APPENDICES*

* Apply to both:
i) Economic Burden of Unintentional Injury in Canada
ii) Economic Burden of Unintentional Injury in Ontario

APPENDIX A

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APPENDIX B

SPECIAL CONTRIBUTION BY WILL PICKETT AND LISA HARTLING

I -INJURY SURVEILLANCE, PREVENTION AND CONTROL

What Is Injury Surveillance?

The Centers for Disease Control define surveillance as “the ongoing systematic collection, analysis, interpretation and dissemination of health data” (Centers for Disease Control, 1992). Injury surveillance has three specific objectives (Declich and Carter, 1994). The first is to describe patterns of injury and to link these to prevention and control measures. The second objective is to study the epidemiology of injury events including incidence and prevalence; occurrence by person, place and time; exposures and risk factors; and development of hypotheses for analytic research. The third objective is to provide baseline information that can be used for the ongoing evaluation and monitoring of prevention and control programs.

How Are Surveillance Data Used?

Data generated through surveillance are compared with some “expected” value or norm. The differences between the observed and expected values are assessed as to their relative importance. These comparisons allow researchers to achieve a number of goals. First, it allows them to estimate the magnitude (in terms of numbers and costs) of injury-related morbidity and mortality. Second, they can detect changes in the occurrence of injury, new injury problems and injury epidemics. Third, they are able to identify potential risk factors associated with injury occurrence. Finally, they can provide an objective basis and generate hypotheses for analytic research (Klauke et al., 1988). The information also provides a factual basis for monitoring and evaluating intervention strategies and for rational decision making with respect to allocating resources, choosing priorities and predicting future needs (Declich and Carter, 1994).

The ultimate goal of surveillance is to control the injury event being observed (Thacker and Stroup, 1994). To this end, an effective surveillance system must be integrally linked with prevention and control initiatives.

Injury Prevention and Control

Dr. William Haddon developed a framework for evaluating injury events and identifying preventive measures (Waller, 1985). Dr. Haddon divided injury events into three phases: pre-injury, injury, and post-injury (Waller and Clemmer, 1993). These three phases encompass concepts of primary, secondary, and tertiary prevention. Primary prevention refers to averting the occurrence of an injury; secondary prevention implies minimizing the harmful effects given that the injury occurs; and tertiary prevention refers to prolonging life with injury and otherwise improving the health status of injured persons. He further noted that each phase involved an interaction between the host, the agent of injury and the environment. This framework (Figure 1) enables one to examine the injury event at all stages that can affect a given outcome. The framework dictates the information that should be collected through surveillance in order to provide a complete and consistent picture of injury events. This information in turn provides direction for the development and targeting of control and prevention programs. For example, instead of emphasizing primarily how individuals can be modified (e.g. through education), the matrix provides insight into how the agent of injury (e.g. equipment design) and/or the environment (for example, a work site) might also be modified to minimize the number or severity of injuries.

FIGURE 1. HADDON’S MATRIX FOR INJURIES

	Host	Agent	Environment
Pre-injury			
Injury			
Post-injury			

Link Between Surveillance and Public Policy

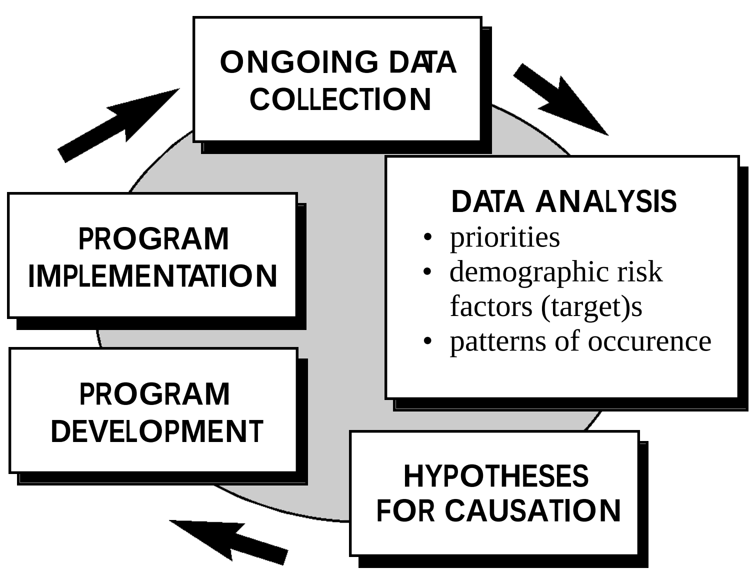
The fundamental premise upon which injury research depends is that injuries are not accidental or haphazard (Postl, 1993). Injuries are predictable events that can be prevented or minimized through an understanding of their epidemiological characteristics (Postl, 1993). In order to effectively control injuries there must be a direct and continuous link between surveillance and collection activities. This vital connection is illustrated in Figure 2 beginning with ongoing data collection. Data are analyzed and provide information regarding priority areas for intervention, potential risk factors and patterns of injury occurrence. This information generates hypotheses regarding causation that in turn drives program development and implementation. Following the implementation of control initiatives, continued data collection provides the information necessary to evaluate and modify ongoing programs.

Cost Studies and Injury Control Research

Postl (1993) has emphasized the need for closer linkage between injury epidemiology and public policy as well as for multi-sector involvement in injury control. Historically, injury prevention programs have relied on the incidence of cases as the objective source of information for setting priorities (Malek et al., 1991). Different program priorities may be chosen if more and/or better information on the costs of injury was available (Malek et al., 1991; Phillips et al., 1993).

Since the mid-1960s, the public health community has been working on costing models for a variety of illnesses (Runge, 1993) but it was not until the mid-1980s that injuries became the specific focus of such an initiative. Data pertaining to the incidence and costs of injuries are needed to “develop, improve and evaluate prevention strategies; target high-risk groups; allocate scarce resources; formulate public health policy; support passage of legislation” (Schuster et al. 1995); and justify “program costs by comparing these with potential savings” (Malek et al., 1991).

FIGURE 2. SURVEILLANCE LOOP



Cost data can strengthen and support the decisions indicated by incidence data. There is also value in knowing the cost of injuries globally to provide a basis for the evaluation of cost effectiveness and cost-benefits of prevention programs as well as to provide additional support for the provision of funds for prevention programs. Cost estimates offer a “quantifiable measure of the public health significance of injuries and the potential savings from reducing their number and severity” (Max et al., 1990). “As advocates we must prepare our legislators with the data and options that will allow them to link public policy to (research) efforts” (Postl, 1993).

II - INJURY CONTROL OBJECTIVES

During the past decade, there have been efforts to develop objectives for the control of injuries within Canadian populations. Below are two such efforts.

Injury Control Objectives for Canada (1991)

The first of these is a 1991 project entitled *A Safer Canada: Year 2000 Injury Control Objectives for Canada* (University of Alberta). This initiative was coordinated by injury control researchers at the University of Alberta, funded by Health and Welfare Canada and the province of Alberta. The process culminated in a national symposium held in Edmonton, May 21-22 1991, at which time a series of goals, objectives and recommendations were put forward. These included specific indicators of injury outcomes that could be monitored. It was hoped that these would provide a focus for injury prevention and control in Canada.

The symposium and its affiliated consensus-building process did help to strengthen and shape health policy within Canada during the past decade. Four recommendations were put forward.

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

2. That the following broad injury control goals be adopted as a framework for a national strategy on injury prevention and control.
   - Reduce injury death and disability across Canada
   - Strengthen public policy regarding injury prevention
   - Improve awareness and education programs in injury prevention
   - Create safe environments
   - Decrease the incidence of injuries related to alcohol and other substance use/abuse
   - Improve systems of trauma care and rehabilitation

3. That objectives developed during the symposium be used to stimulate injury control initiatives throughout Canada.

4. Establishing a national injury surveillance system.

A wide variety of categories of injury were addressed during this project. Indicators of progress towards the national objectives were suggested. These included process indicators (for example, increasing training opportunities for occupational health and safety in Canada), as well as outcome indicators (such as reductions in mortality and morbidity). The following table provides example indicators of the latter that were published as part of the symposium proceedings.

SUMMARY OF EXAMPLE INDICATORS:
YEAR 2000 INJURY CONTROL OBJECTIVES FOR CANADA (SET IN 1991) [a]

Category of Injury	Indicator	Age Group	Baseline, annual rate /105	Target Reduction (2000)
Falls	Mortality	All ages	5.8	25%
	Hospitalizations	All ages	409.4	25%
Head Injuries	Hospitalizations	All ages	196.7	25%
Spinal Injuries	Hospitalizations	All ages	32.0	25%
Injuries due to Fire/flames	Mortality	All ages	1.3	25%
Scalds	Hospitalizations	All ages	51.1	25%
Drowning	Mortality	All ages	1.5	10%
Alcohol-related Drowning	Mortality	All ages	[b]	20%
Cycling Injuries	Mortality	All ages	0.5	15%
Hospitalizations	All ages	7.0	10%	
Off-road Vehicle Injuries	Mortality	All ages	0.3	15%
Hospitalizations	All ages	16.4	15%	
Poisonings	Hospitalizations	0-4 years	[b]	25%
Work-related Injuries	Mortality	All workers	8.2	30%
Lost-time Injuries	All workers	613,836 [c]	30%	
Playground equipment Injuries	Hospitalizations	All	[b]	10%
Motor vehicle crashes	Fatal	All ages	15.4	20%
	Hospitalizations	All ages	182.6	20%
	% Fatal involving alcohol	All ages	46.5% [c]	20%

[a] *Source: University of Alberta (1991)*
[b] *Baseline information not provided*
[c] *Baseline indicator not expressed as a rate per 100,000*

Injury Control Objectives for Ontario (1997)

The second effort to create injury control objectives is the 1997/98 review of *Mandatory Health Programs and Services Guidelines* in the province of Ontario (Ministry of Health, 1997). The provincial Public Health Branch, which has established standards for the province, is leading this review. The standards set out minimum requirements for public health programs and services, and suggest goals for the anticipated impact of these interventions. For injury prevention (including substance abuse prevention), there are five main focus areas. The overall goal of the program is to reduce disability, morbidity and mortality caused by motorized vehicles, bicycle crashes, alcohol and other substances, falls in the elderly and the prevention of drowning in specific recreational water facilities. Indicators were also established to measure progress towards specific aspects of this goal. These were limited to a few key patterns of injury. The latter were identified through an analysis of mortality and morbidity statistics.

SUMMARY OF INDICATORS:

YEAR 2010 INJURY CONTROL OBJECTIVES FOR ONTARIO (SET IN 1997) [a]

Category of Injury	Indicator	Age Group	Target Reduction (2000)
Falls	Mortality	65+	20%
	Hospitalizations	65+	20%
Alcohol-related Injuries	Mortality	All ages	20%
	Hospitalizations	All ages	20%
Injuries due to:	Mortality	All ages	20%
Cycling			
Motor vehicle crashes			
Boating			
Snowmobiles			
All terrain vehicles			
Injuries due to:	Hospitalizations	All ages	20%
Cycling			
Motor vehicle crashes			
Boating			
Snowmobiles			
All terrain vehicles			
Drowning in waters for specified recreational purposes (e.g. public pools)	Mortality	All ages	100%

[a] *Source: Ontario Ministry of Health (1997)*

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

Existing research demonstrates that there are many causes of fall injuries among elderly persons. However, this knowledge has rarely been applied to the development of targeted interventions that have subsequently been evaluated in a rigorous manner. In theory, community interventions can have a meaningful impact on fall injury rates, and therefore the costs of medical treatment for fall injuries. There are no Canadian studies in the biomedical literature which have assessed the latter.

A recent systematic review of randomized controlled trials examined the efficacy of interventions to prevent falls and subsequent injury in older people (University of York, 1996). Of the 36 different studies identified, 23 dealt with exercise regimes, nine examined home assessments, and four examined a variety of other interventions. The most rigorous of the exercise trials were seven linked studies at separate sites in the United States. These examined 10-36 week exercise regimes carried out under the 'Frailty and Injuries: Cooperative Studies of Intervention Techniques' (FICSIT). Pooled results of these studies showed, overall, that people assigned to an exercise group had an estimated 10 per cent lower risk of falling than controls (University of York, 1996).

Six trials that evaluated home assessments and surveillance interventions were considered in the systematic review. All involved "visiting older people at home, an assessment of the safety of the home environment, and a range of interventions such as safety checks, safety modifications, referral to care, and recommendations for exercise" (University of York 1996). Four of these trials showed a reduction in falls in the intervention arm of the trial (Hornbrook et al.., 1994; Tinetti et al., 1994; Carpenter and Demopoulos, 1990; Wagner et al., 1994).

As an example, Tinetti et al. (1994) tailored "interventions to individual risk factors such as multiple drug use, use of sedative/hypnotics, postural hypotension, etc., that were implemented by nurses and physiotherapists". This trial reported a reduction in the reported rate of falls in the year following the intervention from 47 per cent to 35 per cent, as well as substantial reductions in a variety of risk factors for fall injuries.

Cost Studies

There have been no Canadian studies published in the peer-review literature that have estimated either the total costs of elder falls on the health care system or the costs/savings of a fall intervention program.

Studies published in the biomedical literature have estimated treatment costs associated with specific fall-related injuries. These are primarily U.S. data. For example, Brainsky et al. (1997) estimated the economic cost of hip fracture in the community-dwelling elderly to be about $17,000 ($U.S.) per fracture, when medical, non-medical and informal costs were considered. Health Canada has applied a "prevalence-based, human capital approach to translate morbidity and premature mortality into direct and indirect costs" for a variety of illnesses (Moore et al., 1997). Direct and indirect annual costs of all injuries in Canada were estimated at $3.1 billion (direct; $1993 Can.) and $11.2 billion (indirect). However, the authors did not provide a specific figure for elder fall injuries. In the United States, almost $9 billion in lifetime economic cost of injury is estimated from falls occurring in this elderly population each year (Rice and Mackenzie, 1989).

In a recent review of the literature, Anderson (personal communication, Queen's University, 1997) identified only one published randomized and controlled trial that has examined the costs associated with fall prevention and intervention. This study was published by Rizzo and colleagues (1996). This research estimated the costs of a randomized elder falls prevention program implemented in a Health Maintenance Organization in Connecticut. 301 participants, aged 70 years and older and considered at risk, were randomized to receive the following. First, they received intervention - a combination of medication adjustment, behavioral recommendations, and exercises. Or they would receive usual care that included home visits by a social work student. Based on a costing of the intervention itself and a cost comparison of the control and treatment groups, the falls prevention program was cost effective. While the mean cost of the intervention was $925 ($U.S.), follow-up showed that the mean health-care costs were $2,000 less in the intervention group.

IV - ROUTINELY COLLECTED DATA FOR UNINTENTIONAL INJURY IN CANADA

The main purpose of *The Economic Burden of Unintentional Injury in Canada* project was to estimate the overall costs to Canadian society of unintentional injury. To this end, a computerized model was developed in order to automate the process of cost estimation. The resulting model is the Electronic Resource Allocation Tool (ERAT).

In order to apply this tool to a given cost estimation for Canadian injuries, the user would (optimally) have access to various types of Canadian epidemiological data. This includes mortality data, hospitalization data, and data on less traumatic injuries that are treated in other settings. These data are used to generate coefficients that are applied to the costing model. While some of these data are routinely available for Canada, (for example, mortality and hospitalization statistics), other forms of population-based data are not available (such as injuries treated in outpatient settings). As a consequence, many of the assumptions and estimates that have been applied to the Canadian cost model have been taken from the next available option: data from the United States.

There are very practical reasons why the Canadian injury data required to develop comprehensive cost estimates do not exist. As a discipline, injury control is a field that in many ways is still emerging from its infancy. Eyssen (University of Toronto, personal communication) has suggested that the major categories of disease that affect our populations are at varying degrees of maturity with respect to research, and this is reflected in the resources and activities that occur in their respective fields. Cancer, for example, can be viewed as a very “mature” disease. While descriptive, epidemiological studies of cancer still occur, the vast majority of studies in this field involve more sophisticated research designs. Publicly maintained cancer registries have existed for decades in most developed countries. Surveillance of the incidence and patterns of cancer is feasible at national and provincial levels. Funding opportunities for research dwarf those for most other forms of disease.

The field of injury, on the other hand, does not have a long-standing presence within the international research community. As a relatively “immature” disease, Canadian research in this area is very often descriptive as opposed to etiologic, and experimental trials that assess the effectiveness of interventions are uncommon. Disease registries and injury surveillance programs (such as the Canadian Hospitals Injury Research and Prevention Program; Health Canada) do exist, but are often limited in either scope and/or breadth of coverage, or lack the comprehensiveness and length of coverage of existing cancer registries. Most have been developed from administrative databases that have been compiled for other purposes (for example, administrative databases of hospital discharge records).

This state of affairs is improving with time. However, the bottom line is that some of the data required to develop comprehensive cost estimates do not exist on a population basis. Where they do exist, injury data may not be robust (due to limited sample sizes), or readily accessible for research purposes.

The following sections comment on the availability of various forms of data available for the description of major patterns of injury within Canada. Implications for the current economic project are also provided.

Mortality Data

Population-based data for Canada that describe deaths caused by unintentional forms of injury are available. Major sources of these data are the Canada Mortality Database (Statistics Canada), provincial vital statistics registries, provincial trauma registries, provincial and national motor vehicle accident databases, and provincial coroners'/medical examiners' registries.

The economic analysis presented in the current report has used 1994/95 data from the Canada Mortality Database, compiled by the Health Statistics Division of Statistics Canada from provincial vital statistics offices. This database is the standard for research on fatal injuries in Canada. In a recent Health Canada publication, Canaria and Rebuttal (1998) provide a concise description of these mortality data and their application to the surveillance of unintentional injury. This is paraphrased below:

The central vital statistics registry in every province provides Statistics Canada with a standard record of every death. Using the information requested on death certificates regarding the circumstances of the death, injury-related deaths can be identified and categorized. This information is coded according to external causes of injury in the World Health Organization International Classifications of Disease (ICD-9 E-Codes). The ninth revision of the latter has been used in Canada since 1979. While there are limitations to vital statistics with respect to the description of circumstances leading to death, they do include all injury categories and enable temporal comparisons to be made.

Limitations to national fatality data are as follows. Subtle difference in reporting formats exist between provinces, so that there are some inconsistencies with respect to certain data fields that would be useful at a national level. For example, occupation is not collected in all provinces. Where it is coded, it may be misleading, particularly in the case of multiple occupations. Although E-Codes are available on the vast majority of injury-related deaths, it is sometimes difficult to verify their accuracy and there is undoubtedly variation in the quality of this information. Further, detailed information about the source and/or mechanism of injury is often limited or missing. With these caveats in mind, it is still important to recognize that these data are routinely recorded, comprehensive, and accessible for research. They are suitable for use in the current economic study.

Listed are the categories of ICD9 E-Codes that were analyzed in this study:

E800 - E807 - Railway Accidents

E810 - E819 - Motor Vehicle Traffic Accidents

E820 - E825 - Motor Vehicle Non-Traffic Accidents

E826 - Pedal Cycle Accidents

E830 - E838 - Water Transport Accidents

E840 - E845 - Air and Space Transport Accidents

E846 - E848 - Vehicle Accidents not Elsewhere Classifiable - eg. forklifts, cable cars, ice yachts, land yachts

E850 - E858 - Accidental Poisoning by Drugs, Medicaments and Biologicals

E860 - E869 - Accidental Poisoning by other Solid and Liquid Substances, Gases and Vapours

E880 - E888 - Accidental Falls

E890 - E899 - Accidents caused by Fire and Flame

E900 - E902 and **E906 - E909 -** Accidents due to Natural and Environmental Factors - not complete

E910 and E913 - Accidental Drowning and Submersion and Accidental Mechanical Suffocation

E914 and E915 - Accidents due to Foreign Bodies

E916 - E929 - Other Accidents and Late Effects

ICD9 E-Codes not included in the analysis in this study:

E827 - Animal-Drawn Vehicle Accident

E828 - Accidents involving an Animal being Ridden

E829 - Other Road Vehicle Accident, eg., streetcar

E870 - E876 - Misadventures to Patients during Surgical and Medical Care

E878 - E879 - Surgical and Medical Procedures as the Cause, without Mention of Misadventure

E903 - Travel and Motion

E904 - Hunger, Thirst, Exposure, Neglect

E905 - Venomous Animals and Plants as the cause of Poisoning and Toxic Reactions

E911 - Inhalation and Ingestion of Food Causing Obstruction

E912 - Inhalation and Ingestion of Other Objects Causing Obstruction

Hospitalization Data

Comprehensive and national population-based data about Canadian injuries that are treated in hospital are available from several sources. One of these is the registry of hospital discharges maintained by the Canadian Institute for Health Information (CIHI). This database is available directly from CIHI, or indirectly through federal and provincial health ministries, and Statistics Canada. The present economic analysis has used the 1995 CIHI Discharge Abstract Database obtained from Health Canada. Again, this is the standard for applied injury research within Canada, as it provides the best available population-based data on hospitalized unintentional injuries.

Canaria and Rebuttal (1998) have also described the strengths and limitations of these data, as applied to the version maintained by Statistics Canada. These hospital discharge data include records from acute, chronic care, and convalescent hospitals. Hospitalizations for injuries can be identified by ICD-9 E-Codes, and consequently described by circumstance (E-Code) and nature (N-Code). In provinces that collect information on the circumstances leading to injury (all except New Brunswick and PEI), E-Codes are available on over 90 per cent of admissions. Overall and stratum-specific rates of injury obtained from this database should be representative of the Canadian experience for hospitalizations. Limitations to these data are as follows. This database includes records of hospital admission for injury, as opposed to injured persons. There is the potential for people who are re-admitted for the same injury event to be double counted. Some provinces (for example, Manitoba, Quebec and Nova Scotia) do not report all of their hospital discharges to this database.

For specific patterns of injury within Canada, there are additional datasets that researchers can draw upon for population-based work such as the current economic analysis. These include national and provincial registries of motor vehicle injuries (e.g. the national Traffic Accident Information Databank); provincial trauma registries (e.g. the Ontario Trauma Registry), and workers' compensation reports. Data from these registries could only be applied to the study of quite specific forms of injury.

Outpatient Data

In order for the cost model developed for the present economic analysis to be applied optimally, data are also required for non-fatal injuries that do not result in hospitalization. This is a major obstacle within Canada. National, population-based information on these other forms of injury is difficult to obtain. There are three main comprehensive sources of these data. The first of these are population-based health surveys. The second is the Canadian Hospitals Injury Reporting and Prevention Program (Health Canada). The third is provincial data on outpatient medical encounters (there is a registry being developed by Alberta Health).

Canadian population-based health surveys do collect self-reported information on the occurrence of unintentional injuries. Cycle 8 of the 1993 *Canadian General Social Survey* (Statistics Canada, 1993), and the 1994 and 1996 iterations of the National Population Health Survey (Health Canada, 1996) did request information about injuries severe enough to require medical care. These provide basic information about the overall incidence of non-fatal injuries and their treatment among the Canadian population. However, there is a distinct lack of detail in the description of these injury events. Based on the information provided, the injuries cannot be described by ICD-9 E-Codes or N-Codes. If some very broad assumptions were applied, some of these data (for example, age-specific rates of injury) could be applied to the development of an overall cost model for all unintentional injuries in total. They cannot be reasonably applied to the costing of most specific patterns of injury, due to the lack of specificity of the injury descriptions, and (where specific injury descriptions exist) small sample sizes for age-specific rates of injury.

The *Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP)* is a sentinel surveillance system for injuries presenting for emergency medical care in Canadian Hospitals. This project was originally developed in the early 1990s to monitor injuries to children, and there is a preponderance of children's hospitals represented. Since that time CHIRPP has been expanded to include several general hospitals. With the exception of injuries presenting to the two hospitals in Kingston, Ontario, CHIRPP data is not population-based. Overall and stratum specific rates of injury cannot be generated that would be representative of the Canadian experience. ICD-9 E-Codes (which are required for the costing model) are also not recorded on the CHIRPP database.

Alberta Health provides one example of recent efforts to use administrative databases to describe outpatient medical encounters for the treatment of injuries. They are using health provider billing records to develop a composite, computer file for the province. This file will subsequently be linked with other, routinely available government records, which should allow more in-depth study of the etiology of various forms of injury. These data are not, as yet, available on a wide basis to external research organizations.

Comment

The field of injury control research in Canada is clearly very young, and there is great opportunity for major advances in the near future.

In 1991, Canadian researchers and policy-makers met in Edmonton to establish recommendations for a national strategy for injury control. A major recommendation from this symposium was that there was a need for a national, comprehensive injury surveillance program in this country. Secondary analyses of the Canada Mortality Database, and national hospital discharge statistics are now possible. Further, the establishment of the Canadian Hospitals Injury Research and Prevention Program, as well as outpatient databases at the provincial level, provides some information on injuries treated in outpatient settings. However, we still lack a centralized database (analogous to the cancer registries) that can provide a complete picture of the spectrum and distribution of unintentional injuries in Canada. This remains an elusive goal that has been realized in other countries.

In the absence of comprehensive, surveillance data on non-fatal injuries presenting to outpatient settings, as a first approximation the authors of the present, economic study have relied upon the following data:

- Canadian data on fatal unintentional injuries
- Canadian data on hospital admissions for treatment of unintentional injuries
- United States data on outpatient medical encounters for the treatment of unintentional injuries.

This is not an optimal situation. However, in the absence of comprehensive information from Canada, it is a pragmatic solution. While it can be expected that the experiences in the United States may vary from that in Canada with respect to injury treatment, these variations are unlikely to be significant enough that the costing exercise is discredited. The results will provide a good, first approximation of the economic burden associated with unintentional injury in Canada.

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APPENDIX C

DETAILED METHODOLOGY FOR ASSESSING COSTS OF UNINTENTIONAL INJURY

DETAILED METHODOLOGY FOR ASSESSING COST OF UNINTENTIONAL INJURY

Existing State of the Art for Cost of Illness Studies

Current approaches and data allow only a portion of total costs of illness to be estimated. During the past couple of decades significant progress has been made with respect to documenting the direct and indirect costs of treating many major health problems. In view of the recent trends to reduce the level of hospital resources spent and encourage a greater use of non-institutional community-based services (including increasing the amount of time that family members devote to care and treatment of sick relatives), there has been greater effort to reduce many more non-health sector costs associated with given illnesses. Still, for many health conditions, certain gaps remain to be filled and the lifetime costs are unknown. If the latter were known, it would be possible to estimate the benefits of preventing new cases or reducing the incidence of the illness.

The major reason these costs are difficult to measure is that the epidemiology of many diseases is still relatively unknown. We need to know more about the likely course of the disease (that is, the amount of disability it causes, the time between the onset of the condition and cure or death) in order to estimate the amount of health care that is required and the impact of morbidity and mortality on earnings. While we have been making large strides in measuring quality of life (and the factors which affect it, such as the influence of mortality on the family and its life cycle, consequences such as divorce, duration of marriage, probability and duration of widowhood, probability of orphanhood, changes in residence, loss of job, reduced self-esteem, emotional problems, pain and suffering associated with loss of a body part, disability, social isolation, economic dependence, impending death and otherwise reduced quality of life), we are still some distance away from being able to estimate the various social costs and primary and secondary costs associated with major illness categories.

From a societal perspective, it is believed that these costs can be a significant element of the total cost of illness. If they are ignored (because, for example, “hard data” cannot be gathered), then the final estimate of the economic burden of illness can be greatly understated, thus affecting the policy decisions that will ultimately be made. More and more analysts suggest that effort should be made to estimate these costs; if this is not possible then, at a minimum, the researchers should try to quantify the potential impacts in some other way, e.g., frequency of job loss, changes in residence, etc.

The General Approach: Some Guidelines

In reviewing the studies of cost of illness, there is an overall general approach that most analysts seem to follow. By doing so, it is easier for other researchers to better document their work, develop more complete estimates and, hence, to derive consistent and reliable cost of illness studies.

Core Costs

There is a core of costs that are common to most cost of illness studies. These include the direct costs that include all items related to diagnosis, treatment, continuing care, rehabilitation, and terminal care such as expenditures for hospitals, outpatient care, nursing home services, home care, health care professionals, drugs and appliances. The second type of costs are indirect costs (resulting from losses in output due to time lost from work or home making brought about by morbidity and premature mortality). Depending on the perspective taken, that is, the societal point of view being the broadest, the items included in this core can range from narrow to broad. The data being used to derive these core costs should be documented and discussed: their reliability, population base, and other aspects which will help the reader assess the suitability of the data and their limitations.

Indirect Costs

Most studies approximate this part of overall costs by the human capital approach. As noted earlier, output losses are estimated by calculating lost earnings and the imputed market value of unperformed home making services. The value of the latter should be included because omitting them would seriously underestimate the indirect costs of illness. The major concern with the human capital approach is "that it excludes intangibles, only counts earnings [and imputed earnings], and undervalues some groups relative to others because earnings may not accurately reflect one's ability to produce" (National Center for Health Statistics, 1981: 6). Other analysts suggest following the willingness-to-pay approach, which places a value on human life according to the amount of money people are willing to spend to reduce their probability of suffering or death. Objections to this method are "that the value of individual lives depends on the income distribution, with the rich being able to pay more than the poor, and that it is exceedingly difficult for persons to place a value on small reductions in the probability of death" (National Center for Health Statistics, 1981: 6). In their study of the economic costs of four major diseases, Hartunian et al. (1980) estimated that indirect costs were greater than direct costs, ranging from 2 times to 4 times the respective direct costs.

Discount Rate

The discount rate is used to convert a stream of future money values of public sector projects and for such things as future earnings into their present values. From the perspective of the economist, simply summing the lifetime earnings of individuals grossly overstates the present value of an individual. Hence, deriving the present value of future earnings streams is the only true way to measure economic value over a period of time. Furthermore, the higher the discount rate, the lower is the present value of a given stream of resources; using a high discount rate can make a program that has long-term effects appear relatively unattractive. On the other hand, using lower discount rates increases the present value of this stream of resources and, hence, can make a program with long-term impacts look good. Since there is disagreement regarding whether to use a low (i.e., social rate of time preference) as opposed to a high (opportunity cost of using resources in the public sector) discount rate, most analysts recommend finding some balance between the two. This can be done by providing a number of alternative rates: for example, 2.5 per cent, 5 per cent and 8 per cent. The reader should be aware that most discount rates do not include adjustments for productivity changes; hence, a 6 per cent discount rate adjusted for an increase in productivity of 2 per cent per annum will result in an effective discount rate of about 4 per cent (i.e., 1.06/1.02 = 1.039).

Double Counting

Most studies attempt to avoid double counting. For example, taxes and transfer payments are not costs of illness and, hence, should not be included in the estimates of direct and indirect costs. Taxes will have already been included in indirect costs and transfer payments are nothing more than a reallocation of income from individuals (e.g., wage earners) to other individuals (e.g., the disabled). It is important to keep in mind that costs of illness represent the value of resources used, while transfers are shifts of control over the use of resources. The costs of illness are unambiguous losses that would not happen if illness were reduced, while transfers take resources from one part of society and give them to another. It is enough to remember that failure to make this distinction between transfer payments and costs will seriously overestimate the costs of illness.

Be as Comprehensive as Possible

Core costs do not represent a complete assessment of the costs of illness. Increasingly, more and more analysts are attempting to include (and measure) as completely as possible all costs associated with major illness groupings. Once the epidemiology of the respective illness is known, it will be easier to calculate the total costs to society of the illness in question, i.e., including estimates of non-health sector costs, social costs, and secondary consequences throughout the economy. For those impacts that cannot be quantified in monetary measures, consequences should (at least) be listed and assessed by currently available methods; having some idea of these non-monetary impacts, in addition to the monetary costs, will more fully describe the scope and magnitude of the illness. It really is important to try to capture the latest, most accurate data on incidence, recurrence, survival incapacitation, and care and treatment costs.

Use the Appropriate Cost Approach

Further to the discussion related to the prevalence and incidence approaches to estimating costs of illness, it is important to use the appropriate method. For example, if the objective is to derive the economic burden resulting from the prevalence of the illness in a given year, then the prevalence approach that captures the direct and indirect core economic costs would be suitable. If, on the other hand, it is necessary to capture the reduction in costs that would come about from a reduction in the illness, then the incidence approach, which estimates costs from onset until cure (or death), would be appropriate. Regardless of the approach, it also is important to discuss the extent of generalization that can occur as a result of the study.

Sensitivity Analysis

Regardless of how careful the analysts are, all data are subject to varying degrees of imprecision. It is important to identify those parameters for which the estimated costs of illness are most sensitive to changes in value. For example, the costs of illnesses for which mortality is relatively less important compared to morbidity and health care use, or for which mortality happens at older age groups, will be less sensitive to differences in the discount rate that is used. As well, the costs of illnesses that require much greater proportions of hospital care will be relatively more sensitive to inflation of medical care prices. In these cases it is preferable to present a range of estimates. Also, the literature suggests that should measures of reliability of these estimates (e.g., relative standard errors, standard errors, confidence intervals), should be provided whenever possible.

Documentation

Finally, the literature underscores the need to provide detailed documentation of the data, their sources, and the methods that have been used, in order that an independent researcher can duplicate the study and allow for comparison and improvement of the research being attempted. Discussing the estimated costs according to whether they are core and extensions from the core, with a good explanation of the calculations and analysis, will help to assure that the objectives of the cost study can be achieved. As well, since it is difficult to capture “pain and suffering, grief, the value of leisure time, or the symbolic aspects of illness ... shortcomings to economic evaluations should be kept in mind” (Hartunian et al., 1980: 1257).

Overall, cost of illness studies cover such important direct and indirect cost variables as the number of people affected and their productivity, the average number of life-years lost for each disabled or impaired person, and the treatment and other costs associated with the illness in question. As noted in one such study, “reliable analyses require quantification, aggregation, and comparison of effects” (Hartunian et al., 1980: 1258).

Cost Framework

The 2 x 2 Cost-of-Illness Matrix below provides a simple illustration of the costs that could be associated with any unintentional injury. Some injuries like motor vehicle crashes result in instant death where the costs are dominated by productivity losses and where direct costs are limited to ambulance and autopsy (I2 & D2). Yet, other motor vehicle crashes do not result in death, but do result in long-term disability (e.g., spinal cord lesion resulting in paraplegia - D1 & I1). The hospital stay is relatively straightforward in terms of capturing direct costs, whereas the lifetime out-of-hospital direct costs are more difficult to track and capture. The indirect costs depend on the level of functionality and adaptability of the person injured. There could be a lifetime of productivity loss or a period of rehabilitation and vocational training leading to a productive life.

Hence, as a general rule morbidity costs (direct and indirect) that extend beyond a hospital stay for indefinite periods of time are difficult to identify, due primarily to a lack of data. This presented a key challenge since most available data related to unintentional injury resulting in hospitalizations and/or death. Given these data limitations, it was necessary to search the literature for data or coefficients to link into the data available. Data sources and techniques relating to each cell in the cost framework are discussed below.

D1: Direct Morbidity Costs - Hospitalized Unintentional Injuries

The Discharge Abstract Database from the Canadian Institute for Health Information (CIHI) provided the necessary data for calculating the hospital costs for the 1995 incident population. These data were acquired through Health Canada's Laboratory Centre for Disease Control and with the permission of CIHI.

The variables of interest for the study were age, sex, Most Responsible Diagnosis (N-code), Diagnosis 2 code, Diagnosis 2 prefix, Case Mix Group (CMG), length of stay (LOS), and Resource Intensity Weight (RIW). Only those observations with a Diagnosis 2 Prefix that were marked "E" (meaning an injury occurred) were selected from the database. The year chosen was 1995-96.

In order to attach costs to these episodes, the Resource Intensity Weights (RIW) published by CIHI in Resource Intensity Weights: Summary of Methodology, 1995-96, and attached to each case record in the Discharge Abstract Database, were used. The CMG is the only direct link to Resource Intensity Weights (RIW) which are essential to costing hospitalized injuries. The cases were then tabulated into the 99 injury groups defined by ICD-9 E-code, age and sex in the electronic tool (refer to the approach to developing the ERAT later in this Appendix for details). This provided the number of cases, the average age, the average LOS, the average RIW and a distribution of ICD-9 N-

A GENERAL COST-OF-ILLNESS MATRIX

Injury "X"	Morbidity (No Death)	Mortality
DIRECT COSTS	D1: Hospital, Physician Fees,	D2: Emergency Room,
	Drugs, Rehab., etc.	Ambulance, Autopsy, etc.
INDIRECT COSTS	I1: Time away from work; years of disability resulting in forgone income	I2: Potential Years of Life Lost, Future Income Forgone

code injuries for each of the 99 groups. By attaching the cost per RIW unit the hospital costs for the 99 groups were derived.

The following example demonstrates these relationships for an injury from the E-code list.

Example:Mapping ICD-9 E-Codes into CMGS

The figure below is a hypothetical example showing how the E-coded hospital discharges have been mapped into CMGs for the purpose of computing direct morbidity costs. In this example, E910.8: unintentional drowning in swimming pool (without dying) was chosen for demonstration purposes. It has been determined through the data that three N-codes are connected to this E-code.: N991.6, unintentional hypothermia; N854.0, brain injuries NOS; and N861.2, injury to lungs without mention of wound into thorax. Thus, all unintentional drowning in swimming pools are categorized in various proportions into one of these three N-codes. In turn these ICD-9 N-codes are mapped into CMGs. The diagram gives the resulting mapping and the corresponding proportions. The end result of this mapping is a single E-code connected to twelve different CMGs, each with different associated costs, indicated via a specific resource intensity weight (RIW), and each with a different weight in the E-code.

The final step entails a weighted average RIW, multiplying by the value of the base (RIW = 1.0), or the average cost per RIW ($2000 has been used for this example), and then multiplying by the number of E-code cases.

If there were 3,265 drowning in a swimming pool, then the total cost for this E-code would amount to $20.4 million, or $6,236 per case.

The actual data used for this study had a more refined age breakdown by gender for each of the E-codes of interest.

During the early stages of this study, a dollar value for the base (RIW = 1.0) was not available from CIHI. However, The Hygeia Group was aware of the Ontario Case Costing Project[1] that agreed to provide an estimate based on data from eleven hospitals. This represented the “best” data available at this time in Canada. The costs were based on typical cases only (i.e., all atypical cases as defined by CIHI were excluded). Using CIHI’s 1995 CMG grouping methodology the average cost was derived by dividing total costs for all typical cases by the total number of typical cases (i.e., all hospital discharges for the period). Based on this, the average RIW cost used in this study was estimated to be $3,041.71 (i.e., RIW = 1.0 = $3,041.71).

Physician costs (fees) associated with hospitalized unintentional injuries were calculated based on a ratio of medical costs to total hospital costs taken from the Miller et al. (1995), Databook on Nonfatal Injury: Incidence, Costs, and Consequences.[2] This ratio was applied to Canadian hospital costs for unintentional injury to estimate physician costs for this study.

The direct costs associated with out-of-hospital (post discharge) care for hospitalized and non-hospitalized unintentional injuries were derived based on disability coefficients from the data book referred to above. Disability was defined as partial permanent disability and total permanent disability and the respective probabilities were also derived. These disability fractions were used to determine the number of hospitalized and non-hospitalized cases in each major E-code category that would result in longer term, out-of-hospital care. As well, by defining periods of disability for this sub-group of hospitalized and non-hospitalized cases, the information necessary to calculate the indirect morbidity costs were determined (i.e., cell I1 from Cost of Illness Matrix: productivity losses).

D1: Direct Morbidity Costs for Non-Hospitalized Unintentional Injuries

Given that there was not a comprehensive data set available to provide national incidence estimates for non-hospitalized injury, it was necessary to search the literature for alternate data sources. As noted earlier, with the Miller et al. (1995) study, one such source was found based on a ratio of non-hospitalized unintentional injury cases to hospitalized cases, the incidence for non-hospitalized unintentional injury for Canada in 1995-96 was calculated.

This significant data book also provided the data necessary to calculate the ratio of the costs of non-hospitalized unintentional injury to the costs of hospitalized unintentional injury. This ratio was used to estimate the direct costs of non-hospitalized unintentional injury in Canada.

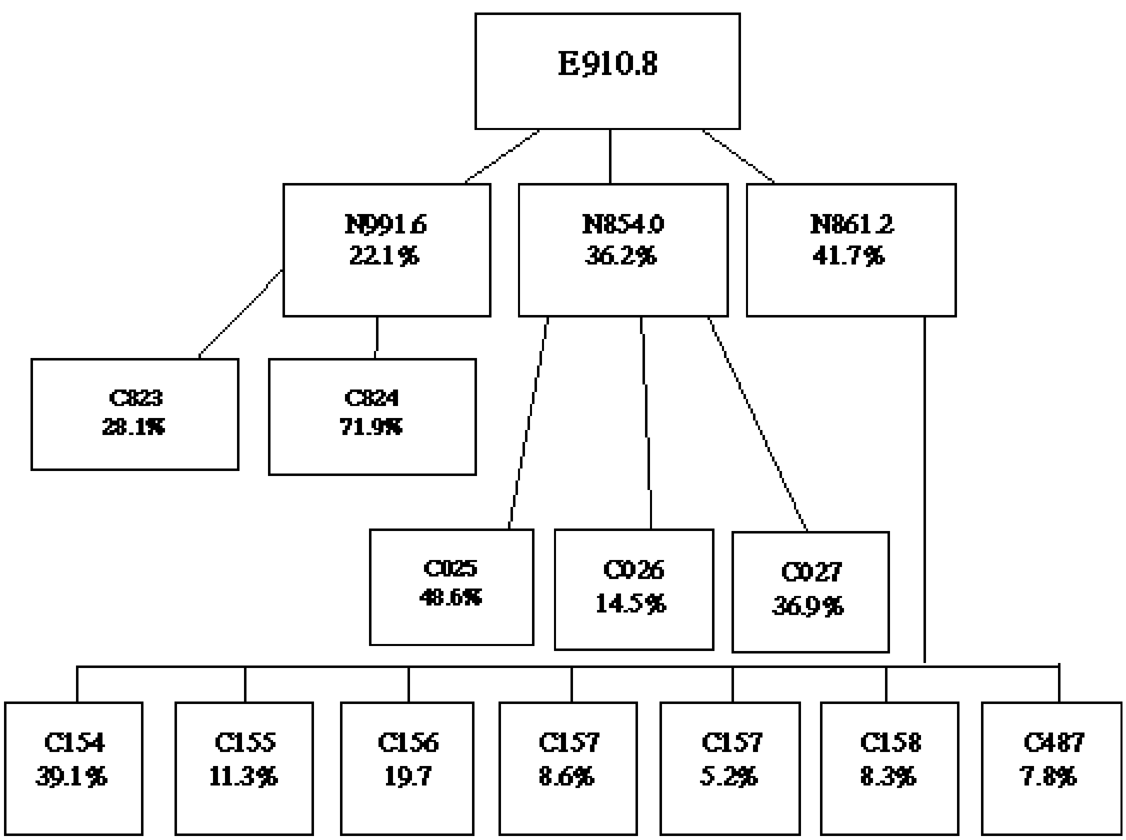
D2: Direct Mortality Costs

The data were not available to calculate the direct costs associated with the deaths caused by unintentional injury. However, it is fair to state that the direct costs would be dwarfed by the indirect costs (i.e., future income forgone).[3] Nonetheless, these costs were not included in the economic burden estimates contained in this report.

I1: Indirect Morbidity Costs

There is an important distinction between morbidity and mortality indirect costs. Morbidity indirect costs are driven by productivity losses associated with partial or permanent disability as opposed to death. Hence, there are degrees of disability and varying levels of indirect costs. Based on the probabilities for partial permanent and total permanent disability in the Miller et al. (1995) data book, disability costs were calculated for the 1995-96 incident unintentional injury population in Canada.

The morbidity indirect costs for this population were calculated based on several variables taken from Statistic Canada's CANSIM[4] database. These variables included the unemployment rate, labour force participation rate, and average wage. Based



on these data, the indirect morbidity costs associated with injury disability were derived by estimating the future earnings forgone using a 1 per cent real wage growth and a 3 per cent discount rate to derive the present value of the indirect costs.[5] Similar to other studies, the indirect cost estimates in this study takes into account varying life expectancies for different age groups, and the discounting of potential future earnings into their present value.

Other indirect morbidity costs are driven by the amount of informal care giving provided to the victims of unintentional injury, especially to the very young or the elderly. These costs represent the productivity losses associated with periods away from employment for the purposes of providing informal care for injured children or elderly relatives. While estimating these costs was beyond the scope of this study, we believed it important to highlight their existence.

I2: Indirect Mortality Costs

The mortality data used for this exercise were acquired from Statistics Canada's Vital Statistics database. These data were compiled into 99 E-code groups for the ERAT. The same economic variables extracted from Statistics Canada's CANSIM database for morbidity indirect costs were used, except they were applied to potential years of life lost due to unintentional injury as opposed to periods of disability.

Again, indirect costs associated with death due to unintentional injuries for periods when an individual was under 18 or over 65 years of age have a value of zero. Other methods could be used (e.g., willingness-to-pay), but were beyond the scope and terms of reference for this study.

CMG	Description	RIW
025	head trauma, not severe, age <70	3.8
026	head trauma, not severe, age >70	3.9
027	head trauma, severe	6.0
154	Other resp. diagnoses, age <18, w/o complic./comorbidity	1.2
155	Other resp. diagnoses, age <18, w/ complic./comorbidity	2.4
156	Other resp. diagnoses, age 18-69, w/o complic./comorbidity	0.8
157	Other resp. diagnoses, age 18-69, w/ complic./comorbidity	4.2
157	Other resp. diagnoses, age >70, w/o complic./comorbidity	4.2
158	Other resp. diagnoses, age >70, w/ complic./comorbidity	3.0
487	Cystic fibrosis, most responsible diagnosis	5.5
823	Other trauma diagnoses, w/o complications/comorbidity	1.6
824	Other trauma diagnoses, w/ complications/comorbidity	2.8

1 A joint initiative of the Ontario Ministry of Health and the Ontario Hospital Association

2 The Urban Institute Press, Washington, D.C.

3 This does not necessarily hold true for the 65+ age groups. However, this is more a measurement anomaly associated with the human capital method.

4 The CANSIM database is a comprehensive source of economic and demographic data. It covers among other things all the components of population and population change (births, deaths, migration), economic indices (GDP, price indexes, interest rates, etc.), and labour market statistics (participation rates, earnings, etc.)

5 The present value of losses incurred in the future is derived by discounting the value of future losses by a measure of the real interest rate (i.e., $10,000 thirty years from now is worth less than $10,000 today).

APPENDIX D

ELECTRONIC RESOURCE ALLOCATION TOOL (ERAT)

The Electronic Resource Allocation Tool

The ERAT (Electronic Resource Allocation Tool) consists of a series of spreadsheets designed to calculate the incidence costs of unintentional injury. The tool was created to fulfill two major objectives:

- to supply modeling and estimation techniques required to fill critical gaps in the available data in Canada

- to serve as a resource tool that can be used by researchers and public health officials at provincial and local levels to support resource allocation, policy development and decision-making.

Modeling and Estimation Techniques

While evaluating The Economic Burden of Unintentional Injury in Canada, the study researchers discovered significant gaps in data currently available. They found that detailed data are only available for deaths and injuries that result in a hospitalized inpatient stay. Injuries that are not treated in a hospital or are only treated in the emergency/outpatient department are not captured or reported through a central body. Furthermore, there is a large data gap for hospitalized injuries that require on-going care outside a hospital setting for either a short period or for a longer term of permanent disability.

Overall, the data gaps point towards two key analytical challenges:

- estimating the type, number and cost of non-hospitalized injuries
- building the full episode of care for hospitalized injuries resulting in short-term and long-term disabilities.

The analytic strategy used to address these methodological problems involved an extensive search through scientific literature to find numbers and ratios that could be used to fill the data gaps. For example, in an American study the researchers found a ratio of hospitalized to non-hospitalized injury. Since Canada has very good information on hospitalized injury available from the Canadian Institute of Health Information, the study researchers were able to apply this ratio to produce an estimate of the number and type of non-hospitalized injuries.

The ERAT: A Resource Tool

Meeting the second objective was entirely dependent on completing the first objective since the latter was essentially a test of the analytic tool at the national level. In order to enable the application of the tool at other levels, it was necessary to allow for the customization of some parameters in the analytical framework or spreadsheet to reflect local conditions (e.g., population size and mix, injury incidence, etc.) Once adjusted, the tool calculates total costs as well as costs for each injury type. The resource tool has been designed to allow for constant updating of current injury and cost information.