THE ECONOMIC BURDEN OF UNINTENTIONAL INJURY IN ONTARIO

presented by

SMARTRISK

SAUVE-QUI-PENSE

THE ECONOMIC BURDEN OF UNINTENTIONAL INJURY IN ONTARIO

presented by

SMARTRISK

SAUVE-QUI-PENSE

in partnership with

Ontario

Ministry of Health and Long-Term Care
Emergency Health Services Branch

Kingston, Frontenac and Lennox & Addington Health Unit

The Economic Burden of Unintentional Injury in Ontario
Submitted to SMARTRISK
1999

Study conducted by Terry Albert and Eden Cloutier
based on the study “The Economic Burden of Unintentional Injury in Canada” by The Hygeia Group.

Additional support for “The Economic Burden of Unintentional Injury in Canada” from Health Canada Santé Canada

Funding for printing and dissemination has been provided by the Government of Ontario through a grant from the Ontario Neurotrauma Foundation in association with the Rick Hansen Institute.

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 LITERATURE REVIEW 1

2.1 ISSUES IN PREVENTING INJURIES 1
2.2 INTERNATIONAL EVIDENCE 2
2.2.1 United States 2
Occupational Falls 2
Motorcycle Crashes 3
Bicycle-Related Injuries 3
Children's Injuries 3
Mortality and Morbidity Resulting From Unintentional Injuries 3
2.2.2 United Kingdom 4
2.2.3 Norway 5
2.2.4 Canada 5
2.3 WHY EXAMINE THE ECONOMIC BURDEN OF INJURY? 6
2.3.1 United States 6
Net Savings from Injury Control Interventions 6
Morbidity and Mortality Costs 6
Workplace Injury Costs 8
Fall Injury Costs 8
Motorcycle Injury Costs 9
2.3.2 Multi-Country Costs 9
2.3.3 Australia 10
2.3.4 United Kingdom 11
2.3.5 Norway 12
2.3.6 Sweden 12
2.3.7 Canada 13

3.0 METHODOLOGY 15

3.1 INTRODUCTION 15
3.2 A COMPREHENSIVE FRAMEWORK FOR MEASURING TOTAL COST OF INJURY 16
3.3 WHAT IS THE COST-OF-ILLNESS APPROACH? 16
3.4 WHAT METHODS AND DATA SOURCES DID WE USE? 18
3.5 THE ERAT: A WORKING SOLUTION TO DATA LIMITATIONS 20

4.0 RESULTS 21

4.1 WHAT ARE THE ECONOMIC COSTS OF UNINTENTIONAL INJURIES? 24

4.1.1 Direct Costs 24

4.1.2 Indirect Costs 26

4.1.3 Total Economic Costs 29

4.2 HOW SENSITIVE ARE THE RESULTS? 30

4.2.1 Change of Discount Rate 30

4.3.2 Change of Unemployment Rate 30

4.3 WHAT IF DIFFERENT SCENARIOS WERE ESTIMATED? 31

4.3.1 The Population Effect Scenario 31

4.3.2 Plausible Injury Reduction Target Scenarios 32

4.3.3 The Scenarios 35

Scenario 1: Falls in the Elderly 35

Scenario 2: A Reduction in Falls in Children 36

Scenario 3: A Reduction in Motor Vehicle Crashes 36

5.0 THE POLICY CONTEXT & RESPONSE 37

5.1 INTRODUCTION 37

5.2 AREAS OF FOCUS 38

5.2.1 Motor Vehicle Crashes 38

5.2.2 Falls 38

5.3 INVESTING IN HEALTH: THE NEED FOR AN INTEGRATED STRATEGY 39

5.3.1 Injury Surveillance is Prevention 39

5.3.2 Prevention and Risk Reduction: Is There a Payback? 40

5.3.3 How Much Should Be Invested in Surveillance and Prevention? 41

5.4 WHAT ARE THE POTENTIAL PAY-OFF STRATEGIES? 42

5.5 WHAT ABOUT FUTURE RESEARCH AND DIRECTIONS? 44

5.6 A PROPOSED FRAMEWORK 45

5.7 CONCLUSION 47

APPENDIX A 51

REFERENCES 52

APPENDIX B 59

I - INJURY SURVEILLANCE, PREVENTION AND CONTROL 60
What Is Injury Surveillance? 60
How Are Surveillance Data Used? 60
Injury Prevention And Control 60
Link Between Surveillance And Public Policy 61
Cost Studies and Injury Control Research 61

II - INJURY CONTROL OBJECTIVES 62
Injury Control Objectives for Canada (1991) 62
Injury Control Objectives For Ontario (1997) 64

III - COMMUNITY INTERVENTION AIMED AT THE PREVENTION OF ELDER FALL INJURIES 65
Cost Studies 65

IV - ROUTINELY COLLECTED DATA FOR UNINTENTIONAL INJURY IN CANADA 66
Mortality Data 67
Hospitalization Data 69
Outpatient Data 69
Comment 70

REFERENCES 71

APPENDIX C 75

DETAILED METHODOLOGY FOR ASSESSING COST OF UNINTENTIONAL INJURY 76
Existing State Of The Art For Cost of Illness 76
The General Approach: Some Guidelines 76
Core Costs 76
Indirect Costs 77
Discount Rate 77
Double Counting 77
Be As Comprehensive As Possible 78
Use the Appropriate Cost Approach 78
Sensitivity Analysis 78
Documentation 78
Cost Framework 79

APPENDIX D 85

ELECTRONIC RESOURCE ALLOCATION TOOL (ERAT) 86
The Electronic Resource Allocation Tool 86
Modeling and Estimation Techniques 86
The ERAT: A Resource Tool 86

1.0 INTRODUCTION

Injury has recently been identified as a major public health problem in Canada and a significant threat to the economy, health care system and overall quality of life. A landmark study unveiled the staggering costs of unintentional injury in Canada amounting some $8.7 billion (SMARTRISK, 1998). Nationally, injury ranks third behind cardiovascular and musculoskeletal disease in terms of societal economic burden (Health Canada, 1997). Yet, it ranks last in terms of the research share of the total costs and it persists as a predominantly hidden epidemic.

The injury continuum spans from unintentional to intentional injuries. Intentional injuries include suicide, homicide and other acts of violence. Unintentional injury is a rather diverse and heterogeneous category ranging from falls to motor vehicles crashes to drowning. These injuries tend to have less identity and recognition in health policy and research in Canada as compared to other health issues.

Other countries have recognized injuries as a major threat to human health and well-being and they have devised action-oriented responses. The United States now have a National Centre for Injury Prevention and Control (Sleet et al., 1998) and the British government has recently identified injury as one of four health priorities along with heart and stroke, cancer, and mental health (Department of Health, 1998).

This study on *The Economic Burden of Unintentional Injury in Ontario* identifies Ontario as one of the major "epicenters" of the injury epidemic in Canada. Over one third of the injuries and the related costs can be attributed to Ontario. This report goes beyond the economic consequences of this public health threat to proposing solutions to reducing human pain, suffering and grief through a truly integrated and coordinated injury control strategy.

It is expected that the results of this study will provide the necessary economic rationale and impetus for policy makers, providers, managers and citizens to make recommendations needed to bring injury prevention to the forefront of health sector policy discussions, as well as to improve existing treatment and rehabilitation approaches. These discussions would encompass behavioural changes, programming initiatives, communications strategies, engineering strategies, legislative, regulatory and enforcement initiatives, community outreach programs, injury and age specific education initiatives and an extension of injury prevention networks and coalitions that would be necessary to bring about significant reductions in unintentional injuries. In addition, recommendations for improving the measurement and reporting of injury information could be important by-products of this study.

2.0 LITERATURE REVIEW

2.1 ISSUES IN PREVENTING INJURIES

The need to reduce the burden of unintentional injury is highlighted by the high proportion of premature deaths, disabilities and costs resulting from injury. Information from Canada and other industrialized countries suggests that the morbidity and mortality rates resulting from unintentional injuries are significant. Because of their impact on premature deaths among children and young men, injuries are considered by experts to be the major health-related cause of lost working years of life (Waller, 1985). Based on data from the American National Health Survey, every year almost a third of the population is injured severely enough to either seek medical care or be unable to perform regular activities for at least one day (Waller, 1985). These injuries are not accidental events. They are predictable: the risk factors are identifiable, and there are preventive interventions available that can minimize their impacts

(Postl, 1993). Injury prevention must therefore be considered an investment.

2.2 INTERNATIONAL EVIDENCE

2.2.1 United States

Occupational Falls

Leamon and Murphy (1995) categorized and analyzed injuries and relative costs arising from occupational slips and falls by age, gender, industry, climate and geographic region. In the US, falls were the second highest cause of work-related fatalities (following motor vehicle crashes). Based on 1988 data from the US National Safety Council, Leamon and Murphy (1995) found that the number of fall fatalities exceeded the combined number of workplace deaths associated with poisoning, electric current, fire, burns and drowning. Their findings were consistent with those in the United Kingdom (Proctor and Coleman, 1988) and West Germany (Hoyos and Zimolong, 1988). The study selected the industry groups of manufacturing, food products manufacturing, restaurants, trucking, construction, health care, drivers and clerical personnel. They found that the estimated annual cost of falls ranged from $44 to $560 per employed worker, depending on the industry sector. When broken down by gender, the fatality rate for males was 5.2 per 100,000 workers, compared with 4.6 for females. Although the gender differences of fatality rates were statistically significant, the authors suggested that increased risk may not be purely a gender effect, but may instead reflect distribution by occupation. For persons aged 45-75 years the second highest cause of unintentional deaths was related to falls, whereas for those aged 75 years and over, falls accounted for the highest rate of unintentional deaths.

The study also found that although younger people tended to fall more frequently, falls sustained by the elderly were more serious. There was a significant increase in falls throughout the winter months, although areas considered high-risk environments did not point to an increased probability of falling.

Furthermore, Leamon and Murphy (1995) looked at two groups of falls based on elevation. Group one were not elevated when the fall occurred, and the second group experienced falls from an elevation, i.e., falls from stairs, ladders, or scaffolds. The findings indicated that falls from an elevation, while less frequent (comprising about 35 per cent of all falls), were more serious than falls on the same level, with costs being 63 per cent more than same-level falls.

Motorcycle Crashes

Since motorcycle crashes can cause severe injuries to the head, the consequences of a motorcycle crash were seen to be far greater than those involving automobiles. Jefferson Rowland et al. (1996) conducted a retrospective cohort-study of injured motorcyclists in 1989. They examined the incidence, type of severity and costs associated with crash-related injuries for groups of motorcyclists with and without helmets. Almost all of the motorcyclists were males with an average age of 30 years.

Their analysis showed that the number of injuries was three times higher and the severity of head injuries four times higher for motorcyclists who did not wear helmets than for those who wore them. Motorcyclists without helmets had a death rate almost two-thirds higher than riders who wore helmets. Furthermore, the average length of stay and readmission to hospital was greater for motorcyclists who did not wear helmets. The total cost of hospital treatment for motorcyclists in 1989 was $5.7 million, of which $3.5 million went to non-helmet users. The most common injuries for both groups of motorcyclists were related to the extremities, but injuries to the face were higher among non-helmet users.

Bolhofner et al. (1994) also examined motorcycle crashes and their economic impacts. The four year study looked at the relationship between the crash and the severity, prevalence and degree of alcohol intoxication. It was found that most of the injuries involved young men, and alcohol consumption had a strong association with the crash. Finally, people involved in crashes involving alcohol sustained more severe injuries to the head, face and extremities.

Bicycle-Related Injuries

Based on data from a trauma centre, Spaite et al. (1995) undertook a prospective cohort study of bicycle-related injury and the effect of alcohol consumption and helmet use. They looked at two groups of cyclists. Group I had detectable blood alcohol levels at time of admission, and Group II had no clinical indication of alcohol consumption. The results and conclusions demonstrated that prior consumption of alcohol increased the likelihood of injury, the severity of the injury and led to longer hospitalization and higher health costs.

Children's Injuries

Fact sheets compiled by the Children's Safety Network (CSN) in the US showed that the largest share of unintentional injury costs in 1992 among children aged 14 and under were accounted for by falls, motor vehicle crashes and burns. Falls also constituted the biggest share of medical costs followed by motor vehicle crashes and poisonings (CSN, 1996). For adolescents and young adults aged 15-24, the CSN indicated that in 1992 injury was the leading cause of medical expenditures. Motor vehicle crashes accounted for the greatest share of total injury costs, followed by falls and poisonings. Their suggested cost-effective prevention strategies aimed at children included bicycle helmets, child safety seats, poison control centres, smoke detectors, and injury prevention counselling by pediatricians. For adolescents and young adults they recommended laws against serving intoxicated customers in bars and restaurants, intensive sobriety checkpoint programs, and the use of automobile safety belts and motorcycle helmets.

Mortality and Morbidity Resulting From Unintentional Injuries

Leger (1994) reported that unintentional injuries are the fourth leading cause of mortality in the United States. Based on 1986 data from the National Center for Health Statistics, Leger found that motor vehicle crashes represented half of the total number of unintentional injury-related deaths. Not only were motor vehicle crashes the major cause of injury, but the population group most affected was the youngest in society. Unintentional injuries do not affect the population uniformly. Although they represented the fourth leading cause of death in the US, they were the leading cause of death for people between the ages of 1 and 37. When potential years of life lost (PYLL) before age 65 were considered, the reason unintentional injuries ranked first with respect to economic loss became clear: they accounted for about 2.3 million years of life lost in any given 12 month period. Leger (1994) reported more than 2 million deaths in 1987. The four major causes of those deaths were heart disease, cancer, stroke and unintentional injuries. Motor vehicle crashes, accounting for 51 per cent of total unintentional injury deaths, were by far the most frequent cause of death, followed by falls, drowning, fire and burns.

Unintentional injures can also cause disability "when they result in some degree of permanent injury or when they render the injured person unable to effectively perform regular duties or activities for a full day beyond the day of injury" (Leger, 1994: 85). Disabling injuries affected more than 9 million people in 1988, including almost 2 million injuries resulting from motor vehicle crashes. More than 3 million were home-based injuries; more than 2 million were sustained from public injuries and almost 2

million from work-related injuries (Leger, 1994, Table 2). Estimates based on 1987 data from the National Center for Health Statistics also showed that unintentional injuries were responsible for over 194 million bed days and more than 621 million restricted-activity days, resulting in 2.6 days of restricted activity per person, per year in the United States.

A comprehensive and path-breaking study done in the US by Miller et al. (1995) looked at the severity and the consequences of injuries in terms of disabilities or losses in productivity. The authors examined the incidence of fatal and non-fatal injury, and discussed various approaches to the development and improvement of future research. Basically, they found that injuries, which are preventable, have substantial long-term medical and societal costs, particularly since they affect the most productive work years. Miller et al. (1995) urgently stressed the need to control injuries, and underscored the need to improve intervention programs related to unintentional injury.

The database they developed (selected from several national data sets) formed the basis for estimating both the cost of injury and the local, state, and national consequences of injury in the US. The database served as a tool for building an 'injuries cost-estimate module' and for gathering information on long-term costs, professional fees, wage losses, non-hospitalized incidence (from hospital discharge data on the nature of injury), length of stay, and hospital payment. While the data was based on 1985 Census estimates of the incidence of injury, the cost calculations were based on 1989 US dollars. The study also examined national injury incidence by body region, nature of injury and hospitalization status in the US. Also included were tabulations of injury by various causes such as motor vehicles, work place, consumer products, and intentional injury inflicted by others. Specific findings indicated that almost 57 million non-fatal injuries were reported in 1985 in the US, and of that total, 90 per cent were medically treated and just over 4 per cent were hospitalized.

Miller et al. (1995) categorized the incidence of injury for non-fatal incidents into three groups: body region, body part and the nature of injury. The body regions that accounted for the most injuries were the lower and upper extremities, followed by the face, scalp and neck. The most significant hospitalization rate was for injuries to the internal organs/abdomen/pelvic regions, multiple body regions, and the brain/skull, for which the overall hospitalization rates ranged between 28.5 to 21.3 per cent.

Partial or permanent disability resulting from injuries accounted for almost 700,000 cases annually. The largest number of total permanent disabilities resulted from injuries to the lower extremities, followed by head/skull injuries. While injuries to the brain/skull were the most debilitating over the short-term, spinal cord injuries claimed the longest period of impairment, followed by injuries to the internal organs. Miller et al. (1995) also estimated the probability of occurrence of disability for both permanent and partial disability. Injuries to the extremities represented the greatest cause of partial disability, and injuries to the spinal cord showed the highest probability of permanent total disability.

2.2.2 United Kingdom

Evans (1994) reported on injuries related to road and rail transport in Great Britain and showed that there were over 14,000 such deaths per year in Great Britain over the past decade. These fatalities represented about 2 per cent of all deaths and 13 per cent of all life-years lost under the age of 65, because those who died in these situations were, on average, relatively young. Of the 14,000 fatalities per year, 5,000 were the result of injuries in the home and on the roads, and 500 the result of injuries at work. There were about 230 rail transport fatalities per year, of which about 80 were passengers, staff and

other people who were lawfully on railway property. About 150 of those killed were trespassers who were unlawfully on railway property at the time of injury, and who were either struck by trains or killed by electricity. Air and merchant shipping each had about 50 deaths per year on average, though these figures can be strongly influenced by a single disaster.

2.2.3 Norway

Kopjar and Wickizer (1996 a, b) examined the risk of unintentional injury in the home in Norway during 1990 to 1993 in a community with a population of 100,000. The study did not include injuries that occurred among the elderly in institutions or among children in day-care centres. The findings suggested that the high incidence of home injuries among children was entirely due to high risk rather than to high time exposure. Among people aged 75-84 years or older, the per population incidence was, respectively, 2.5 and 6.2 times higher than the incidence for the comparison group. Also, the incident rate of injury was high among children aged 6 months to 6 years. These ratios indicated a U-shaped distribution, with injury being more prevalent among children and the older population.

Kopjar and Wickizer (1996 a, b) also looked at the type of injury at home among different age groups. Falls were by far the most common type of injury, accounting for 49 per cent of the total number of injuries. There were more injuries (57 per cent) among preschool children. After age 45, the proportion of injuries caused by falls increased with age, reaching 84 per cent among people aged 75 years and older. Cuts, stings, and punctures accounted for 22 per cent of the overall cases.

2.2.4 Canada

It is obvious from the previous discussion that Canadians can learn much from research being done in other countries. In fact, there are notable similarities between findings from the Canadian literature and studies done abroad. A recent review of the literature as well as a review of the mortality and hospitalization data in Canada related to injuries among seniors indicated that the four leading causes of death resulting from injury were falls, motor vehicle crashes, suffocation and fires. It also showed that the four leading causes of hospitalization for injuries were falls, drugs, motor vehicle crashes and poisoning (Raina, Torrance and Lindsay, 1997). According to 1989 data, falls were responsible for about two-thirds of all injury-related discharges from hospital, more than 70 per cent of injury-related days of hospital care (usually to treat fractures of the lower extremities), and more than half of all deaths for Canadians over the age of 65. Motor vehicle crashes were the second leading contributor to the use of medical and hospital services by seniors in Canada. The physical nature of seniors (especially in the older age groups) means that falls often result in more serious fractures and longer periods of recovery (and, hence, longer use of health care resources). A significant point the authors made is that “in addition to economic costs, one of the very important consequences of injuries is changes in lifestyle. Injuries among seniors may mean the difference between dependency that requires institutionalization and independent living in the community of choice” (Raina, Torrance and Lindsay, 1997: 9).

The previous discussion highlights some important findings. First, the significant mortality and morbidity rates are associated with major injury groupings such as vehicular incidents, falls, poisoning and drowning. Next, there appears to be a notable relationship between the severity of the injury (and, hence, its potential impact on long-term disability) and the body region affected by the cause of the injury. This suggests that even if total prevention may be difficult to achieve, programs, products, policies and legislation may need to be developed to reduce considerably the impact injuries have on vulnerable regions of the

body such as the spinal cord, the brain/skull, and the lower extremities. Finally, not all age groups are affected similarly, especially given that falls are much more of an issue among the preschoolers and elderly women than other age groups, and that younger males are much more affected by motor vehicle crashes than other groups in the population.

2.3 WHY EXAMINE THE ECONOMIC BURDEN OF INJURY?

Overall, injury is recognized as one of the leading public health problems facing Canadians. The epidemiological information suggests that there are substantial costs incurred from unintentional injury. Not only from the perspective that already scarce health care resources are required to treat, care for, and rehabilitate injured persons, but also from the high number of productive years of life lost due to premature death and long-term disability. No less important are the costs associated with the pain and suffering experienced by injured persons, their families and friends.

Just how extensive are these costs? How significant is the economic burden of unintentional injury in Canada? Through the literature we can gain some insight with respect to the nature and extent of the economic costs of injury. Regrettably, though, most of this evidence is found in countries other than Canada.

2.3.1 United States

Net Savings from Injury Control Interventions

In a report to the US Congress in the late 1980s, Rice and MacKenzie (1989) estimated potential economies to society of selected interventions for injury control. The interventions that were considered included a child pedestrian injury campaign, bicycle helmet promotion, driver education programs, a license age of 17, motorcycle helmet use laws, reduced ignition of cigarette paper, air bags, side crash protection, and automatic vehicle lights. A review of their literature revealed that the cost of the control intervention was often unknown (or was not reported) and found that "researchers who evaluate the effects of interventions seldom include cost estimates of the interventions" (Rice and MacKenzie, 1989: 112). It was further observed that in order to calculate savings from such interventions, the following data would be required:

- a = number of injuries of given severity to which an intervention applies
- b = cost of injuries by severity
- c = proportion of each severity level reduced by the intervention
- d = reduced costs = Sum of ai x bi x ci, where i = each severity level
- e = cost of applying or incrementing the intervention.
- Net savings = d - e (Rice and MacKenzie, 1989: 112).

The researchers concluded that through better application of existing knowledge, a large proportion of severe injuries could be reduced. For those interventions where data was available, the net savings (after deducting the cost of injury control programs) were in the $ billions. For instance, "savings in the $ billions were found for air bags ($5-$19 billion), and a minimum licensing age of 17 ($1.7-$4.3 billion). Tens of millions would be saved by reduced cigarette porosity ($187-$1,100 million), high seat backs in cars ($14 million), motorcycle helmet laws in states without them ($97-$1,200 million), bicycle helmet use promotion ($183-$284), and child-pedestrian programs ($58-$180) (Rice and MacKenzie, 1989: 136). Of particular importance for researchers and policy makers is the observation that "cost could be reduced substantially by collection and use of better data on the clustering of injuries geographically in some cases and in particular populations in others. Better data on the extent of current implementation and costs of implementation would contribute to more rational choices among programs and policies" (Rice and MacKenzie, 1989: 137).

Morbidity and Mortality Costs

It has been shown by some researchers that health care expenditures for injury make up only a part of total costs, accounting for between 40 per cent and half of total costs (Miller et al., 1993; Rice and MacKenzie, 1989; Health Canada, 1997). Indirect costs, which include loss of earnings due to morbidity, accounted for the remaining 50-60 per cent of total injury costs.

Leger (1994) also examined the economic implications of unintentional injuries based on the human capital approach developed by Rice (1966). The economic burden was divided into direct and indirect costs. The direct costs represented all resources that could be distributed to other sectors of the economy in the absence of injury, such as doctor fees, hospitalization costs, treatment, etc. The indirect costs included the loss in productivity due to disability or premature death resulting from injuries. Disability costs included loss of work plus the value of lost household tasks following an injury. Based on data from the National Safety Council, the cost to the nation for injuries in 1988 was at least $143.4 billion (Leger, 1994). This figure included $70.2 billion due to motor-vehicle crashes, $47.1 billion due to work-related injuries, $17.4 billion resulting from home-based injuries and $10.9 billion due to public incidents.

The estimate of $70.2 billion in 1988 was broken down into different types of costs. The wage losses and insurance and property damage losses explained a much larger amount of the total loss than did the medical expenditures. Not included in this total were the costs to public agencies, such as police departments, fire departments and courts, and indirect losses to employers for off-the-job incidents to employees, the value of cargo losses in commercial vehicles and damages awarded in excess of direct loss. Based on National Safety Council estimates, the following estimates of the per-case costs of motor vehicle-related deaths and injures and property damage were compiled. These included $290,000/per death, $13,100/per nonfatal disabling injury, $30,600/per incapacitating injury, $7,500/per non-incapacitating evident injury, $1,000/per possible injury, and $1,700/per property-damage incident (Leger, 1994).

Of the estimated $47.1 billion spent on work-related injuries in 1988, wage losses accounted for $7.9 billion, medical expenses for $8.1 billion, $6 billion and $3.1 billion for insurance administration and fire loss, respectively, and an indirect cost of $22 billion. Not included was the value of property damage, other than fire-related damage. On a per-injury basis, the cost of one work-related incident per worker was estimated to be $410 and the cost of one work-related injury resulting in death was $550,000. The cost of one work-related injury resulting in disability was $16,800 (Leger, 1994).

Miller et al. (1995) found that fatal injuries claimed 143,000 lives annually. The authors estimated the per-fatality medical cost of deaths from injury to be $7,567 US. Total spending per fatality, which included other costs such as funerals, coroner costs and emergency transportation, was estimated to be about $11,000 per case.

With respect to non-fatal injuries, Miller et al. (1995) reported that the medical bill in 1985 was almost $43 billion (in 1989 dollars). The total cost for all injuries was about $49 billion, of which hospitalized injuries accounted for 70 per cent (or $35 billion). Total costs of medical treatment varied by body region. For example, the medical costs for treatment of the extremities were highest, partly due to the frequency of these injuries. The cost of spinal cord and internal organ injuries per case was much higher, even though the frequency of occurrence was not as high as were injuries to the extremities.

The average cost of spinal cord injuries ($529,346 per case) was found to be the most expensive type of injury. Injuries to the internal organs/chest/abdomen/pelvis were next, at a cost of $3,613 per case. The average total cost per hospitalized case was $11,898, which generally accounted for the costs of room and board. The average medical cost per non-hospitalized case was $661. Furthermore, among these cases, brain/skull injuries (at an average of more than $1,200 per case) accounted for the highest cost, while for minor injuries the average cost per non-hospitalized case was $284.

Professional fees varied among injuries. Miller et al. (1995) calculated the ratio of professional fees to hospital payment for all different injuries, and found that, for injuries to the extremities, the ratio of professional fees to hospital charges was 0.594, and in the case of spinal cord injuries, the ratio was 0.242. The variation in the ratio was assumed to be due to the fact that some injuries require intensive and highly specialized evaluation and treatment services which may not necessarily result in longer hospital stays.

Workplace Injury Costs

Miller and Galbraith (1995 b) examined the substantial amount workplace injuries cost as a proportion of national health care costs. The cost estimates identified the workplace as an important area at which to direct injury intervention programs. On-the-job motor vehicle crashes were a particularly costly injury category. Overall, they estimated that workplace injuries cost American society about $140 billion annually. This included $17 billion in medical and emergency services, $60 billion in employee and employer productivity losses, $5 billion in insurance costs and $62 billion in lost quality of life.

The Miller and Galbraith (1995 b) estimates were based on data derived from Workers Compensation Programs that pay the medical costs for about 80 per cent of workplace injuries. Crash injuries accounted for 3 per cent of all workplace injuries but made up about one sixth of work-related injury costs. Workplace per-injury costs are almost six times higher than the average. The high cost of work-related injury stems from both the high fatality rate and from litigation with non-employees over multi-vehicle crashes. On-the-job crash injuries accounted for 8 per cent of total crash costs (Miller and Galbraith, 1995 b). Another $11 billion resulted from injuries to others involved in crashes with commercial vehicles at fault. Costs for work-related crashes were higher than costs for other types of crashes. Miller and Galbraith (1995) also looked at the injury costs by severity. Compensable lost work injuries were the most expensive. Less serious non-fatal injuries comprised only 5 per cent of the total workplace injury costs.

Miller and Galbraith (1995 b) also calculated that costs per injury averaged $2.5 million per fatality, $46,000 per compensable injury, $1,600 per non-compensable lost work injury, and $650 per injury without work loss.

Workplace injuries made up 20 per cent of total injuries. According to Rice and MacKenzie (1989) and Miller, Cohen and Rossman (1993), these costs were significant, accounting for 32 per cent and 38 per cent, respectively, of total medical costs. Quality of life losses accounted for 43 per cent of workplace injury costs. When compared with other causes of injuries, workplace injuries accounted for 61 per cent of motor vehicle crash costs (Miller, 1993), and 73 per cent (Miller, Cohen and Wiersema, 1995) to 77 per cent (Miller, Cohen and Rossman, 1993) of victim crime costs.

Fall Injury Costs

Rice and MacKenzie (1989) estimated that the cost of fall injuries was more than $37 billion in 1985. These costs were concentrated within the two major groups

affected by fall injuries - the elderly and members of the workforce. Englander et al. (1996), reported the financial impact of slip and fall injuries in the United States and provided an update of annual economic costs imposed by fall injuries. The researchers provided some initial perspectives on the magnitude of the fall injury problem, by observing that 30 per cent of the over 65-year-old cohort living in the community fall each year. There was an especially high prevalence rate among those seniors living in nursing home facilities. The rate was as high as 40 per cent among those over 80 years of age. Moderate to severe injuries were experienced by 20 per cent to 30 per cent of those who are in this age group, causing a reduction in mobility and independence as well as a greater risk of death. Falls were the sixth leading cause of death among persons over the age of 65. They further found that non-fatal falls have been statistically associated with greater fear of future falls, functional deterioration, and institutionalization. Fall-related injury accounted for 17 per cent of work-related injuries and 12 per cent of fatalities in the workplace. They were also found to be the second highest cause of work-related deaths. Furthermore, approximately one-third of fatalities in the construction industry and 75 per cent of deaths among ironworkers were caused by falls.

Adding up the direct costs, the morbidity costs, and the mortality costs gives a total cost per fall victim. The total cost of falls in the US was arrived at for a given year by multiplying this total cost figure by the number of falls that occurred that year. Rice and MacKenzie (1989) found that the cost per fall victim in 1985 was $3,033 overall; $3,735 for males and $2,440 for females. The direct costs were lower for males than for females, but the mortality and morbidity costs were higher for males. The latter result likely reflects higher rates of labour force participation and pay on the part of males. Perhaps more striking in their findings was the way in which direct costs of fall injuries increased with advancing age in both males and females.

Englander et al. (1996) restated these figures (originally based on 1985 dollars) in terms of 1994 dollars. These adjustments indicated that the cost per fall injury in 1994 for the overall population increased to $4,692 from $3,036 in 1985. The estimated total costs of fall injuries in 1994 were $64.2 billion in 1994, compared to $57.6 billion in 1985 (estimated in 1994 dollars).

Motorcycle Injury Costs

As was noted earlier, Bolhofner et al. (1994) examined injuries resulting from motorcycle crashes. The economic impact (direct and indirect costs) of such injuries was $17.9 million, with patient costs accounting for about half of the overall costs.

2.3.2 Multi-Country Costs

An important multi-country study (Elvik, 1995) examined the economic costs of traffic fatalities in twenty motorized countries in 1991. The objectives of the study were threefold. They set out to determine the cost of traffic injuries in these countries and their rate of variation from country to country. They also wanted to look at the various methods of estimating the costs of a traffic fatality in each country, and to also ascertain the major reasons for variation in the costs of a traffic fatality among motorized countries. The economic costs per fatality varied from 0.87 million Norwegian kroner (the Netherlands) to 17.8 million kroner (Switzerland), with the average value being 5.67 million kroner (1$US was valued to be roughly the same as 7 Norwegian kroner).

In most countries which considered lost quality of life, it was found that this factor alone accounted for more than half of the total economic burden of traffic crash fatalities. In general, costs related to lost quality of life doubled the cost of traffic crash fatalities. The value of lost productive capacity (which was not estimated the same

way in all countries) also varied substantially among countries, but not as much as for the value of lost quality of life.

The value of lost quality of life was estimated using different methods in different countries. In Great Britain (Jones-Lee, 1989), New Zealand (Miller and Guria, 1991), Sweden (Persson and Cedervall, 1991) and the United States (Miller et al., 1991), the value of lost quality of life was based on estimates of road users' willingness to pay for reduced risk of fatality. In Denmark, Finland and Switzerland (Krupp et al., 1993), the value of lost quality of life was based on implicit values derived from public decision making on health and safety. In Belgium, France, Italy, Luxembourg and Spain, the value of lost quality of life was based on the court-awards approach (Krupp et al., 1993). This approach did not measure the individual's willingness to pay for reduced risk, but it did measure the compensation given to relatives of those fatally injured. The rest of the twenty countries included did not estimate the value of lost quality of life for fatally injured traffic crash victims in 1991. The twenty countries included were divided into five groups with respect to the calculation of these costs:

- Countries using the net-loss-of-output approach only: The Netherlands
- Countries using the gross-loss-of-output approach only: Australia, Austria, Canada, Germany, Japan, Norway, and Portugal
- Countries combining the loss-of-output with the court-award approach: Belgium, France, Italy, Luxembourg, and Spain
- Countries combining the loss-of-output approach and valuation of lost quality of life based on public decision: Denmark, Finland and Switzerland
- Countries combining the loss-of-output approach and valuation of lost quality of life based on road user willingness-to-pay: Great Britain, New Zealand, Sweden and the United States.

The estimated cost to society increased enormously due to the increased use of different methods of calculation and to revisions in the valuation methods used. Elvik (1995) suggested that the economic valuation methodology with respect to traffic incidents has evolved through four major phases:

- The first phase lasted from the 1950s until the 1960s. During this phase, costs were (in most cases) based on the net-loss-of-output approach, and no allowance was made for lost quality of life.
- The second phase ran from the 1960s into the 1970s. Economic valuations were (in most cases) based on the gross-loss-of-output, that is the consumption of the injury victim was no longer subtracted from the value of lost production.
- In the third phase, covering the period from the 1970s until the late 1980s, an arbitrary value entitled pain, grief, and suffering was added to the gross-value-of-lost output in a number of countries. This value was meant to capture the "human cost" (i.e., lost quality of life) of incidents.
- In the fourth phase, starting in the late 1980s, a number of countries explicitly added estimates of the value of lost quality of life based on the willingness-to-pay approach.

These four phases referred to what may be termed state-of-the-art valuation methods. Not all countries went through them all, and it was suggested that some countries were still in the first phase.

2.3.3 Australia

Research done in Australia on the economic impact of road injuries (Hendrie, Rosman and Harris, 1994) showed that hospital inpatient costs (almost $14 million) were the major component of the medical costs. When added to the cost of rehabilitation and other medical costs, they were estimated to account for almost 8 per cent of the direct costs attributed to road crashes. The study was based on data for 1988, and covered all

road casualties injured severely enough to be admitted to hospital. The average hospital inpatient cost was $3,373 per casualty and, with an average length of stay of 7.7 days, the average bed-day cost was $438. Teaching hospitals accounted for almost 80 per cent ($11 million) of the inpatient costs. Average teaching hospital inpatient costs were $4,681 per casualty. The inpatient costs for non-teaching hospitals was $1,625. The average length of stay was 9.6 days at teaching hospitals and 5.1 days at non-teaching hospitals, and average bed-day costs at teaching and non-teaching hospitals were $546 and $307 respectively. Surviving road casualties admitted to hospital for acute care accounted for 90 per cent of total hospital costs attributed to road injuries in 1988 in Western Australia, and fatalities accounted for 2 per cent of the total hospital costs. Hendrie, Rosman and Harris (1994) also examined the type and severity of injury. A significant linear relationship was found between the severity-scoring scale and the body part injured. An aggregate set of nine body regions including the head, spine, lower extremities, upper extremities, trunk (abdomen/chest) and "other" (face/external/neck) was selected. Injuries to the lower extremities accounted for a major portion of the total hospital costs, exceeding the cost of injuries to both the head and spine. When considered in terms of average cost per casualty, the most expensive injuries were those to the lower extremities and spine. The cost of treating patients at teaching hospitals was significantly higher than the cost of treatment at non-teaching hospitals for all body regions.

In addition to examining the relationship between body region and the severity of injury, Hendrie, Rosman and Harris (1994) observed that hospital costs were also influenced by the age of those injured. For the same injury, older patients were more likely to have adverse prognoses and a longer duration of stay than younger patients, which had a tendency to increase hospital costs.

The results of the study showed that for patients under 15 years of age, average total costs of hospital stays were $2,695. The costs were $3,484 for those aged 15 to 54, and for those over 55 years of age, they were $5,854.

Another factor found to have an impact on the cost of injury was the type of road user, i.e., automobile drivers and passengers, motorcyclists, pedal cyclists injured in traffic incidents, and pedestrians and pedal cyclists injured in non-traffic crashes. Automobile occupants accounted for 38 per cent of total hospital costs of road crashes, while other major road hospital users contributing to hospital costs were motorcyclists (18 per cent) and pedestrians (18 per cent) (Hendrie, Rosman and Harris, 1994).

Pedestrians had the highest average cost per casualty ($6,634), a cost that was found to be significantly higher than the average cost incurred for other road user types. There was no significant difference in the average hospital costs for pedal cyclists injured in traffic crashes ($4,184), motorcyclists ($3,958) and automobile occupants ($3,797). For pedal cyclists involved in non-traffic crashes, the average cost of casualty ($1,719) was significantly lower than for all other road user types. The authors' multivariate data analysis determined that four factors were statistically significant (with $p < 0.05$): type of hospital (teaching/non-teaching), body region, injury severity level, and road use type (Hendrie, Rosman and Harris, 1994).

2.3.4 United Kingdom

Based on published data from the Department of Transport in the United Kingdom, Evans (1994) estimated the costs of road deaths and injuries. The total costs of road injuries in Great Britain were estimated to be just over £10,000 million, of which fatalities accounted for 31 per cent and all injuries accounted for 81 per cent.

2.3.5 Norway

In Norway, the aggregate annual cost (direct and indirect) during the first year following injury was approximately $3 million or $1,300 per case. Injuries among persons younger than 24 years of age accounted for 41 per cent of all cases but only 10 per cent of total costs. In contrast, injuries among persons aged 75 years and older accounted for 12 per cent of cases but for 50 per cent of the medical costs (Kopjar and Wickizer, 1996 a, b).

2.3.6 Sweden

In Sweden, Lindqvist and Brodin (1996) estimated the economic burden of all unintentional injuries during one year in a specific geographical district. The objectives were to provide comparative information and to assist in the planning of injury prevention programs. The costs (calculated in 1991 prices) to the health care system (including outpatient care, primary care and hospital care) were 3.59 million SEK. The costs to trade and industry amounted to 12.08 million SEK, and the costs to health insurance were 1.38 million SEK. Lindqvist and Brodin (1996) reported that of all causes of death in Sweden, injuries were responsible for the greatest loss of years, primarily as a result of premature death for the population under the age of 65, of whom the largest risk group was young males.

The study examined four categories of injuries. It first looked at home injuries, i.e., all incidents which occurred in any type of home and/or residence-related premise such as a flat, a house, a driveway, a garage, etc. It also examined work-related injuries, defined as any incident that occurred at the work place or other location where the injured employee happened to be at the time (either working in-house or out on a work-related assignment). It also included traffic injuries that occurred during the course of work, sports injuries, i.e., incidents during games or physical training, whether for recreation or competition, and "other" injuries, i.e., those occurring in an environment or during an activity not defined above, for example another public place, school or day care centre. Sports-related injuries occurring at school were included in the sports category (Lindqvist and Brodin, 1996). The results showed that 17.1 per cent of emergency cases were related to such injuries. The Lindqvist and Brodin cost calculations were based on the type of injury, gender differences, age, degree of severity, and body location. The loss of productivity resulting from these injuries accounted for the highest cost to the community (77 per cent of total costs). Medical inpatient care costs, which amounted to 18 per cent overall, were especially significant in the case of home injuries (39 per cent). For work injuries the cost of inpatient care was marginal. Home-based injuries accounted for the largest share of community costs (29 per cent), with the "other" group having the lowest share (14 per cent).

For both genders combined, Lindqvist and Brodin (1996) found that the 20-50 age group incurred the highest proportion of costs to the community, the exception being home injuries for women 70 and over who accounted for half of total community costs. For traffic, "other" and sports injuries, women 40 years of age and over accounted for a higher proportion of the costs than did younger women, while the share of costs for men aged 39 and younger was greater than that for older men.

With respect to major body regions affected, the extremities accounted for 74 per cent of total costs. The lower extremities accounted for the largest proportion of costs for injuries incurred in the home, in traffic and at sports, while the upper extremities made up the largest share among the work-related and "other" injury groups. When costs were considered in relation to the degree of severity, it was found that serious injuries made up 16 per cent of the total cost, but accounted for only 3 per cent of all injuries.

Moderate injuries accounted for 69 per cent of the cost and made up 48 per cent of the incidents, while minor injuries comprised 12 per cent of the cost and made up 49 per cent of all events. Of all traffic injuries, only 5 per cent were classified as severe, with this group accounting for no less than 25 per cent of costs for traffic injuries (Lindqvist and Brodin, 1996).

2.3.7 Canada

It is clear that there is notable evidence from other countries with respect to the economic costs of unintentional injuries. Yet, with the exception of a sports and recreational injuries paper produced in Quebec (1990), nothing specific has been published in this regard in Canada. However, Health Canada (1997) recently released a study which estimated that the total national economic burden of all major categories of illness in 1993 was almost $157 billion, of which the total direct costs of care, treatment and rehabilitation amounted to about $72 billion (or 46 per cent of the total). The principal illness categories which accounted for the greatest claim on society's resources were cardiovascular diseases (about $20 billion), musculoskeletal diseases (about $18 billion), injuries (just over $14 billion), and cancer (slightly more than $13 billion). Here, injuries refer to both unintentional and intentional injuries. Overall, "these four categories accounted for half (50.2 per cent) of the cost of illness that could be classified by diagnostic category" (Health Canada, 1997:12).

The total economic costs of illness have almost doubled from $79 billion in 1986 to $157 billion in 1993. During that same period of time, the economic burden resulting from all injuries in Canada has increased by 27 per cent from $11 billion to $14 billion. As a proportion of the total economic burden, direct costs to the health care system were highest for cardiovascular diseases (37 per cent), followed by cancer (25 per cent), injuries (22 per cent), and musculoskeletal diseases (14 per cent).

There seems to be little doubt that from the perspective of both society at large and individual Ontarians, the high proportion of premature mortality, disabilities and costs resulting from these four major areas, underscores the need to reduce their economic burden.

There does not seem to be any doubt that injuries are a leading cause of death, disability and years of life lost, especially among younger age groups. Evidence from many countries suggests that these deaths, productivity losses, and direct costs to the health care sector and other related sectors result in a significant economic burden to society.

In the sense that there has never been a "bottomless pit" of money, society's resources have always been scarce. However, in view of the current philosophy of balanced budgets and fiscal responsibility, health care decision-makers, providers, managers, and citizens have been forced to place much more emphasis on cost-efficiency and effective resource management. Thus, anything that can avert or significantly reduce the impact of injury would be a welcome addition to the arsenal of health care decision-making strategies. Unfortunately, we do not clearly document the economic costs associated with unintentional injuries and, hence, we are not in a position to state anything concrete regarding the nature and extent of the problem nor outline the savings to society which could be realized through targeted prevention strategies.

While increasing attention has been given to injury as a critical public health issue, the vast majority of Ontario's health care resources are directed at treating injuries rather than preventing them. If injury prevention is ever going to be elevated to the forefront of Ontario's health and social agenda, then comprehensive research must be conducted into the long-term economic

costs of injury and the potential savings that could be realized through injury prevention strategies.

3.0 METHODOLOGY

3.1 INTRODUCTION

Determining the cost of injury will have implications not only for health care expenditures and resources, but will also have an impact on society, employers, patients and families. Thus, a system of measurement is needed that quantifies the total cost of injury in terms of the fundamental elements that result from injury.

Within this system of measurement it would be possible to quantify the total cost of injury and begin to ask questions about the wider issues such as:

- What is needed to improve the processes and reduce total cost?
- What kinds of programs can be developed which identify actions that are modifiable and will cause a reduction or elimination of an injury at different levels? For example, how can a change in personal behaviour or structured safety programs reduce the incidence of injury?
- What are the roles of both the employer and the health care providers? For example, health care providers produce services aimed at prevention, treatment, and rehabilitation: what are the most cost-effective treatments? Also, employers influence the total cost through types of worker compensation payments, sick day pay, training cost, etc. How can they reduce the cost of injury?
- Finally, what is the cost for individuals or for family members who are affected directly by an injury that may cause the loss of life or a loss of quality of life?

This comprehensive methodological approach should be able to reveal and measure the true cost of injury and help to reduce these costs at cross-organizational and societal levels. It should also provide evidence regarding programs that are preventive in nature. In order to measure the multi-dimensional aspects of expenditures related to injury, it is first necessary to understand the exact elements of this total cost. These societal costs of injury estimates are useful for policy planners as they consider the cost and burden of injury to patients and their family, third party private payers and government. Furthermore, as the total cost continues to rise, organizations that are fiscally responsible for the treatment and rehabilitation of injury (i.e., employers, government and other third-party payers) will want to control these costs.

The importance of data collection, especially the measurement of direct and indirect costs, should be emphasized, since this information can be used for the economic evaluation of specific elements of the health care delivery system. For example, cost-containment strategies could cause higher medical costs if more costly inpatient care (rather than outpatient care) is utilized, or lower medical costs may be associated with higher non-medical costs if employees take more time off work as result of less efficient and less costly treatment. Therefore, knowledge of the factors that influence these costs (obtained through these comprehensive data collection systems) is required. Through careful analysis of these costs we would be able to provide better health coverage for the individual and, at the same time would be able to reduce the total cost of injury to employers, government as well as the purchasers/customers of care.

Another reason for requiring a comprehensive assessment of cost of injury relates to the situations where, when not all information on total cost is available, employers offer less health care coverage to their employees than otherwise might be necessary. The impact may have an adverse effect on total cost. Such decisions on the real total cost of injury may cause more financial burden to the employee, resulting in higher indirect cost such as more sick days or training cost of replacement workers.

3.2 A COMPREHENSIVE FRAMEWORK FOR MEASURING TOTAL COSTS OF INJURY

The measurement of total injury expenditures has improved in past decades. Total injury expenditures are captured by four main categories: medical costs, non-medical costs, lost opportunity costs and intangible effects. The first three categories (medical, non-medical and lost opportunity costs) are quantifiable costs of injury. Intangible effects (for example, reduced quality of life) are difficult to quantify. Various researchers have used different approaches to collect and calculate cost estimates. The framework shown in Table 1 can be used as a base line and conceptual approach for estimating the different elements of injury-related costs.

3.3 WHAT IS THE COST-OF-ILLNESS APPROACH?

As a result of the increasing importance of economic evaluation, especially to help public policy makers set priorities and make resource allocation decisions, cost-of-illness studies are integral elements. It is essential to use consistent methods and data in order that the findings of the growing number of cost-of-illness studies can be compared; it is not just a question of achieving 'accounting nicety'. Without the classic work done by Dorothy Rice (who developed the methodology used for estimating the costs of major illnesses in the United States), it is likely that the existing methodological approach would be underdeveloped.
Her study marked the foundation for a host of subsequent cost-of-illness estimates (e.g., Acton, 1973; Berry and Boland, 1977; Conley and Milunsky, 1975; Fraser et al., 1976; Hartunian, et al., 1980; Luce and Schweitzer, 1978; Mills and Thompson, 1978; Rufener et al., 1976; Scitovsky, 1982; Smart and Sanders, 1976; Weisbrod, 1971). It is curious to observe that negligible work in this area has been done in Canada.

TABLE 1: A FRAMEWORK TO MEASURE TOTAL COSTS OF INJURY

Medical Costs	Non-Medical Costs	Lost Opportunity Costs	Intangible Effects
• inpatient care • outpatient care • health care providers • drugs • durable medical goods	• worker compensation payments • sick day pay • fill-in labour costs • insurance adjustment costs • litigation costs • training costs • permanent replacement costs • cost of making improvements to prevent future injuries • wages not paid out due to worker injury	• employee health nurse costs • supervisor administrative and fill-in-costs • benefit coordinator administrative costs • safety committee administrative costs • business office administrative costs	• changes in employee productivity • change in customer satisfaction • change in employer risk • lower academic achievement • decreased future employment opportunities

Cost-of-illness studies distinguish and measure both direct costs (the value of resources used to treat the persons incurring the illness) and indirect costs (the value lost to society as a result of the illness in question). Direct costs are composed of all the goods and services used for the diagnosis, treatment, continuing care, rehabilitation, and terminal care of people experiencing a major illness or impairment, usually categorized according to major diagnosis or diagnosis groupings, e.g., case mix groupings (CMGs) related to cancer or heart problems. These cost categories include expenditures for hospitalization, outpatient care, nursing home care, home care, services of physicians and other health professionals, pharmaceuticals, rehabilitation (as well as the costs of prostheses, appliances, eyeglasses, hearing aids, speech devices, etc.), which will help the patient overcome the impairments associated with the major illness. Also included are the administrative costs of third-party payers (public and private) who fund such expenses.

Indirect costs represent the losses, i.e., the goods and services that are not produced as a result of the impairment. The value of time lost from work and home making due to morbidity and premature mortality is measured by earnings data and the market value of unperformed home making services. In addition to causing lost time from work, illness can also negatively impact on productivity (for example, through lower productivity of ill persons on the job and absenteeism).

In addition to the direct and indirect costs, there are often other expenditures which patients and families must bear as a result of an illness. Costs involving sectors other than health include the cost of transportation to health care providers (locally and to other centres as well as out-of-area living costs), household expenditures (for example, extra costs for household assistance, special diets and clothing, items for rehabilitation, alterations to property such as ramps, and counselling services) and property losses (for example, automobile crashes resulting from alcohol abuse, air and water pollution, etc.) Other associated costs could include such things as the time spent visiting offices of physicians, other health professionals, and hospitals by patients and/or family members, as well as the time lost from work by members of the family when someone in the family is sick.

Another cost category that is difficult to measure but which is nonetheless important is the category related to social costs and quality of life. As a result of certain illnesses there can be a variety of psychological and social deterioration. For example, an individual may experience the loss of a body part or loss of speech. He or she may also suffer from disfigurement, disability, impending death, pain and grief, which may force that person and/or family members and friends into economic dependence and social isolation, loss of opportunities, relocation of living quarters, or other unwanted changes in lifestyle. These illnesses, especially if they become longer in duration, may bring about anxiety, low self-esteem, resentment and emotional problems that may require psychotherapy, all of which may result in family conflict, anti-social behaviour, perhaps even suicide. Children may experience disrupted development and delinquency, resulting in reductions in quality of life beyond the capacity of existing rehabilitation to restore the ability to function from day to day. Also, lower academic attainment could hinder future employment prospects. When these potential psychological and social difficulties are added to the financial burden, the problems may seem insurmountable.

In addition to looking at the economic costs of illness from the perspectives of direct and indirect costs, the literature shows that two general approaches can be used to estimate these costs: the prevalence approach and the

incidence approach. The prevalence approach, which is by far the one most commonly used, assigns the costs of the major illness "to the years in which they are borne or are directly associated" (Hartunian et al., 1980: 1250). The incidence approach involves "estimating the lifetime direct and indirect costs of the new cases of a condition or group of conditions which have their onset (incidence) in a given year" (Scitovsky, 1982: 474). Unlike the former method, this approach emphasizes that "it is necessary to estimate not only the direct costs of these new cases accruing in the first year, but also the present value of direct costs (the stream of costs associated with the given health problem) which may accrue in the future, until the patient dies" (Scitovsky, 1982:474).

For conditions which are short-run in nature or which are steady-state chronic health problems, both approaches produce the same results. For policy makers wanting to control current health care expenditures, the prevalence approach is highly appropriate. However, if policy makers are looking to assess the benefits of preventing or reducing/ameliorating the incidence of specific health problems, then the incidence approach is more useful and accurate. While both methods have their place, the incidence approach does require "far more extensive, detailed, and specific data than the prevalence approach developed by Rice" (Scitovsky, 1982: 484). Another advantage of the prevalence approach is that it provides "total national health expenditures and thus avoid(s) double-counting, which is a danger when using the incidence-based approach, especially when estimating the costs of only some specific diseases (Scitovsky, 1982: 475).

Regardless of the approach, studies of the economic costs of illness suggest that long term illnesses in particular have significant economic impacts. The most recent data for Canada show that, collectively, we spent about $80 billion (or some 10 per cent of the GDP) for health care (Health Canada, 1996). The resources that we spend represent the amount of goods and services that cannot be targeted to other societal priorities. "Direct costs have this effect by diverting part of the societal economic product to medical treatment and care; indirect costs simply reduce the overall economic product" (Hartunian et al., 1980:1250). In order to more completely estimate these impacts we have to understand the primary and secondary relationships as well as the interplay among the various illnesses and economic variables.

3.4 WHAT METHODS AND DATA SOURCES DID WE USE?

For the purposes of this study on the economic burden of unintentional injury in Ontario, the incidence costing approach has been employed to estimate the lifetime costs of the 1996 incident population in Ontario (see Appendix C for a detailed elaboration of the methodology). Otherwise, all future direct and indirect costs for all unintentional injuries in 1996 have been assigned to the year in which the injuries occurred. For some injuries, most of the direct costs will be incurred and paid for in 1996 (for example, the episode is contained to 1996). The rationale for choosing this approach was the importance of capturing the future stream of direct and indirect costs for injury episodes extending beyond 1996 (discounted to present value) that will be incurred for the 1996 incident population.

The perspective for this study is societal. The viewpoint for cost-of-illness (COI) studies has a bearing on the schedule of costs to be included. For example, from a societal perspective, transfer payments such as Canada Pension Plan (CPP) disability and social assistance are not considered costs since they are a reallocation of resources and the net effect of the transfer to society is zero (Rice et al., 1990; Thompson et al., 1989).

Others argue that personal transfers should be included as a cost since, if illness did not occur, then transfer payments could be used for other purposes, such as reducing the deficit (Cassidy et al., 1995). It should be noted that if this study were conducted from the perspective of government, then transfer payments would be considered a cost.

Unintentional injuries result in direct health care costs (for example, hospital, medical, rehabilitation, and drugs) and indirect costs to society (lost productivity due to time away from major activity or premature death). For example, motor vehicle crashes can cause immediate death or either short-term or long-term disability. The younger the victims, the higher the direct and indirect costs could be, especially for crash-related deaths and long-term disability. The magnitude of the direct costs will vary according to the severity of the crash, ranging from short-term hospital expenditures (where recovery is relatively quick) to long-term rehabilitation, medical, drug and occupational training costs.

In order to document these costs, it is essential to have information on the complete episode associated with each of the unintentional injuries. This must cover the range of cases from those dealt with completely in a hospital setting to those which encompass institutional, ambulatory, rehabilitation, home care and other related costs over long periods of recovery or, in extreme cases, during the remaining period of an individuals' life expectancy. Regrettably, the only comprehensive Ontario data related to unintentional injury episodes are those for the hospitalized part of the events (see Appendix B, for the discussion about data limitations). More specifically, the data sets with which we were able to work with are:

- The Discharge Abstract Database from the Canadian Institute for Health Information (CIHI) had the required data on hospital episodes related to unintentional injuries, 1995-96.

- The Resource Intensity Weights (RIWs) from the CIHI were used to attach average costs to the hospital episodes derived from the Discharge Abstract Database.

- The mortality database from Statistics Canada's Vital Statistics were used to estimate lost productivity due to premature deaths; for example, potential years of life lost (PYLL).

- Unemployment rates, labour force participation rates, and average wage rates from Statistics Canada's CANSIM database were used to estimate the monetary value of the productivity losses resulting from morbidity and premature death.

- Population data and projections from the Canadian Pension Plan database were used in the calculations of direct and indirect costs related to unintentional injuries.

While the above hospital and death data are necessary, they are not nearly sufficient to allow for a comprehensive documentation of all costs associated with unintentional injuries in Ontario. There is nothing to indicate the nature and extent of the out-of-hospital episodes resulting from injuries in Ontario. In order to get around these rather significant data limitations, proxy measures that would provide the complete picture had to be developed.

An extensive search of the literature revealed a major US study that proved to be instrumental in helping to fill the large gaps (by providing missing data and coefficients) and which allowed for a reasonably complete estimate of the economic burden of unintentional injury in Ontario. Without the study by Miller et al. titled Databook on

Nonfatal Injury: Incidence, Costs and Consequences (1995), our research would have been severely compromised (see Appendix B). Below is a list of areas that were impacted positively by this source.

- Direct morbidity costs for out-of-hospital episodes related to unintentional injuries. US ratios of episodes and related costs of non-hospitalized to hospitalized cases (which were assumed to be similar for Ontario) were used to estimate both the incidence and the costs of unintentional injury in Ontario. Also, permanent partial and total disability were estimated using these coefficients.

- Indirect morbidity costs (or productivity losses) associated with permanent partial and total disability, almost all of which is not captured by Ontario hospital episode data. Costs will vary according to the degree of disability and, hence, the US disability coefficients related to two disability categories (partial or total) applied to the population in Ontario. Again, it was assumed that the American and Ontario/Canadian situations were comparable.

  Hence, all the mortality data is taken directly from Statistics Canada's Vital Statistics data set. The morbidity data is based largely on the CIHI database, and includes adjustments and imputations for missing elements. Furthermore, the indirect cost data for mortality is based on adjusted vital statistics, in order to put them on the same footing as the morbidity data.

3.5 THE ERAT: A WORKING SOLUTION TO DATA LIMITATIONS

The Canadian study that this Ontario study is patterned after involved the development of the Electronic Resource Allocation Tool (ERAT). The ERAT is a spreadsheet based injury classification and costing model which can be applied at the national, provincial and local levels depending on data quality and availability. It essentially is constructed with a mix of actual data and variables extracted from a comprehensive U.S. injury study (Miller et al., 1995). The actual data drives the external variables within the ERAT and results in the construction of full injury episodes and the related costs.

The ERAT is a costing framework designed to address these data limitations. Mathematical procedures have been programmed to operate behind a spreadsheet format in a "turn-key" method of operation. When injury-specific information is plugged in, the ERAT produces injury-specific direct and indirect costs as well as overall injury costs for a population.

The primary data source for determining unintentional injuries resulting in a hospitalization was the Canadian Institute for Health Information's (CIHI) Discharge Abstract Database. The data are collected on a fiscal year basis and the most recent data available were for the 1995-96 fiscal year. This data was adjusted to approximate the calendar year 1996 for the purposes of this study.

The original ERAT was adapted and used to produce the analytical output for this study on *The Economic Burden of Unintentional Injury in Ontario*. Ontario-specific population, hospital and mortality data were inserted to create an Ontario ERAT.

Additional information on the ERAT is available in Appendix D - Electronic Resource Allocation Tool (ERAT).

4. RESULTS

As shown in Table 2, the largest cause of the more than 2,800 deaths in 1996 was motor vehicle crashes (39 per cent), followed by falls (35 per cent), poisoning (9 per cent), drowning and suffocation (4 per cent), and fires (3.5 per cent). The remaining 10 per cent were related to non-motor vehicle crashes, water transport incidents, railway and pedal cycle, air and space, and transportation, natural and environmental and other non-classified incidents.

Of the more than 43,000 hospitalizations due to injuries in 1996, falls accounted for almost 63 per cent (see table 3). Motor vehicle crashes accounted for 8 per cent of all hospitalized injuries and poisoning for almost 4 per cent. The remaining 25 per cent were due to non-motor vehicle crashes, pedal cycles, railways, water, air and space transportation, etc. Table 4 shows that the major cause for non-hospitalized injuries requiring treatment are falls (43 per cent), motor vehicle crashes (10 per cent) and poisoning (3 per cent). The remaining 44 per cent were either non-classified or as a result

TABLE 2 - 1996 DEATHS RESULTING FROM UNINTENTIONAL INJURY DISTRIBUTION BY MAJOR CATEGORY, ONTARIO, 1996*

Major Cause of Death	Number	% Distribution
Motor Vehicle	1,110	39.0
Falls	991	34.8
Poisoning	263	9.2
Drowning and Suffocation	105	3.7
Fires	100	3.5
Water Transport	39	1.4
Air & Space	15	0.5
Railway	21	0.7
Pedal Cycle	1	less than .1%
Other*	199	7.0
Total	2,844	100.0

** Other includes, the following categories: railway, motor vehicle non-traffic, pedal cycle, water transport, air and space, natural and environmental, recreational and other incidents.*
Note: Percentages or numbers might not sum due to rounding.

TABLE 3 - UNINTENTIONAL INJURIES RESULTING IN HOSPITALIZATION, DISTRIBUTION BY MAJOR CATEGORY, ONTARIO, 1996*

Major Cause	Number	% Distribution
Falls	27,289	62.9
Motor Vehicle	3,474	8.0
Poisoning	1,649	3.8
Pedal Cycle	839	1.9
Fires	173	0.4
Water Transport	112	0.3
Drowning and Suffocation	111	0.3
Air & Space	41	0.1
Railway	13	less than .1%
Other	9,681	22.3
Total	43,382	100.0

* *See footnote Table 2.*

TABLE 4 - UNINTENTIONAL INJURIES RESULTING IN NON-HOSPITALIZATIONS, DISTRIBUTION BY MAJOR CATEGORY, ONTARIO, 1996*

Major Cause of Injury	Number	% Distribution
Falls	301,119	43.4
Motor Vehicle	68,291	9.8
Poisoning	19,259	2.8
Pedal Cycle	9,585	1.4
Fires	3,834	0.6
Water Transport	1,719	0.2
Drowning and Suffocation	885	0.1
Air & Space	505	0.1
Railway	244	less than .1%
Other	288,190	41.5
Total	693,631	100.0

* *See footnote Table 2.*

of pedal cycle, fires, water transport, drowning and suffocation or air and space.

Table 5 reveals the extent to which various causes of injury resulted in either partial permanent disability or total permanent disability as defined by labour market participation. Once again, falls had the largest impact with motor vehicle crashes a distant second. Of the 15,000 injuries resulting in a partial permanent disability, 65% were attributable to falls. Similarly, falls account for almost 64 per cent of all total permanent disability. All injuries resulting in some form of disability generated almost $900 million in direct costs (55 per cent attributable to falls) or 60 per cent of the total direct costs for 1996.

Examination of the data for deaths and hospitalizations resulting from unintentional injuries points to some general observations. First, motor vehicle crashes and falls accounted for a substantial amount of deaths and hospitalizations. More women than men are affected by falls, and the situation is particularly evident for women over the age of 70. A review of the literature by researchers at McMaster University pointed out that “seniors generally had the highest rates of mortality and hospital days stay due to falls (and) the physical vulnerability of seniors often results in more severe fractures and longer periods of recovery” (Raina, Torrance and Lindsay, 1997: 33-34). For males under the age of 60, unintentional injuries account for a greater amount of premature death and for a disproportionate proportion of hospitalizations than for females. Here, motor vehicle crashes are significant contributors to the situation. Next, the body regions most affected by unintentional injuries were the lower extremities resulting from falls among the senior population, and the brain/skull and spinal cord arising from motor vehicle crashes among males under the age of 60.

TABLE 5 - UNINTENTIONAL INJURIES RESULTING IN DISABILITY, DISTRIBUTION BY MAJOR CATEGORY, ONTARIO, 1996 *

Major Cause of Disability	Partial Permanent Disability**	Total Permanent Disability**
Falls	9,907	723
Motor Vehicle	1,072	128
Poisoning	358	11
Pedal Cycle	279	26
Fires	86	4
Water Transport	39	3
Drowning and Suffocation	23	10
Air & Space	14	1
Railway	5	0
Other*	3,447	233
Total	15,231	1,140

* *See footnote Table 2.*

*** Partial permanent disability and permanent disability are defined with respect to labour market participation*

Children aged 10 and under died more frequently from drowning and motor vehicle crashes, but were more often than not admitted to hospital for injuries resulting from falls and poisoning. Research from other jurisdictions is consistent in this regard. For example, Agran, Winn and Anderson (1995) found that for children in California aged 0-14 (and supported through their review of the literature), falls were the leading cause of injury across all age groups, followed by transportation-related injuries (including pedestrian, pedal cycle and motor vehicle occupant injuries), poisonings (especially for children aged 1-4). For most of those cases hospitalized as a result of injuries, the length of stay in hospital was less than a month, with the average length of stay being about 5 days. Overall, for children under the age of 10 in Canada, the body region most often affected by unintentional injury was the brain/skull, (SMARTRISK 1998).

4.1 WHAT ARE THE ECONOMIC COSTS OF UNINTENTIONAL INJURIES?

The major economic costs of unintentional injury are divided into direct costs and indirect costs. Direct costs encompass goods such as medications, prostheses, and services such as health care provider consultations involved in treatment and rehabilitation. Indirect costs account for the individual's inability to perform his or her major activities (and, hence, the lost productivity to society) which result from the injuries. As well as these economic costs there are certain intangible costs associated with injuries such as pain and suffering, economic dependence and social isolation. While these costs are difficult to quantify in economic terms, they are costs nonetheless and, hence should at least be identified.

The main cost ingredients were gathered for the major injury mechanisms, namely, pedal cycles, falls, pedestrians and motor vehicles, and (where possible) by major age group, sex, and the nature of the injury (that is, the major region of the body affected by the injury). It was easier to capture and estimate economic costs for injuries with short-term characteristics (primarily involving hospital stays only) and for fatalities resulting from major injuries. If it had not been for the contribution from the excellent US research (Miller, et al. 1995), it would have been much more difficult to do so for injuries which have a longer-term disabling nature. From the Miller et al. Source (1995), it became possible to derive estimates of the characteristics of these episodes. For example, the severity (mild, moderate, severe) could be examined, as could the length in various states of recovery, rehabilitation, and care in institutions and/or the community (see Appendix C and Appendix D). The information gathered allowed for more complete estimates and ranges of economic costs to be developed.

4.1.1 Direct Costs

For major injuries, the significant direct costs include medical and paramedical services as well as costs for medical and rehabilitation services provided by physicians, occupational therapists and physiotherapists. Physician costs occur in the emergency department of hospitals, in hospitals following admission and outside hospitals. Costs here include the total hospital days associated with the injuries, the average cost of professional fees for those stays, as well as any other operating and capital costs related to the injury visit. Other direct costs include such things as ambulance expenses, various employer-related costs, and whether or not the injuries are severe enough to require continued rehabilitation and/or community-based care.

Based on the analytical framework and methodology discussed earlier, the total direct costs of major unintentional injuries for 1996 in Ontario were estimated to be almost $1.5 billion, of which 13 per cent was

for hospital costs, 25 per cent for medical costs, and almost 2 per cent for rehabilitation. Over 60 per cent of total direct costs were accounted for by the non-institutional costs consumed by people living with permanent disability resulting from injury. The remaining $600 million was spent on inpatient expenditures (hospital, medical and rehabilitation, 24 per cent of the total), and for non-institutional costs (medical and rehabilitation) not associated with permanent disability (16 per cent of the total). Not surprisingly, the most significant single categories of direct costs of injury were related to falls ($871 million) followed by motor vehicle traffic crashes ($125 million), and poisoning ($39 million). Together these three major groups comprised over 70 per cent of total direct costs resulting from unintentional injury.

Injuries assigned to the “other” category represent a significant economic burden to Ontario society (almost 29 per cent of total direct costs). Unfortunately, little is known concerning the nature and cause of these injuries and, hence, they remain both a serious public health threat and a research challenge.

TABLE 6 - DIRECT COSTS ($ MILLIONS) RESULTING FROM UNINTENTIONAL INJURY, DISTRIBUTION BY MAJOR CAUSE OF INJURY AND TYPE OF EXPENDITURE, ONTARIO, 1996*

Expenditure Category	Motor Vehicle Crashes	Falls	Drowning and Suffocation	Poisoning	Fires	Other	Total
HOSPITALIZED CASES							
Hospital	12.4	141.5	0.2	2.6	0.6	29.9	187.3
Medical	10.8	109.2	0.2	1.8	0.3	23.8	146.0
Rehabilitation	0.8	7.2	0.0	0.2	0.0	2.0	10.2
Sub-Total	**24.0**	**257.9**	**0.4**	**4.6**	**0.9**	**55.7**	**343.5**
NON-HOSPITALIZED CASES							
Medical	15.8	125.5	0.3	5.9	0.6	76.0	224.1
Rehabilitation	1.0	8.4	0.0	0.1	0.1	5.4	15.2
Sub-Total	**16.8**	**133.9**	**0.3**	**6.0**	**0.7**	**81.5**	**239.3**
PERMANENT DISABILITY	**84.6**	**479.7**	**3.6**	**28.4**	**4.0**	**280.5**	**880.7**
Total Direct	**125.4**	**871.4**	**4.4**	**39.0**	**5.6**	**417.6**	**1,463.5**

** See footnote Table 2*

4.1.2 Indirect Costs

For the purpose of this study, the indirect costs of unintentional injury in Ontario relate only to losses in productivity. These productivity losses have been estimated according to the human capital approach. The longer that injuries keep people from doing their major activities, the greater will be the loss in productivity. This fact underscores the need to identify the seriousness of the injury and, hence, the expected or average length of time that injured people stay in various states of recovery, rehabilitation, or care and maintenance.

Regrettably, Ontario data with respect to long-term disability resulting from injuries does not exist. For the required coefficients we relied on the US experience documented in the Miller et al. (1995) data. Unfortunately, except for cases of partial and total permanent disability, data to determine the degree of impairment did not exist. Hence, due to the lack of any measure for the short-term loss during recovery and rehabilitation, the estimates derived for economic loss are understated. The indirect costs are estimated by projecting the individual's income that would have been anticipated had the injury not occurred. For this figure, the probability of working was adjusted by the likelihood of unemployment and multiplied by the average wage, and adjusted to the lost working span between the ages of 18 and 64, inclusive. It was also assumed that labour productivity would increase at a constant rate of growth, reflecting a situation that would have accrued over the life cycle of the injury victim. Since costs incurred in later years need to account for the time-value of money not expended immediately, discounting is essential.

TABLE 7 - INDIRECT COSTS ($ MILLIONS) RESULTING FROM UNINTENTIONAL INJURY, DISTRIBUTION BY MAJOR CAUSE OF INJURY AND TYPE OF PRODUCTIVITY LOSS, ONTARIO, 1996

Category of Productivity Loss	Motor Vehicle Crashes	Falls	Drowning and Suffocation	Poisoning	Fires	Other	Total
MORBIDITY COSTS							
Cases While Hospitalized	0.6	1.9	0.0	0.1	0.0	1.0	3.6
Partial Permanently Disabled	62.7	255.8	1.7	22.5	5.2	264.1	611.9
Total Permanently Disabled	45.1	125.3	3.7	4.3	1.5	98.9	278.9
SUB-TOTAL	**108.4**	**383.0**	**5.4**	**26.9**	**6.7**	**364.0**	**894.4**
Mortality Costs	333.3	28.4	36.9	80.5	35.6	74.9	589.7
TOTAL PRODUCTIVITY COSTS	**441.7**	**411.3**	**42.3**	**107.4**	**42.3**	**439.0**	**1,484.1**

** See footnote Table 2.*

TABLE 8 - TOTAL ECONOMIC COSTS ($ MILLIONS) RESULTING FROM UNINTENTIONAL INJURY, DISTRIBUTION BY MAJOR CAUSE OF INJURY, ONTARIO, 1996

Cost Category	Motor Vehicle Crashes	Falls	Drowning and Suffocation	Poisoning	Fires	Other	Total
DIRECT COSTS							
Hospitalized Cases	24.0	257.9	0.5	4.6	0.9	55.7	343.5
Non-Hospitalized Cases	16.8	133.9	0.3	6.0	0.7	81.5	239.3
Disability	84.6	479.7	3.6	28.4	4.0	280.5	880.7
TOTAL DIRECT COSTS	**125.4**	**871.4**	**4.4**	**39.0**	**5.6**	**417.6**	**1,463.5**
INDIRECT COSTS							
Morbidity Costs	108.4	383.0	5.4	26.9	6.7	364.0	894.4
Mortality Costs	333.3	28.4	36.9	80.5	35.6	74.9	589.7
TOTAL INDIRECT COSTS	**441.7**	**411.3**	**42.3**	**107.4**	**42.3**	**439.0**	**1,484.1**
TOTAL COSTS	**567.1**	**1,282.8**	**46.8**	**146.4**	**47.9**	**856.6**	**2,947.6**

* *See footnote Table 2.*

As suggested above, morbidity losses are incurred when the injury results in time lost from major activity or in some form of disability. This can be experienced either while hospitalized for treatment and rehabilitation and/or while in the community. As Table 7 shows, the productivity losses for persons while hospitalized as a result of unintentional injury were estimated at about $3.6 million, with most of these costs being accounted for by falls (53 per cent) and motor vehicle traffic crashes (almost 17 per cent). By far, the greatest productivity losses resulting from unintentional injury were associated with periods of permanent disability. The total productivity costs for permanent disability (estimated at a discount rate of 3 per cent) were calculated to be almost $900 million, where partial permanent disability accounted for almost 69 per cent of this total. As was found for direct costs of unintentional injury, the two most significant categories were falls (43 per cent of total disability-related productivity losses) and motor vehicle traffic crashes (12 per cent of this total). The five major categories of motor

TABLE 9 - SUMMARY OF TOTAL ECONOMIC COSTS RESULTING FROM UNINTENTIONAL INJURY, DISTRIBUTION BY MAJOR CAUSE OF INJURY, ONTARIO, 1996*

Cause of Injury	Total Cost	Direct Cost	Indirect Cost
Falls	1,282,787,707	871,445,665	411,342,042
Motor Vehicle	567,075,296	125,372,388	441,702,908
Poisoning	146,444,045	39,022,655	107,421,390
Pedal Cycle	63,510,607	33,403,210	30,107,397
Fires	47,929,769	5,614,085	42,315,684
Drowning and Suffocation	46,763,434	4,417,755	42,345,679
Water Transport	22,343,144	4,186,395	18,156,749
Railway	10,254,234	641,754	9,612,480
Air and Space	8,335,108	1,590,033	6,745,075
Other*	752,141,742	377,786,126	374,355,616
Total	$2,947,585,085	$1,463,480,065	$1,484,105,020

* *See footnote Table 2.*

TABLE 10 - % DISTRIBUTION OF TOTAL COSTS, DISTRIBUTION BY MAJOR CATEGORY, ONTARIO 1996*

Cause of Injury	Total Cost	% of Total
Falls	1,282,787,707	43.5
Motor Vehicle	567,075,296	19.2
Poisoning	146,444,045	5.0
Pedal Cycle	63,510,607	2.2
Fires	47,929,769	1.6
Drowning and Suffocation	46,763,434	1.6
Water Transport	22,343,144	0.8
Railway	10,254,234	0.3
Air and Space	8,335,108	0.3
Other*	752,141,742	25.5
Total	2,947,585,085	100.0

vehicle traffic crashes, falls, drowning and suffocation, poisoning and fires combined accounted for almost 60 per cent of the total morbidity indirect costs resulting from unintentional injury in Ontario in 1996.

Not only were the morbidity/productivity costs connected with unintentional injury, but there were also mortality/productivity losses associated with untimely or premature deaths caused by various categories of such injury. For purposes of this study, these losses were calculated using the human capital approach. A discount rate of 3 per cent was used to estimate the present value of these costs. This study points to the high proportions of deaths among younger age groups as a result of motor vehicle traffic crashes, poisoning, and drowning and suffocation, resulting in a significant number of premature deaths. The lifetime productivity costs to society as a result of untimely deaths in these three major categories combined were estimated to be over $450 million (or over 75 per cent of the total mortality costs). Motor vehicle traffic crashes were responsible for about 57 per cent of productivity losses due to premature mortality, followed by poisoning (almost 14 per cent), and drowning and suffocation (almost 6 per cent, Table 7).

4.1.3 Total Economic Costs

Summing the direct and indirect costs for major categories of injuries and fatalities resulting from a major injury provided estimates of the economic costs per victim of unintentional injury in Ontario. When the costs of all unintentional injury were considered, the economic costs of unintentional injury were almost $3 billion in Ontario in 1996, again calculated at a discount rate of 3 per cent (see tables 8 and 9). More than two-fifths of this overall cost, or $1.3 billion, was attributed to falls, with about another fifth ($567 million) caused by motor vehicle traffic crashes (Table 10). The total societal economic burden (direct and indirect) of unintentional injury was over $260 for every Ontario resident in 1996.

Nationally, the respective per capita economic burden estimates for other health conditions were cardiovascular disease ($660), musculoskeletal diseases ($595) and cancer ($438) (Health Canada, 1997).

It has been estimated that the annual economic burden of unintentional injury in Canada amounts to some $8.7 billion. Ontario generates over one-third of this total (SMARTRISK, 1998).

Direct costs accounted for almost $1.5 billion of total costs; indirect costs accounted for another $1.5 billion. Falls generated about 44 per cent of total costs, followed by motor vehicle crashes (19 per cent) and poisoning (5 percent). Again, the “other” category remains significant, but ill-defined.

Recent aggregate Health Canada (1997) figures on the total economic burden of all illness in Canada in 1993 estimated that the overall economic costs of all, i.e., including unintentional and intentional injuries to be about $14 billion. Unintentional injuries in Canada, which amounted to almost $9 billion in 1995-96, represented close to two-thirds of the total economic burden associated with all injuries (SMARTRISK 1998). Furthermore, these estimates take on greater significance when one considers that, of all unintentional injuries, the two major categories of falls and motor vehicle traffic crashes accounted for three-fifths of the total economic burden of unintentional injury in Canada as is the case for Ontario.

4.2 HOW SENSITIVE ARE THE RESULTS?

4.2.1 CHANGE OF DISCOUNT RATE

Discount Rate	Total Costs	Direct Costs	Indirect Costs
3% (Base Case)	$2.9 B	$1.5 B	$1.5 B
5%	$2.3 B	$1.2 B	$1.1 B

** rounding accounts for discrepancies*

Applying a 5 per cent discount rate resulted in a 22 per cent reduction in overall costs (over $650 million). Direct costs decreased by some $260 million (18 per cent) and indirect costs decreased by almost $390 million (almost 26 per cent). Rounding accounts for discrepancies. As can be seen, the effect of a lower discount rate has a more pronounced impact on indirect costs than direct costs.

Again, the bulk of the decrease in total costs came from the three top E-code groups: falls (-37 per cent); motor vehicle crashes (-21 per cent) and other unintentional incidents and late effects (-21 per cent). Overall, these three injury categories represented almost 84 per cent of the decrease in direct costs and over three quarters of the decrease in indirect costs. A lower percentage decrease in indirect costs was related to the elderly cohort in the falls category, as compared to a higher percentage in motor vehicle crashes associated with a younger cohort.

4.2.2 CHANGE OF UNEMPLOYMENT RATE

Unemployment Rate	Total Costs	Direct Costs	Indirect Costs
9.7% (Base Case)	$2.9 B	$1.5 B	$1.5 B
8%	$3.0 B	$1.5 B	$1.5 B
% Increase	0.9	0	1.9

** rounding accounts for discrepancies*

If the unemployment rate dropped to 8 per cent, overall costs would increase by 1 per cent, or roughly $28 million. Again, the three top injury categories accounted for over 75 per cent of the cost increase ($21 million). The increase is limited to indirect costs where the increase in time working increases the aggregate value of future earnings forgone due to injury. It is important to note that as the economy improves and as more jobs are created, the calculated costs associated with unintentional injury rise.

4.3 WHAT IF DIFFERENT SCENARIOS WERE ESTIMATED?

Some factors influencing the future costs of unintentional injury in Ontario are beyond the control of the decision makers (for example, the changing characteristics of the Ontario population), while other factors can be influenced (such as reducing incidence through injury prevention). The important fact to consider is that there is an interactive effect. For example, it is known that between 1996 (the base year for data) and the year 2010, the Ontario population is expected to increase (Canada Pension Plan, 1995). At the same time, there will be a shift in the structure of the population as the "Baby Boomers" continue to age. While this population growth and shift will be outside the realm of policy making, it is known that older people have more unintentional falls than younger people and, hence, these population shifts will likely result in greater numbers of people at risk.

Based on this information, various scenarios were run through the ERAT. The first scenario was designed to illustrate the population effect on the future costs associated with unintentional injury. The remaining scenarios were intended to illuminate the potential cost savings associated with meeting injury reduction targets for major causes of unintentional injury.

4.3.1 The Population Effect Scenario

The following Table 11 consists of the summary output from the ERAT based on the population projections referred to above. Based on these projections, the overall Ontario population is expected to increase by 12 per cent with a commensurate increase of total costs of unintentional injury of over 12 per cent. Of particular interest is the increase in direct costs of 19 per cent relative to the almost 6 per cent increase in indirect costs. This points clearly to the impact of an aging population who generate lower indirect costs measured as foregone earnings. While this phenomenon is not expected to generate significant increases in indirect costs, the anticipated increase in direct health care costs associated with the increased size and aging population could be substantial (over $275 million). Moreover, 63 per cent ($1.1 billion) of the 2010 direct costs ($1.7 billion) would be accounted for by falls, a common injury among older age groups.

TABLE 11 - SCENARIO 1: POPULATION EFFECTS ON ECONOMIC COSTS OF UNINTENTIONAL INJURY IN ONTARIO

	Population	Total Costs	Direct Costs	Indirect Costs
1996	11.3 M	$2.9 B	$1.5 B	$1.5 B
2010	12.6 M	$3.3 B	$1.7 B	$1.6 B
% Increase*	12.0	12.3	18.9	5.7

** rounding accounts for discrepancies*

4.3.2 Plausible Injury Reduction Scenarios

One of the significant strengths of the ERAT is the potential to model the effects of reducing unintentional injury mortality and morbidity in Ontario and other jurisdictions. The major challenge is to produce realistic and evidence-based "what-if" scenarios that focus on reducing different types of unintentional injuries for different age groups.

The literature on injury prevention and injury reduction targets established in Canada (see Appendix B) and in Britain (for example, UK Foreign & Commonwealth Office, 1995) offers sufficient information which can generate workable reduction scenarios for Ontario. Based on knowledge of risk factors in the general population such as the involvement of alcohol in different types of injury events (drowning, fires, motor vehicle crashes), the British set the following key targets:

- To reduce the death rate among children aged 15 and under by at least 33 per cent by the year 2005
- To reduce the death rate among young people aged 15 - 24 by at least 25 per cent by the year 2005
- To reduce the death rate among adults aged 65 and over by at least 33 per cent by the year 2005.

A more refined set of targets was identified for Canada in 1991 at a two-day consensus building meeting of experts (Injury Prevention and Awareness Centre, 1991). In conjunction with information from the literature, the targets and objectives developed at this meeting have been used to run three scenarios through the ERAT to estimate the cost savings for Ontario (direct and indirect) that could be realized by reducing the incidence of unintentional injuries. Relevant excerpts from the report of the consensus meeting follow.

TRANSPORT INJURY CONTROL OBJECTIVES – REDUCTIONS*

Objectives	Baseline per 100,000 in Canada	Target % Reduction
1.0 Reduce fatal injuries from transportation crashes in all age groups.	Unavailable	25%
2.0 Reduce injuries requiring hospitalization from transportation crashes in all age groups.	Unavailable	25%
3.0 Reduce fatal injuries caused by motor vehicle crashes. Groups at risk:	15.38 (1998)	20%
3.1 15-24 years	31.77	Reduce to 27.02
3.2 0-14 years	5.78	4.62
3.3 65+ years	19.5	15.6
3.4 status Indian/Inuit	Unavailable	Unavailable
4.0 Reduce injuries requiring hospitalization caused by motor vehicle crashes. Groups at risk:	182.61 (1998)	20%
4.1 15-24 years	392.32	Reduce to 313.16
4.2 0-14 years	106.84	85.47
4.3 65+ years	146.55	117.24
4.4 status Indian/Inuit	Unavailable	Unavailable
5.0 Reduce the proportion of fatal injuries due to alcohol-impaired drivers.	46.5% (1989)	20%
6.0 Reduce the number of casualty collisions caused by deficiencies in design, construction and maintenance of the road environment.	4498 collisions (1989)	10% Reduced to 4040 collisions

** University of Alberta (1991)*

HOME AND COMMUNITY FALLS*

Objectives	Baseline per 100,000 in Canada	% Change Over Past 4 Years	Target % Reduction
1.0 Reduce deaths from falls in all age groups.	5.80 (1988)	+2.65	25%
2.0 Reduce deaths from falls in the following target groups:			25%
2.1 0-1 year	0.27	-50.0	
2.2 0-4 years	0.68	-29.17	
2.3 5-14 years.	0.22	+29.41	
2.4 65-84 years	30.34	-1.36	
2.5 85+ years	366.48	+4.61	
3.0 Reduce hospitalizations from falls in the following target groups:	409.41 (1987)	-2.27	25%
3.1 0-1 year	453.84	-10.13	
3.2 1-4 years	349.45	-1.11	
3.3 5-14 years	348.58	-2.66	
3.4 65-84 years	1497.05	+0.17	
3.5 85+ years	6258.61	+3.79	
4.0 Reduce hospitalizations from:			25%
4.1 head injuries (all age groups)	196.66 (1987)	-7.59	
4.2 spinal injuries (all age groups)	32.01 (1987)	+2.89	

** University of Alberta (1991)*

4.3.3 The Scenarios

The three scenarios chosen targeted the following high incidence and high cost areas.

- Hip fractures and falls in the elderly
- Falls in children in the 0 - 9 age range
- Motor vehicle crashes

The rationale for choosing these areas is based on the findings of this study.

- Over 62 per cent of the total economic burden associated with unintentional injury in Ontario can be attributed to motor vehicle crashes and falls.

- The societal productivity losses (indirect costs) associated with the almost 20,000 injuries resulting in a permanent disability or death amounts to some $1.5 billion. Motor vehicle crashes and falls account for over 57 per cent of the total indirect costs.

- Unintentional injuries suffered by children, youth and young to middle-aged adults generate almost 85 per cent of the $1.5 billion in productivity losses in the Ontario economy.

Essentially, the areas processed through the ERAT provide coverage for three main age groupings: children, young adults and the elderly. The scenarios represent only a sampling of many possible scenarios and, hence, are by no means exhaustive. They are evidence-based and therefore represent plausible limits for reduction. In combination, the scenarios produce almost $300 million in savings to Ontario society.

Scenario 1: Falls in the Elderly - A Reduction in Hip Fractures

Falls generate almost 60 per cent of the direct health care costs ($870 million) and care for the elderly represents about 45 per cent of these costs. About 75 per cent of the direct costs relating to falls were associated with providing care to elderly women.

Based on hospital morbidity data, it was determined that about 40 per cent of falls among the elderly which resulted in a hospital stay were attributable to hip fractures. In fact, hip fractures are the most common type of fall injury among the elderly and a recent Canadian study estimated that the number of annual hip fractures in this age group would increase from 23,375 (1993-94) to a staggering 88,214 by the year 2041. Furthermore, the same study estimated that about 7 per cent of the hip fractures among the elderly result in death (CMAJ, 1997).

While the reduction targets set in Britain and Canada range from 25 per cent to 33 per cent for unintentional injury in general, we chose to model the impact of a more conservative reduction target of 20 per cent of hospitalizations due to falls across the board for Ontarians aged 65 and over. It was assumed that although hospitalization would be averted, the injury would still occur for three quarters of these falls, and that some form of out-of-hospital care would be required (i.e., one quarter of the falls could be completely averted). The ambulatory nature of the care also implies a reduction in the severity of the injury and a commensurate reduction in the period of disability.

Preventing falls among the elderly could potentially result in almost 3,000 fewer hospitalizations and over 700 fewer permanently disabled people over the age of 65. The net savings from this target reduction are $55 million annually.

Scenario 2: Reduction in Falls in Children in the 0 - 9 Age Range

The literature and data examined in this study reinforces the fact that childhood falls continue to be a significant problem in Ontario. These injuries cost Ontarians almost $220 million each year (the direct costs for this age group amounted to 14 per cent of the direct costs associated with falls across all age groups). Among children and youth, males represented slightly more (9 per cent) of the direct costs associated with falls. This second scenario reduces the incidence of falls by 20 per cent across the board for children in the 0 to 9 age group.

This reduction would result in almost 500 fewer hospitalized children in Ontario, over 4,000 fewer non-hospitalized injuries, and 185 fewer injuries resulting in some form of permanent disability. The net savings amount to some $44 million annually.

Scenario 3: Reduction in Motor Vehicle Crashes

Based on the Canadian injury reduction targets and information available from the injury prevention literature, this scenario consists of four components. First, based on evidence that alcohol is involved in approximately 40 per cent of fatal motor vehicle crashes, it was assumed that mortality could be reduced by 20 per cent through a 20 per cent decrease in the incidence of drinking and driving. This assumes that these crashes would not have occurred.

The second component assumed that speed limits would be reduced from 100 km/hr to 90 km/hr resulting in a 15 per cent decrease in mortality associated with motor vehicle crashes. This does not mean that these crashes would not occur, but rather that the impact speed would be reduced, resulting in a commensurate decrease in mortality. It was also assumed that one third of the lives saved would result in hospitalization, while the other two thirds would be cared for in an ambulatory setting.

The third element was based on the Canadian injury reduction targets for motor vehicle crashes that assumed a 20 per cent reduction in the number of injuries resulting in hospitalization. This would therefore be a severity reduction. It was also assumed that one half of this group would have required some form of ambulatory care.

Finally, a 10 per cent reduction in the number of motor vehicle crashes caused by design, construction and maintenance of the road environment was assumed.

This scenario produced the following impressive savings.

- Over 380 fewer deaths
- Over 900 fewer hospitalizations
- Over 6,400 fewer non-hospitalized injuries
- Almost 250 fewer injuries resulting in some form of permanent disability.

The net savings from this scenario amount to over $180 million annually.

5.0 THE POLICY CONTEXT & RESPONSE

5.1 INTRODUCTION

The estimated economic costs developed in this study are conservative. They do not include the burden on families and other informal caregivers. Indeed, as the population continues to age, the demands on informal care will also increase. At the present time it is estimated that 80 to 90 per cent of support for the elderly and disabled is provided by wives and daughters (as reported in Angus et. al., 1995). If fall injuries are not addressed, the burden on informal caregivers could become a significant challenge for families and society. Furthermore, productivity losses were estimated only for the population aged 18 to 64, a segment of the population which is considered to be the accepted working age group in Ontario. If other age groups are included in the calculation of productivity losses, and if the informal care noted earlier were translated into monetary terms, the overall economic costs of unintentional injuries would be significantly higher than those estimated in this report.

It is clear that the direct and indirect costs of unintentional injuries in Ontario are high. There are a few remarkable points to understand behind these figures. First, the majority of direct costs are not the result of hospital-based medical treatment and rehabilitation. These costs represent only slightly more than one fifth of all direct costs of injuries. Second, of all unintentional injuries resulting in hospitalization, falls and motor vehicle crashes account for over 80 per cent of the direct costs. Third, the indirect costs of unintentional injuries are higher than the direct costs of treatment and rehabilitation and they account for over half of the total economic costs of unintentional injury in Ontario. Finally, the most significant loss to society (in terms of lost productivity) is not due to premature deaths resulting from fatal injuries but rather the loss in productivity associated with disability caused by unintentional injuries. These morbidity costs account for over three fifths of all indirect costs and more than 30 per cent of the total economic burden to Ontario society. When the morbidity costs are combined with the ongoing medical and rehabilitation costs for injury victims following their release from hospitals, it is evident that continuing treatment, rehabilitation and loss-in-productivity due to disability are responsible for almost 70 per cent of the total economic burden of unintentional injury in Ontario. As some researchers suggest, “fatal injuries may be less of a drain on the health care system than nonfatal injuries, since death often occurs before the injured person can be taken to the hospital” (Rivara, Grossman and Cummings, 1997:617). Still the loss of young lives due to injury generates over half of a billion dollars in indirect costs each year in Ontario.

If the status quo were to be maintained, the total economic burden of unintentional injury could conservatively reach almost $3.3 billion (in $1996) by the year 2010. As that group of the population living with the disability resulting from unintentional injury ages, the health problems normally associated with aging may be compounded as a result of injury-related disabilities with which they have been living and, hence, the total costs could actually be higher. However, if an effort had been made to reduce the total economic costs resulting from unintentional injuries with reference to the three scenarios shown in the previous chapter, then Ontario could quite possibly have realized savings of about $300 million annually (in $1996).

5.2 AREAS OF FOCUS

The cost-effectiveness of injury prevention is more than a matter of ideology and speculation. However, many individuals view injuries as random yet inevitable occurrences. In other words, people often think that unintentional injuries simply happen; that they cannot be prevented. Traditional epidemiology examines illness and disease by relating the agent (toxin or microbe), host and the environment. William Haddon was the first person to use this framework for injuries, suggesting that the event leading to an injury is separate from the injury itself and, therefore, should be the focus for injury prevention (Rivara, Grossman and Cummings, 1997). Stemming from this, falls and motor vehicle crashes involve events, each of which can be influenced by many factors that can be altered through prevention.

5.2.1 Motor Vehicle Crashes

Motor vehicle crashes take many young lives each year and result in serious short-term and long-term disabilities for others. Seat belts, alcohol, speed limits, road engineering and driver attitude and behaviour all play a significant role and point to areas for investing in targeted prevention strategies and interventions. For example, seat belts and air bags have been shown to reduce injury by 61 per cent and hospitalizations by 33 per cent. Reducing the number of people who drive while under the influence of alcohol is another area where savings can be achieved and human pain and suffering reduced. A recent US study found that alcohol was involved in 41 per cent of fatal injuries and 9 per cent of nonfatal injuries sustained in motor vehicle crashes (Rivara, Grossman and Cummings, 1997). It has also been demonstrated that reductions in speed limits would result in a decreased risk of mortality. One study (Barach and Richter, 1998) notes that a 10 per cent increase in impact speed translates into a 40 per cent rise in risk of death. Israel provides a specific example where raising the speed limit from 90 to 100 km/hr led to an 18 per cent increase in road fatalities (Barach and Richter, 1998).

5.2.2 Falls

The data generated through the ERAT developed for this study underscores the significant public health problem and associated costs of falls in Ontario. The risk factors associated with falls in the elderly (mostly females) are a history of falls, impairments related to cognition, balance and gait, chronic health conditions, frailty and low body mass index, inappropriate use of medications (especially diuretics and psychotropic drugs), and dwelling place hazards (Rivara, Grossman and Cummings, 1997). Hip fractures are the most common type of fall injury among the elderly and a recent Canadian study estimated that the number of annual hip fractures in this group would increase from 23,375 (1993-94) to a staggering 88,214 by 2041. Furthermore, it was estimated that about 7 per cent of the hip fractures among the elderly result in death (CMAJ, 1997; 157: 1357-63). This clearly demonstrates the effect injuries have on an aging Ontario population and underlines the need to target prevention interventions at this group.

The data contained in this report also show that childhood fall injuries are another significant problem in Ontario. Previous studies have used childhood injury deaths as a marker for non-fatal childhood injuries where, for every death, it was estimated that there would be an additional 45 inpatient stays and 1,300 emergency room visits (Injury Awareness and Prevention Centre, 1991). This did not include visits to other ambulatory settings such as physician offices.

Hence, the rationale is clear for investing in injury prevention and also for targeting our efforts. The next steps involve funding and action.

5.3 INVESTING IN HEALTH: THE NEED FOR AN INTEGRATED STRATEGY FOR UNINTENTIONAL INJURY

As discussed earlier, the term "unintentional injury" is not a commonly understood term and represents a diverse range of injuries from falls to motor vehicle crashes, drowning and poisonings. The issue of unintentional injury therefore suffers from an "identity crisis" and appears to have become lost on the health policy agenda. Most people view illnesses such as heart disease and cancer as the major diseases that impact on societal well-being as well as on limited financial resources. However, injuries ranked third and amounted to about 11 per cent of the total annual economic burden (Health Canada, 1997). Unfortunately, although injuries rank third in terms of economic burden, they rank last in terms of the research share of total costs (i.e., less than 0.5 per cent, Health Canada, 1997). This may explain the lack of progress in adequately addressing the issue of preventing unintentional injuries.

Unintentional injury continues to persist as a significant threat to the health and financial well-being of Ontario. There is a strong economic incentive to invest in strategic and targeted prevention programs and interventions directed at the different types of unintentional injuries. By conducting this study, it became evident that better and more integrated information and surveillance systems are required to guide and support the prevention effort. Furthermore, there is an ever pressing need to invest sufficient funds in order to produce a payback both financially and in terms of reduced human pain, suffering and disability.

5.3.1 Injury Surveillance is Prevention

Surveillance of the occurrence of unintentional injury is an integral part of prevention. It is the information lifeline for injury control and the equivalent of turning on the lights in order to enable targeted prevention programming and strategies.

Injury surveillance has three objectives (Declich and Carter, 1994). First, it should outline patterns of injury and link these patterns to prevention and control measures. Second, it should include the epidemiology of events that lead up to an injury. The third objective is to monitor the impact of prevention. Inadequate surveillance results in sub-optimal prevention. Insufficient funding of the surveillance-prevention-evaluation cycle will also result in poor prevention outcomes and could lead to the equivalent of injury epidemics.

A case in point is the finding that over 25 per cent of the total economic burden associated with unintentional injury is loosely classified as Other Incidents and Late Effects. Although the costs are apparent, the prevention response is difficult to ascertain given the uncertainty associated with the injury definition and reporting. This is a clear indication of the need for improved classification and surveillance of unintentional injury.

Unintentional injury is a broad category covering many types of injury across different age and risk groups. Similar to HIV/AIDS, it is composed of multiple epidemics involving falls among the elderly, falls among children, motor vehicle crashes, farm injuries, and poisonings, each of which occur in varying proportions amongst different age/sex groups in different geographical areas. Hence, surveillance and prevention of unintentional injury in Ontario will require a multivalent, integrated and coordinated response.

During the past decade, there have been efforts to develop objectives for the control of injuries. However, except for a few areas, a concentrated provincial or national effort has not been launched to achieve these objectives. In 1991, a project entitled A Safer Canada: Year 2000 Injury Control Objectives (University of Alberta) yielded a national consensus on a series of injury control objectives. The following recommendations were made:

- That the government of Canada recognize injuries as a major cause of death and disability that requires a national injury prevention strategy

- That the injury control objectives developed be used to stimulate injury control initiatives throughout Canada

- That a national injury surveillance system be established.

The years that have passed since this project was launched represent a missed opportunity for injury prevention strategists. Although there has been some progress in the area of surveillance and prevention, Ontario and the rest of Canada have not maintained the momentum from this national consensus-building exercise: a national injury prevention strategy still does not exist. A second effort to create injury control objectives has recently been completed by the Public Health Branch of the Ontario Ministry of Health in 1997 through the Mandatory Health Programs and Services Guidelines (Ontario Ministry of Health, 1997). Again, while injury reduction targets were set and indicators were established to measure progress, an overall strategy identifying best practice and innovative injury prevention, levels of investment in prevention, and the necessary collaborative partnerships between government, non-government organizations, the public health infrastructure and community-based organizations was conspicuously absent.

Presently, Ontario maintains a good record of hospitalized injuries. Improvements in the classification of injury could be accomplished and could include such items as whether alcohol was involved at the time of injury. The Canadian Institute for Health Information is currently completing some of this work. However, there remains a large void in the surveillance of non-hospitalized injuries in Ontario and across Canada. As a result of this study, it was estimated that there were almost 700,000 non-hospitalized injuries in Ontario in 1996. Other than this figure, there is little known about the epidemiological details or the characteristics of these injuries. Without such information, it is very difficult to develop an appropriate prevention response. Surveillance would go a long way towards turning on the lights.

5.3.2 Prevention and Risk Reduction: Is There a Payback?

Many people view injuries as inevitable, chance and random occurrences. In fact, the opposite is true. “Injuries are not accidental or haphazard events. They are predictable, the risk factors are identifiable, and interventions are available to prevent and minimize the impact of injuries” (Postl, 1993). For example, seat belts have reduced the number of deaths and the severity of injuries associated with motor vehicle crashes. Modern injury epidemiology examines the event leading to an injury in combination with the injury itself. Hence, falls and motor vehicle crashes involve events, each of which can be influenced by many factors that can be altered through prevention and risk reduction. The significant costs of unintentional injury in Ontario provide a strong economic incentive to invest in injury prevention and risk reduction.

A recent report that looked at the economic dimensions of HIV/AIDS estimated that Canada invests approximately $83 million per year (federal, provincial and private sources) or $2.65 per capita in the national prevention effort. The report emphasized the

critical need to "stay as close as possible to the leading edge of this elusive epidemic...through investing in a strategic national sentinel surveillance system" (Albert & Williams, 1998). This early warning system is a prerequisite to effective prevention strategies.

Like HIV infection, unintentional injury is sensitive to prevention programs. For example, an intervention designed to prevent falls among the elderly reduced the incidence of falls by 12 per cent at a cost of $891 per subject (Tinetti et al., 1994). In 1996, there were over 180,000 falls among the elderly amounting to almost $400 million or about $2,100 per fall. By preventing 20 per cent of these falls, about $55 million in direct health care costs would have been saved. Assuming the cost per injury prevented is $891, the total cost of preventing these injuries would have amounted to just over $32 million, resulting in net savings of $23 million. Injuries involving younger Ontarians would provide an impressive payback from prevention, primarily because of the gains in productive living. Assuming that Ontario had set an overall reduction target of 30 per cent for all unintentional injuries across all age groups, the result would have been over 220,000 fewer injuries and almost $900 million in gross savings. Based on the limited information available on the cost of prevention programs, and in the interest of deriving a conservative estimate of savings, it is assumed that the cost per injury prevented is $1,000 ($220 million). This would have yielded net savings of over $650 million in direct and indirect costs. The savings in direct costs alone ($440 million) would have provided a positive net return of almost $220 million. It is obvious that the magnitude of the payback from prevention is impressive.

5.3.3 How Much Should Be Invested in Surveillance and Prevention?

Although it is difficult to estimate how much should be invested in injury prevention, international comparisons can be used to provide some benchmarks for setting per capita investment levels. Furthermore, examining investment levels in the prevention of other illnesses could also assist in determining an amount. The choice of illness is important in this case since the disease in question must have a level of prevention in order for the comparison to be valid. The degree to which a disease or injury is preventable is another factor that should be considered. Unfortunately, there are very few diseases for which the national investment in prevention has been quantified. However, Canada's investment in HIV prevention has recently been quantified (Albert & Williams, 1998) and, as an infectious disease with known modes of transmission, HIV infection is preventable. It is known that both HIV and unintentional injuries can be prevented, the annual incidence of each is known, and the direct and indirect costs for each have been documented.

In 1996 there were an estimated 3,940 new HIV infections and the lifetime direct and indirect costs amounted to some $750,000 per case. Hence, the incidence costs for HIV infection in Canada in 1996 amounted to almost $3 billion. The federal government and the provinces responded to this disease burden by investing $83 million ($2.65 per capita) in HIV prevention in 1996. Given that the liability for caring for an HIV infected person resides primarily with the provinces, it follows that the provinces invest considerably more in prevention than the federal government. In the case of HIV, the provinces invested over 67 per cent of the total, the federal government invested 24 per cent, and the private sector and municipalities invested 5 per cent and 4 per cent respectively.

The incidence costs associated with unintentional injury in Canada in 1995 amounted to about $8.7 billion - almost three times the HIV incidence costs. Using this scaling ratio, Canada could invest upwards of $240 million annually ($8 per capita) in the fight to prevent unintentional injury (SMARTRISK, 1998). In Ontario, this would suggest that an investment of $90 million could be considered, split roughly 70/30 (provincial/federal). This should be viewed as a "ball park" estimate that is based on the HIV estimate of federal, provincial, municipal and private investments in HIV prevention. This pooling of funding also underscores the need to integrate and coordinate the prevention and surveillance activities needed to combat unintentional injury in Canada.

5.4 WHAT ARE THE POTENTIAL PAY-OFF STRATEGIES?

Tengs et al. (1995) reported that out of almost 600 life-saving interventions reviewed, 133 were directly concerned with injury-prevention strategies which, taken together, indicated a median cost of $48,000 (1993 $US) per life-year saved. For example, mandatory seat belt use legislation was found to cost between $69 and $98 per life-year saved. Laws requiring smoke and fire detectors in homes ranged anywhere from no cost to $8,100 per life year saved. Mandatory motorcycle helmet laws ranged from no cost to $2,000. Highway improvements (such as grooved pavement, flashing lights at railway crossings and the widening of bridges on existing highways) cost anywhere from $29,000 to $82,000 per life-year saved. Speed limit enforcement cost between $6,600 to $510,000 per life-year saved. Various traffic safety education programs (for example, driver improvement schools for bad drivers, improved traffic safety education for children up to grade twelve, improved basic driver training programs, alcohol safety programs for drunk drivers, etc.) ranged from no cost to $84,000 per life-year saved.

Finally, vehicle inspection programs (e.g., random, compulsory and periodic) cost between $1,500 and $57,000 per life-year saved. While the studies showed significant variation in cost-effectiveness estimates, the very noteworthy aspect of this review was comprehensive compilation of such programs with which to actually do some comparisons. No other study in the literature has moved this far forward.

Earlier, the results of the substantial work done by Rice and MacKenzie (1989) were highlighted. Recently, Rivara, Grossman and Cummings (1997), encapsulated their results and noted that "in an analysis of nine injury-prevention measures, Rice and MacKenzie estimated that the costs of intervention were substantially outweighed by the savings from preventing such injuries" (Rivara, Grossman and Cummings, 1997: 617). Rice and MacKenzie (1989) showed that net savings to society were found for air bags in automobiles, a minimum licensing age of 17, driver education in public schools, reduced cigarette porosity, high seat backs in automobiles, motorcycle helmet legislation, bicycle helmet use promotion, and child-pedestrian programs. Rice and MacKenzie also stated that "a substantial proportion of severe injuries could be reduced by a greater application of current knowledge (and that) the potential savings, net of the cost of injury control programs, is in the billions of dollars for the interventions for which data are available" (Rice and MacKenzie, 1989:136).

Legislation is one strategy that could offer substantial potential to reduce the total economic costs of unintentional injury in Ontario. A number of studies (e.g., Bass et al. (1993); Ginsberg and Silverberg (1994); Hatziandreu et al. (1995); Children's Safety Network (1996)) suggest that, regarding the use of bicycle helmets, legislative programs appear to be the most cost-effective, especially in terms of the speed that results begin to be realized. Confirming the findings of Rice and MacKenzie (1989), Hatziandreu

et. al., (1995) maintain that the least effective programs seem to be the school-based interventions. In their review of the literature, Bass et al. (1993) concluded that legislative efforts that result in automatic, passive reductions in childhood injuries are the most effective public health initiatives. They did suggest, however, that the legislative approach may require some form of educational reinforcement, but did not indicate where that should occur. The Children's Safety Network (CSN) (1996) indicated that a dollar invested in the following prevention strategies would realize positive societal savings: bicycle helmets (savings of $30), child safety seats ($32), poison control centres ($7 in medical costs), smoke detectors ($55-$70), and injury prevention counselling by pediatricians ($13). Recently, a Canadian pediatrician advocating for initiatives aimed at reducing childhood injuries also stressed the need for concerted legislation in this regard. Also, to underscore the significant requirement for such legislation, the pediatrician recommended the establishment of a national centre for childhood injury prevention and control as an essential first step (Pless, 1996). With respect to the role that pediatricians could play in the prevention of "injuries from motor vehicle collisions, burns, and falls in children younger than five years, Miller and Galbraith estimated that nearly $13 would be saved for every $1 invested in counseling" (Rivara, Grossman and Cummings, 1997: 617).

With respect to adolescents and younger adults, the literature clearly points out the risk associated with motor vehicle crashes. In the US motor vehicle occupant injuries are the leading single cause of all injury-related deaths, followed by drowning, pedestrian injuries, and motorcycle injuries (Children's Safety Network, 1996). It was also indicated that injury was the leading factor associated with medical spending for these younger age groups, with motor vehicle crashes being responsible for the greatest share of the costs of unintentional injury, followed by falls and poisonings. The CSN further indicated that by investing one dollar in the following interventions, positive economic savings could be realized: laws against serving intoxicated patrons of bars (savings of $94), an intensified sobriety checkpoint program ($7), adult use of automotive safety belts ($110), and convincing motorcyclists to wear helmets ($180).

As the Ontario population continues to age - the leading edge of the 'Baby Boomers' will begin to turn 65 around the year 2010 - prevention and reduction of injuries among seniors continues to become a top priority. While we seem to understand the nature and characteristics of falls in this age group, "we understand little about the most effective ways of preventing or averting their occurrence" (Raina, Torrance and Lindsay, 1997:14). With respect to the prevention of injuries and death resulting from motor vehicle crashes, researchers suggest that efforts "should be multidisciplinary and should include prevention of the occurrence of motor vehicle crashes, prevention of injury once a crash occurs, and prevention of adverse outcomes after the injury has occurred. Prevention of injuries and crashes due to motor vehicles requires intervention and surveillance at several levels, including federal, provincial and local, and involves changes in the host, the agent, and the environment" (Raina, Torrance and Lindsay, 1997:17).

5.5 WHAT ABOUT FUTURE RESEARCH AND DIRECTIONS?

This study uses the cost-of-illness approach to identify and document the economic burden of unintentional injury in Ontario. The estimates are based on data routinely collected on deaths and hospitalizations resulting from major categories of unintentional injury.

To derive these estimates, the Electronic Resource Allocation Tool (ERAT) was developed. The ERAT can be adapted for use by decision-makers to assess the nature and size of the injury problems. It can also be used to set broad prevention priorities, to assist in allocating prevention resources, and to promote safety. However, the motivation behind the development of the ERAT stemmed from a critical injury information gap in Ontario and across Canada.

The US researchers were able to work with data that documented the injury episode outside the hospital setting, a luxury that was unavailable for the purposes of this study. The fact that this is considered a luxury speaks volumes about the paucity of data on unintentional injuries in Ontario and across Canada. In view of the significance of the non-hospital costs of unintentional injury, there is a need to develop data sets that would allow Ontario researchers and policy makers to document the full range of episodic costs associated with these injuries, and not only those costs to the victims themselves. It was impossible to include the economic burden of family members and friends into the calculations. This is one the reasons for suggesting that the estimates are conservative. As the size of the hospital sector is reduced, there does not seem to be any doubt that the burden on both the patients themselves and their informal caregivers will increase. These costs need to be documented. For example, Osberg et al. (1996) examined the impact of childhood injuries on work and family finances in the US. They found that, even with less severe injuries, many parents experienced difficulty in maintaining regular work schedules, a situation that often resulted in adverse effects on family finances. Needless to say, "parents of children who were more severely injured and had more impairments reported significantly more problems with work and family finances at both 1 and 6 months post-discharge ($p<0.001$)" (Osberg et al., 1996: 894). Policy makers will have to address the enormous economic burden associated not only with the direct costs of the injuries themselves, but also with work and financial difficulties.

Data on the overall incidence costs associated with injuries is much in demand. Data is also needed on the value of non-remunerated activities, especially for a growing segment of the population that contributes significant value-added to activities that care for disabled family members and friends, elderly family members, and children and adolescents recovering from periods of incapacitation. Finally, data is required on the late effects resulting from non-hospitalized acute-care injuries (which, according to Miller et al., 1995, are significant), and on the effects of multiple injuries. As was recommended by Miller et al. (1995), there is also a need in Ontario for improved estimates of functional capacity loss resulting from injuries that would allow for better cost estimates.

Aside from the need to develop better data on unintentional injuries and their economic costs, researchers have identified requirements for improvements in the information on various prevention strategies themselves. Tengs et al. (1995) observed that, "despite continuing interest in cost-effectiveness, we could find no comprehensive and accessible data set on the estimated costs and effectiveness of risk management options. Such a data set could provide useful comparative information for risk analysts as well as practical information for decision makers who must allocate scarce resources (Tengs et al., 1995: 369).

Most importantly, however, it must be understood that research alone is not sufficient. Research must be integrated within an overall injury prevention and control strategy. While research creates knowledge and evidence there will be a critical need for dissemination and knowledge management within a strategic framework.

5.6 A PROPOSED FRAMEWORK

"The newer concept of prevention, as it developed, was applied almost wholly to disease, to the sick. The injured were largely forgotten…"
—John E. Gordon, 1949
(Barss et al., 1998)

Other countries have recognized injuries as a major threat to human health and well being and are taking steps to ensure the issue is addressed . The United States have a National Center for Injury Prevention and Control and the British government has recently identified injury as one of four health priorities along with heart and stroke, cancer and mental health.

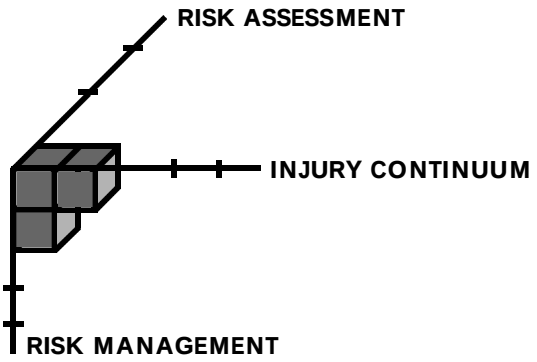
As the UK has reinforced, unintentional injuries "are a major cause of avoidable ill-health, injury and death in Britain and a very important cause of short-term illness and often permanent disability. Children, young adults and older people are particularly vulnerable. Unintentional injuries are the most common cause of death in people under 30 years. Many are preventable by information and education, and through improved planning and design of the environment, better management in the workplace or greater vigilance and supervision in the home" (UK Foreign & Commonwealth Office, 1995: 1).

Despite the magnitude of the public health threat that injuries pose and the significant societal losses that accrue, these injuries tend to have less identity and recognition in health policy and research than other health issues. As a result of this historical identity problem, the heterogeneity and multi-causal nature of the issue and under-funding of research, less progress has been made in the area of injury prevention and control than might be expected. Ontario has a unique opportunity to give this silent epidemic focus, leadership, coordination and a unique approach to advancing a research agenda and knowledge management. The challenges that injuries present to the research community call for and lend themselves to a multidisciplinary and multivalent approach to injury prevention and control.

Therefore, it is proposed that the basic policy framework be premised on an inter/multidisciplinary, multi-organizational and evidence-based risk management model. It assumes that taking risks is part of life and that risk minimization and reduction will enhance the quality of life and the well-being of Ontarians. It is also based on a rational, integrated, cooperative and collaborative injury research program.

A risk management and risk assessment framework underpins the initial concept that should be explored. Figure 1 depicts a three dimensional analytical framework that could be used to organize a large-scale research program. Each cube represents a distinct injury area where the "tool kits" of the various disciplines can be brought to bear on the risk assessment and risk management axes.

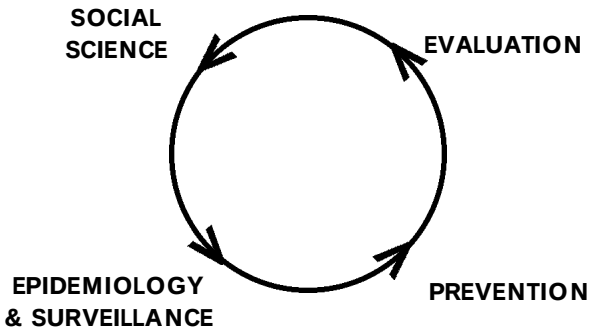
Figure 1: Analytical Framework

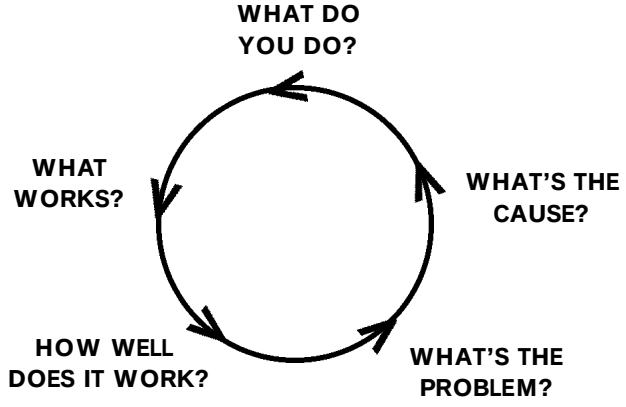


Risk assessment will rely on sound research in epidemiology, surveillance, social science, biomedical science and engineering. The risk management stream will involve prevention programmers/social scientists, evaluators, economists and policy makers. The model relies on "science to understand the causes of injury and how they occur; applies the findings from scientific studies to create programs and interventions to prevent injuries" (Sleet et al., 1998); and the dissemination of best practice guidelines for the delivery of these programs.

The iterative nature of the relationship between surveillance/epidemiology, social science, prevention programming and evaluation is critical to creating evidence-based injury prevention and control. This interdependency is illustrated in Figure 2.

Figure 2: Evidence-Based Injury Prevention and Control Loop





Current injury surveillance is predominantly passive (i.e. the counting and classification of injuries). An active surveillance system would rely on a combination of epidemiological and behavioural research to identify populations at risk of injury so that targeted prevention programs can be designed and delivered at the leading edge. Hence, this type of surveillance is akin to "switching-on the lights" for prevention programming.

In addition to guiding what works and why and what doesn't work and why, the evaluation section of the iterative loop ensures that the prevention response is both allocatively and technically efficient. In other words, providing guidance on doing the right things and doing them right. Best practices and their dissemination are a natural output of this process.

5.7 CONCLUSION

Every hour of every day, 85 Ontarians are unintentionally injured (over 2,000/day), eight Ontarians die daily from these injuries and over 16,000 are disabled every year. Overall, almost 750,000 Ontarians are injured each year.

Acknowledging the need to act is the first step. The next step is to get the key players and stakeholders together to devise, resource and operationalize a Provincial Injury Prevention Strategy. The rationale is clear. The consequences of not acting are far-reaching for this significant health problem. High level commitment is required in order to create a truly integrated response. Ontario needs leadership - someone “at the helm” - in order to effectively address the problem of unintentional injury.

Ontario has acknowledged and responded to other significant health issues by developing and implementing strategies. The time has come to acknowledge and recognize the problem of unintentional injury and develop and invest in a strategy. This is a problem requiring a truly integrated response involving a partnership between the provincial government, federal government, non-governmental and community-based organizations involved in injury prevention and risk management.