, yet most ATV accidents occur in children younger than 16.

It is safe to conclude that there were young children illegally operating an ATV without a helmet and/or that a parent or supposedly responsible adult was operating the ATV but did not ensure the child was protected. A great deal of teaching and learning surrounding the usage of helmets would be deemed essential. If this is reflective of adult behaviour and role modelling in Newfoundland, a lot is left to be desired. These findings are supported by others (Cvijanovich et al., 2001; Boswell et al., 1996; Gibbs et al., 1997).

Skidoo, seadoos, and boats accounted for 30 of the documented THIs resulting from MVAs (4 %). The age group mostly affected was those aged 25-44, where 12 cases were found, making 40 percent of THIs resulting from this cause. This snowmobile finding parallels what has been found in the literature (American Academy of Pediatrics, 2000; Beilman et al., 1999). It is suspected that this age group was mostly affected because a great deal of balance, coordination, and agility is needed to operate any of these motorized vehicles. These skills and abilities are noted to be most characteristic of an adult (Ebersole & Hess, 1994).

As there are obvious preventative mechanisms/practices to prevent motor vehicle and bicycling accidents, and because pertinent legislation around these were thought to impact their use, most of the emphasis of this

research was placed on helmet, seatbelt, and drinking and driving issues. However, some other noteworthy causes require highlighting.

5.6 Falls

Falls in this study included those that fell from a height above ground, such as off a patio deck, down a flight of stairs, or off furniture and also a slip and fall from ground level, such as occurs with tripping. Falls, by far, were the most common cause of a THI in this Newfoundland study (31.2 %). This finding was similar to that found for Canada where falls were the number one source of THIs (NTR, 1999) and also ranked high for the U.S., where it was found to be the second most common cause of THI (NIH, 2000).

Incurring a THI as a result of a fall was found particularly in children ages 0-15 years old (32 %) and also in people ages 75 and greater, where falls made up 79.1 % of all THIs in this age group. That children were the ones most frequently incurring a THI from falling was not surprising, as is supported by findings by Beattie (1997), Betz et al. (1986), and Kirchner (2000). The elderly were also found to have a high incidence of THI from falling (Ebersole & Hess, 1994; NIH, 2000).

It was observed through the Newfoundland chart review that children frequently fell short distances from areas such as shopping carts, beds, other furniture, and countertops. This was not an unusual finding (Beattie, 1997;

Betz et al., 1994). It was at first unexpected to document infants falling from seats placed on the countertop and for children to fall down over a flight of stairs in a walker. However, Kirchner (2000) found this to be a common occurrence. Still, it is felt that much education on the safety of children is needed here in Newfoundland.

The high incidence of serious falls in the elderly is not perceived as unusual or outstanding. Due to the elderly's natural and/or pathological declining cognitive and sensory functions, they are more susceptible to decreased memory recall, decreased vision, and decreased hearing (Ebersole & Hess, 1994; NIH, 2000; Luukinen et al., 1999). Good information on these factors was not readily available in the charts reviewed for this study.

5.7 Pedestrians

Any person at any hour of the day, and at any day of the year, walking along the roadside, has the potential to be hit by a motor vehicle. People incurring a THI in a pedestrian accident accounted for 8.4 percent of the population studied. Once again, more males (61.9 %) than females (38.1 %) were involved and the age group most affected was under age 15 (31.1 %). This finding was similar to what had been found in the literature (Patrick et al., 1998; Hill et al., 1996). Betz et al. (1994) add that due to the natural growth and development of children, it is not uncommon to see children as the frequent sufferers of pedestrian-related accidents that incurred THIs.

In this study, however, there was an unexpected finding where four of the 231 pedestrian-related THIs (1.7 %) were of young children in their own driveways. Often it was a parent who was backing out in the family vehicle who caused the accident. This initially unexpected finding however, is supported by other research (Hill et al., 1996). Certainly some heightened awareness of safety in child play could be implemented for parents. A second unusual observation was for the older 25-44 year olds, who were injured as pedestrians (7.8 %). In four of the charts reviewed (1.7 %), the pedestrians were, in fact, inebriated when they were hit. In some cases it may be the very person who left their vehicle parked to walk home because they felt they were too impaired to drive that got hit by a drunk driver.

5.8 Sports/ Play

In this study, sports/play contributed significantly to all THIs incurred from 1985-98 (12 %). This finding parallels what has been found in the literature (NIH, 2000; Baker et al., 1994; Buechner et al., 2000; Bailes & Cantu, 2001). The age group most significantly affected by this cause was found to be those aged 0-15 years (18.6 %). Betz et al. (1994) support this finding, with the rationale that it is children, anyhow, who are typically involved in sports and play. However, as Bailes and Cantu (2001) add, it really depends on what type of sport or play is ongoing. In this study, sports injuries resulting from hockey, soccer, and softball were the most common;

in play, sliding, swinging, and "horseplay" were the most common. The numbers found here could, perhaps, undoubtedly be much higher, as many of the THIs that are incurred from sports/play are said to go unreported (NIH, 2000).

5.9 Abuse

Shaken baby syndrome has been identified as a major cause of THI in the very young (NIH, 2000). Most of the 12 cases of "abuse" in this study occurred in children less than one year old (83.3 %); one case occurred in a six-week-old baby. This is an unsettling finding. Head injury can impact a child's progression through some very important stages of growth and development. It is felt that a great deal of education is needed in this area, but that good role modelling and early identification of the risk factors would be assets.

5.10 Other Etiological factors of THIs

Assault was another rare cause of THIs in this Newfoundland sample, being responsible for 1.5 percent (41 cases) of the total head injuries incurred. It occurred most frequently in people ages 15 and under (39 %) and ages 25-44 years (36.6 %). Once again, more males (80.5 %) than females (19.5 %) were prone to a head injury from this cause. Assault as a major cause of head injury was a common finding in the literature, particularly for the U.S. where firearms and other weaponry were frequently

used (NIH, 2000; Gilthorpe et al., 1999; Langley et al., 1996; Brickley & Shepherd, 1995).

Brawls were another etiological factor investigated for their influence on THIs. They were responsible for 2.8 percent (76 cases) of total THIs. Fighting involved mostly people aged 16-24 years old, where it produced 5.8 percent (27 cases) of the THIs incurred for this age group. Fighting injuries were more frequent in males (69 cases) than females (7 cases), as was reported in previous literature (Hussein et al., 1994; Cherpital, 1993). In this study, alcohol use was noted in 15 of the 76 cases (19.7 %) of THIs due to fighting. Alcohol, as was already mentioned, does have the potential to increase one's risk-taking behaviour, especially amongst young males (Cherpital, 1993). However, documentation was not consistent and alcohol use in this study refers only to those drinking and driving.

The 14 cases of suicide attempt occurred most frequently in people aged 25-44 years (57.1 %) and more frequently in males (92.9 %) than females (7.1 %). As males typically use a more lethal means of suicide attempt and are thus more likely to cause head injury than are females, this finding is not surprising (Johnson, 1989).

Animal attacks accounted for only 0.4 percent of all head injuries experienced. In this study, all 11 cases of THI resulting from an animal attack were caused by dogs. Most of the THIs as a result of an animal attack

were in children ages 15 and younger (80 %). Having children as the most frequent victim of an animal attack and incurring a THI as a result of it was not unusual (Hussein et al., 1994; Adesunkanmi et al., 1998).

Incurring a head injury from being hit by a foreign object accounted for 102 (3.7 %) of the total number of THIs incurred in this study. These injury causes ranged from things such as falling trees, rocks being thrown, and walking into doorframes, to bumping into furniture. Fifteen-year-olds and younger were the age group most often affected, making up 57.4 percent of all THIs incurred for these ages. To find that children are the most susceptible age group for getting THIs as a result of a foreign object is not unusual (Betz et al., 1994). It should be added, however, that this classification of foreign object injury does not include weapons used in fights, assaults, or abusive situations, nor does it include injuries with objects such as bats, which are included in sports/play injuries.

From the review of the charts, there were 14 THIs incurred in the workplace (0.51 %). Of the 14 injuries found, people aged 25-44 felt the biggest impact (57.1 %). Since this portion of the population involves mostly employed people, this is not unexpected. They would be the ones most likely to suffer injury as a result of work-related duties. The most common work-related injury involved heavy construction and equipment

work areas, so only a small number of head injuries was anticipated. This is supported by the literature (Hussein et al., 1994).

5.11 Outcome

Most patients with THIs as revealed from this study were discharged home (92.2 %). This is a good indication that the head injury was not severe and that the person, in the medical doctor's opinion, was well enough to go home and function optimally on his/her own. They no longer required the specialized services of the health care system, at least not enough to keep them in hospital. Beattie (1997) discovered a similar finding.

Only 3.8 percent of the population studied were disabled to the point that they had to be transferred to another health care institution for some form of care and rehabilitation. At times, they were even transferred to long-term care institutes such as nursing homes. Those that incurred head injury and were left severely disabled often had to be sent to rehabilitation institutes somewhere outside of the province, such as Sunnybrook Hospital in Toronto, to receive treatment not available in Newfoundland.

Only four percent actually died in hospital because of the THI. This is a relatively small percentage of people dying due to traumatically induced head injuries, which is a very promising result. The data entered here, however, are exclusive of the people who died at the scene of the accident. Given today's technological advances in health care and early intervention,

perhaps, more and more people are making it to hospital where resusitative measures are quickly and more efficiently implemented.

Physiological outcome was determined by using the Glasgow Coma Outcome scale with the categories of good recovery, moderate disability, severe disability, vegetative state, and death (Hall et al., 1985; Snoek et al., 1981). It is perhaps more meaningful and beneficial to explain the patient's physiological outcome. When a person incurs a THI, they have the potential to suffer from serious sequelae. Rarely are the consequences limited to only one set of symptoms, impairments, or a disability (NIH, 2000).

Over 85 percent (87.2 %) of all patients experiencing a THI ended up with a good recovery status. For these people, normal life activities resume, even though there may exist a minor neurological or pathological deficit (Hall et al., 1985). This proportion of cases with "good recovery" is high but no other studies capturing cases and outcomes in this manner were found for comparison. Fewer people are enduring severe THIs and their sequelae because of today's increased emphasis on safety and infrastructure changes/alterations (NIH, 2000). Also, due to today's increased education on prevention and an overall heightened public awareness made possible through the media, THIs may result in less severe and fewer sequelae. This is an optimistic outcome because people are left with a satisfactory level of functioning.

Only a small percentage of people with a THI in this study were diagnosed with a moderate disability as a result of the injury (1.4 %). For those who retain a moderate disability as a result of the THI, are still able to function to a relatively high degree in society (Snoek et al., 1981; Hall et al., 1985; NIH, 2000). Some examples of disabilities that belong in this category from the research are decreased vision in one or both eyes, decreased hearing in one or both ears, and difficulty with short term memory recall. The NIH (2000) study confirms that although head injury may result in physical impairment, the more problematic consequences involve one's cognition, emotional functioning, and behaviour.

One hundred and ninety two cases (7 %) experienced a THI which left them with a severe disability. These people are not able to function independently in the community (Snoek et al., 1981; Hall et al., 1985). Some examples of a severe disability that were found in this research were major personality changes, with behaviour that is very aggressive or inappropriate in society, and total loss of memory. As NIH (2000) points out, although most complications become apparent in the first few days, some may not surface until months later, depending on the severity of the trauma.

Only 10 people (0.4%) who incurred a THI fell into the category of vegetative state. The people here were unconscious and revealed only

minimal sign of brain function (Snoek et al., 1981). Derived from the research, such persons were dependent for all of their activities of daily living. They were typically fed with a tube inserted into their stomach, received fluids intravenously, and had to be manually positioned and turned. These persons, could not talk, walk, or comprehend commands.

Only four percent of people died as a result of their THI. From the review of the charts, eight patients were first placed on brain death protocol with no sign of life except for brainstem functioning, and they died shortly thereafter. In approximately six cases, organs were salvaged for transplantation. To determine the true impact of THIs, it would have been necessary to find out the total number of deaths from THIs that occurred at the scene of the accident. These were victims of THIs that would not have been admitted to hospital and therefore would not have showed up in hospital charts. Only the charts of those that suffered and/or died from THI after being admitted to hospital are included in this study.

It is important to note here as well that admission criteria was not perceived to have changed during the study period. Although the health care of Newfoundland, like any other province/state/country has received the benefits of advanced technological change and modern treatment, this was not perceived to have significantly changed in the time period studied. Similarly, no significant number of hospital beds or nursing units were

closed during this time frame, that would have potentially impacted on the number of THIs sent home instead of being admitted. Additionally, no change in triage or referral patterns between areas of Newfoundland and Labrador were noted during this time.

5.12 Head Injury Type

The most common type of head injury for the population of Newfoundland studied was an intracranial injury of other/ unspecified nature with/without mention of open intracranial wound (37.0 %).

The second most common type of head injury was a concussion (14.9 %). Concussions are generally perceived to be less serious, with a low probability of producing severe sequelae. Zentner et al. (1996) in their study of bicycling and head injuries found that 70 percent of head injuries incurred from bicycling resulted in good recovery. They found that 14.9 percent of these were diagnosed with concussion.

5.13 Preventative Programs

In spite of the overwhelming high percentage of people recovering from their THI with good status, four percent of people still died as a result of THI. These injuries, for the most part, could have been prevented. It is well documented in the literature that 90 percent of all injuries are preventable (NTR, 2000; Think First Foundation of Canada, 2000). Much research has proven that engaging in simple behaviours such as fastening

your seatbelt, not drinking and driving, and wearing a helmet does significantly reduce head injury and injury in general (Bolen et al., 1999; NTR, 1999; Think First, 2000; Martin, 2001).

The impact of publicly promoting safety was found to be especially so in those communities/provinces/states/countries that implemented legislation around their use. For those places that implemented compulsory helmet use, seatbelt use, and not drinking and driving, and reinforced their laws through education and media and community programs, a great impact was found (Think First Foundation of Canada, 2001; Bolen et al., 1999).

Seatbelt legislation initially introduced to this province in the early 1980's never got really enforced until the early 1990's. In this study, a greater majority of the people were wearing seatbelts than not. In the first half of the study, years 1985-1991, more people were not wearing seatbelts (n=120) than were (n=97). This compares to the second half of the study, years 1992-1998, where more people wore their seatbelt (n=155) than did not (n=88). Even though there was a reversal of figures with respect to who was wearing a seatbelt and who was not over the time that it became more strictly enforced, to find out that 37.9 percent overall still do not wear their seatbelt is not good enough. Perhaps the current fines of 50 to 500 dollars, the demerit point system stipulations, and other judicially enforced penalties

are not severe enough. If stiffer penalties were implemented, then maybe we would witness a greater reduction in the number of people violating the law.

As for *drinking and driving*, not much has been found in the way of drinking and driving legislation and its effectiveness. From the results generated for Newfoundland, there is not much to be said for implementing such legislation. For the first half of the study, 1985-1991, significantly more people were not drinking and driving (n=174) than were (n=82). Similarly, for the second half of the study, more people were not drinking and driving (n=206) compared to those who were (n=113).

Legislation for drinking and driving seemed to have little effect on decreasing head injuries in Newfoundland. In fact, those answering yes to drinking and driving in the second half of the study (n=113) exceeded those found to be drinking and driving in the first half of the study (n=82), when legislation was supposedly not strictly enforced. It becomes obvious therefore, that a decision to change the alcohol level from 0.08 to 0.05 was a good move, but it did not really get through to the rising number of people who continue to drink and drive. Perhaps, the penalties of driver licence suspensions, fines of upwards to $1,000.00, and the overhanging threat of a prison sentence are not steep enough to deter people from drinking and driving. Besides the efforts exerted by advocacy groups against drinking and driving, such as MADD and SADD, children in the school system are

continuously being reminded of the importance of wearing your seatbelt and not drinking and driving. Awareness programs such as these, perhaps, need to be increased to obtain the desired societal effect.

Bicycle *helmet* wearing in Newfoundland was, in the past, promoted through the Newfoundland and Labrador Safety Council with the schools as middlemen. They offered subsidized purchase of bicycle helmets to all children attending the schools in Newfoundland. This program was called "Lids for Kids" and targeted the disadvantaged children in communities. This offer was sent home to parents to review and avail of if they so chose. At present time, all funding has been exhausted so now the council just delivers the literature to all schools and designates a teacher to present it to the children. However, the Safety Council still offer bicycle rodeos to children which presents instruction on bicycle and helmet safety. Additionally, the local children's hospital, the Janeway Children's Hospital, took part in a CHIRP Program, Children Head Injury Resource Protection Program, a nationally recognized organization that advocates and promotes the importance of wearing helmets and prevention.

Additionally, the local food take-out business, McDonald's, paired up with the local Royal Newfoundland Constabulary police enforcement organization to pass out free food coupons for those that were wearing their

helmets while on bicycles. This was done on a periodic basis by passer-by police vehicles. This program, unfortunately, has not continued.

These were all efforts to increase public awareness, educate the public, and actively enforce passed legislation. With only four municipalities in the whole province, however, enforcing this legislation for all ages and imposing a $25.00 fine for not wearing the helmet, much more widespread implementation is needed in the rest of the municipalities of the province. Additionally, when asked about the strictness in enforcing this legislation in St. John's and Mount Pearl, the response was always, "No, we would not always stop the bicyclist who was not wearing a helmet", particularly, if it were "An adult" and "Our manpower monitoring this legislation is quite small", all pointing to the fact that although the legislation is present, it is not necessarily being enforced.

The usage of helmets and the importance of them is not only an important issue with respect to bicycles. It is also important with respect to the use of ATVs, skidoos, and motorcycles. Injury seemed to be particularly decreased in those areas where helmet legislation was present (Rourke, 1994; Sosin et al., 1996; Vulcan & Lane, 1998).

Education, media awareness, policy and legislation, and role modelling have all been found to play a role. Many prevention programs/ activities in St. John's and Newfoundland are in place in an effort to help

prevent injury. However, due to the still unacceptably high frequency of head injuries occurring in Newfoundland, it is felt that education to increase awareness and preventative behaviors is still very much needed.

With respect to *other causes* of head injuries, much benefit can be gained from education, particularly for children and/or child care. In this study, children were documented to frequently fall from countertops, fall down stairwells while in walkers, get hit by a motor vehicle in their own driveways, and suffer from physical abuse.

For the province of Newfoundland and Labrador, health care professionals in the community, such as community health nurses and social workers, are most likely to suggest and promote child safety in these areas. Other programs located in Newfoundland that address the issue of child safety are Safe Kids Canada and KISS (Kids in Safety Seats) (Safe Kids Canada, 2002). These are non-profit organizations that promote the safety of children, in general, including the home and environment, and also in car seats, walkers, highchairs, etc., respectively. Walkers, in fact, are now illegal in Canada (Newfoundland and Labrador Safety Council, 2001).

Pedestrian safety is also important (American Brain Injury Association, 2001; Durkin et al., 1999). In this study, 231 head injuries occurred to pedestrians. At present, the larger communities of Newfoundland have in place during the school year crosswalk personnel to

ensure that the children get across the street safely and bus monitors to ensure the safe loading and unloading of school buses. The Brain Injury Association of America (2001) and the Newfoundland Brain Injury Association (2001) also help parents to teach their children prevention, i.e., look both ways before crossing the street.

Sports/play also has preventative issues that may be assessed. Although not much programming is in place to monitor playground and/or sport safety, others have found education and training in these areas to be important (The American Brain Injury Association, 2001; Baker & Patel, 2000). Provincially and nationally, there exist advocacy groups to promote the safety of children in playgrounds (Kids Safe Canada, 2002; Newfoundland and Labrador Safety Council, 2001).

Although the incidence of THIs from occupational causes is quite low (n= 14), the workplace is still an area that needs to address safety issues. Most larger workplaces in Newfoundland have in place occupational health and safety committees that meet regularly and address workplace hazards and unsafe practices (Government of Newfoundland and Labrador, 2001). Secondly, the Newfoundland and Labrador Safety Council (2001) provides occupational health and safety training for those interested in obtaining it.

5.14 Other effects of THIs

The occurrence of a THI not only impacts on the individual's physiological status; it also has the potential to impact on one's quality of life, financial status, family, and society in general. Chronic employment, divorce, economic strain, and substance abuse have been mentioned in previous studies (NIH, 2000). This study was not designed to assess these effects but, through the review of the charts, the researcher repeatedly was made aware of the impact of THIs.

This personal and familial impact became especially apparent from the social workers' notes. Situations mentioned were the father who was now in a vegetative state with a non-working wife and a newborn child, the placement problem of a patient with major THI-induced behavioral problems, and the individual who would be unable to return to his job because of the severe nature of his injury. As well as impacting heavily on families, people who suffer from THIs place additional strain and burden on social service agencies, law enforcement, and the courts.

5.15 Limitations

Limitations have been identified in this study that could have potentially altered the results obtained. First, this study only considers those head-injured people that were actually admitted to hospital. It does not take into account those who died at the scene of the accident, those who suffered

a mild hematoma or concussion and went home from the scene of the accident, or those who came to emergency and did not get admitted. It also therefore, could not assess those cases of homicide and completed suicide, for example, as they would have died at the scene. This could definitely skew our results towards a population admitted with a better prognosis; omission of those with mild injuries could result in admission with poor prognosis. Secondly, only charts from three hospitals on the Avalon Peninsula in the greater eastern area were reviewed, as this was the most densely populated region of the province. Based on a detailed review of the first and last year of the study period the number of charts reviewed from those sites, however, represented an estimated 64 percent of all head injuries experienced in Newfoundland and Labrador in the study period. The results would have been more generalizable had all of the health care institutions across the province been included.

Of all charts eligible for review, 292 were missing, incomplete, or lost in storage. Many pieces of information from the charts were missing. These were in the form of patient demographics, the nature of the head injury experienced, the etiology of the THI, and the nature of the outcome of the injury. ICD codes were sometimes wrongly assigned e.g. broken nose vs. head injury; these accounted for less than two percent of charts. A cross

reference with E-codes was not done. It is unlikely this would have significantly changed the cases obtained.

Also missing were etiology; the position one was in if MVA was the source of the THI; the seatbelt; helmet; alcohol status if applicable; and having to indicate this status then as not given, and finally, the indication of the blood alcohol level (BAC), if applicable. With regard to outcome of THI, dates. hospital outcome and/or glascow outcome status were frequently missing.

Incompleteness of the chart entailed such issues as that occurred when the doctor no longer practiced at the health care facility and the patient's chart was not completed. Pertinent pieces of the charts were sometimes missing such as the admission/discharge summary, the emergency record and the doctor's history and physical. These are the main elements of the chart from which basic pieces of information were obtained.

Finally, a total of 27 charts were deemed irretrievable and were thus not reviewed.

Chart information may also have been inaccurate. Potential sources of error include the doctors evaluation of the patient at the time following the injury. Drunken, confused and traumatized patients are at a high risk of giving incomplete or wrong information around the occurrence of the THI. For example, "yes, I wore a seatbelt" may in fact not be a reliable statement

by somebody who was confused or intoxicated. Intoxication, as well, could result in a more serious assessment. The rapid recovery from what was actually a lesser injury could skew the results. Coding of THIs was also questioned. Where there was mentioned of two types of head injury, often times there was only one coded for. Also, incorrect coding, as illuded to above, was also an issue.

5.16 Unexpected Findings

In the course of gathering data from the charts for this study, some unexpected findings were observed, i.e., some of which reflect the way health care is delivered to the people of Newfoundland and Labrador.

First of all, for every patient that entered the emergency department with a traumatic head injury, pertinent information was not even obtained. After having been involved in an MVA and incurring a head injury questions about drinking and driving, not wearing a helmet, or not wearing a seatbelt, may not even have been addressed. These are very vital pieces of information for the researcher that could potentially lead to the reason why someone got killed in an accident or charged for causing the accident that caused death and/or bodily harm. However, it is not written hospital policy that a toxic screen be done when someone is admitted drunk, nor is it written hospital policy to find out the details of whether or not someone wore a

helmet or a seatbelt. It is purely upon the discretion of the casualty officer in the emergency department to order such a test.

In 1997, the Health Sciences Center undertook the project of developing a trauma registry. This system provided a centralized collection of accident relevant information which would make the retrieval of health statistics much more easily obtainable. This form was completed for every injury incurred from an accident and would even address the information found missing in this study, such as helmet status, seatbelt status and alcohol status. The person employed to do this, however, became quickly frustrated at the lack of help received to complete such a large task and left this position. At present, therefore, the project is at a standstill and the overwhelming health care deficit holds no promise for fulfillment of this role that requires assistance.

5.17 Conclusion and Future Research Direction

THIs appear to be on the decline over the last number of years, from 1985 to 1998. THIs are still a major cause of morbidity and mortality at the provincial, national, and international levels. Most head injuries are preventable. With the implementation of legislation and bylaws, people appear to increase their use of preventative behaviours, but with minimal fines, insufficient manpower to enforce legislation, and the nature of the geography of the province of Newfoundland, people can quite easily avoid

being penalized for not doing so. An associated decrease in THIs with the implementation of compulsory seatbelt usage and compulsory helmet usage was found. The impact of a stricter drinking and driving regulation was uncertain. However, there is much more education and heightened public awareness needed in all areas.

While many preventative programs exist provincially and nationally, there is still much need for improvement, particularly with respect to childcare. This could be a goal for our healthy public policy makers, so as to continue to decrease the economic, personal, societal, and family burden that so often accompanies THIs.

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Appendix A

_____ Study Number
_____ Chart Number

Chart Audit Form

Descriptive Study of head injury discharges in NFLD, 1985-1998

Demographics

1) Age at the time of injury _____
2) Sex: M_____ F_____
3) Location of injury:_____ Not given:_____
(community, street, etc.)

Injury

4) Date of injury ___/___/___
d m y
5) Date of admission ___/___/___
d m y

6) Injury sustained (ICD Code applied):_____ _____ _____ _____

7) **Cause of injury:**
a) MVA-car/truck
b) MVA-skidoo/seadoo/boat
c) MVA-ATV
d) MVA-motorcycle
e) Fall from height
f) Slip/Fall
g) Fight/brawl
h) Animal involvement i.e. moose/mva
i) Sports/Play
j) Pedestrian
k) Struck with a foreign object
l) Explosion
m) Suicide attempt
n) Abuse
o) Work related
p) Bicycling
q) Animal attack
r) Plane crash
s) Assault

IF MVA:
1) Driver
2) Front passenger
3) Back passenger
4) Other
5) Not given

Helmet Status
1) Yes
2) No
3) Not given

Seatbelt Status
1) Yes
2) No
3) Not given

8) Outcome of hospital admission
1) Discharge ___/___/___ d m y
2) Transfer ___/___/___ d m y
3) Death ___/___/___ d m y

Alcohol Status
1) Yes
2) No
3) Not given

9) Physiological Outcome
1) Vegetative State
2) Severe Disability
3) Moderate Disability
4) Good recovery
5) Death

If yes, BAC=_____
BAC not given_____
Date of sample:
___/___/___
d m y

Appendix B

Documents that were mailed out to each of the health care boards prior to implementation of the study:

- Human Investigation Committee (HIC) application
    - HIC approval.
    - HIC amendments
    - Research Proposals Approval Committee (RPAC) approval
    - International Classification of Diseases (ICD) code listing for all head injuries incurred as a result of trauma
    - Letter of application to ask if the research could be conducted at the individual institutions
    - Letters of support for the proposed research, i.e. Dr. Roy West (Associate Dean of Memorial University's Division of Community Medicine), Dr. F. Maroun (Chief of Neurosurgery, Health Sciences Center), and Mr. Geoff Ewing (Manager, Department of Transportation).
    - A one page summary of goals, purpose, and methodology

Appendix C

ICD codes for traumatic head injury used in the study:

a) 800 series- Fracture of vault of skull

b) 801 series- Fracture of base of skull

c) 803 series- Other and unqualified skull fractures

d) 804 series- Multiple fractures involving skull or face and other bones

e) 850 series- Concussion

f) 851 series- cerebral laceration and contusion

g) 852 series- Subarachnoid, subdural or extradural hemorrhage following injury

h) 853 series- Other and unspecified intracranial hemorrhage following injury

i) 854 series- Intracranial injury of other and unspecified nature

j) 873.0, 873.1, 873.8, 873.9-Open wounds to the head

k) 905.0- Late effect of skull fracture or facial. bones

l) 925.1- Crushing injury of face and scalp

m) 920 series- Contusion of face, scalp, and neck, except eye

n) 921 series- Contusion of eye and adnexa

n) 950 series- Injury to optic nerve pathways

o) 951 series- Injury to other cranial nerves

p) 331.4- obstructive hydrocephalus

q) 431- Intracerebral hemorrage

r) 348- Cerebral edema

Appendix D

The varying types of THIs incurred in Newfoundland and Labrador, 1985-98

ICD Code Series	Head Injury Description	Frequency (n)	Percentage
800	Fracture vault of skull	300	8.5 %
801	Fracture of base of skull	390	11.0 %
803	Other skull fractures	70	2.0 %
804	Multiple fractures involving skull or face and other bones	11	0.31 %
850	Concussion	527	14.9 %
851	Cerebral laceration	66	1.9 %
852	Subarachnoid/subdural/ extradural hemorrhage	112	3.2 %
853	Other and unspecified intracranial hemorrhage	29	0.82 %
854	Intracranial injury of other and/or unspecified nature	1307	37 %
873.8/9/0	Open wounds to the head	346	9.8 %
331.4	Obstructive hydrocephalus	30	0.85 %
348	Cerebral edema	46	1.3 %
431	Intracerebral hemorrhage	13	0.37 %
920	Contusion of face, scalp and neck, except eye	172	4.9 %
921	Contusion of eye and adnexa	49	1.4 %
950	Injury to optic nerve	38	1.1 %
951	Injury to other cranial nerves	26	0.74 %
	Total:	**3,532**	**100.0 %**