New Zealand Injury Prevention Strategy

Rautaki Ārai Whara o Aotearoa

Five-year Evaluation
The costs of injury in New Zealand and methods for prioritising resource allocation

New Zealand Government

Authors

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Citation

Suggested citation:

Wren, J., and Barrell, K., 2010. The Costs of Injury in New Zealand and Methods for Prioritising Resource Allocation: A background briefing paper to inform the evaluation of the New Zealand Injury Prevention Strategy. New Zealand Injury Prevention Secretariat, ACC, Wellington, New Zealand.

Acknowledgements

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Executive Summary

This paper has been prepared to help inform the evaluation of the *New Zealand Injury Prevention Strategy 2003* (the Strategy), which has been requested by the Government.

Purpose of Paper

The New Zealand Injury Prevention Secretariat (the Secretariat) has been asked to provide a comparative New Zealand total social and economic cost estimate of all injuries and the six injury priority areas respectively, and to consider the use of economic methods to inform future investment decisions in injury prevention. This paper has been developed to address these information needs. The paper reports the results of a work programme that has:

- reviewed the health economics models and associated issues that must be understood when undertaking cost of injury studies
- reviewed the published New Zealand cost of injury studies to identify the methods utilised, and the size of the cost estimates calculated for various injury events
- calculated a new total social and economic cost of injury estimate for all injuries and the six injury priority areas respectively, drawing upon the lessons learnt from the reviews undertaken
- briefly reviewed the ways in which economic methods can be used to inform injury prevention investment decisions, and made recommendations for their use in New Zealand
- drawn conclusions and made recommendations about undertaking future cost of injury work to provide both better standardisation in approach and greater cost discrimination between injury areas.

History and Usefulness of Cost of Injury Studies

Cost of injury studies have been around for approximately thirty years, and first made their appearance when major policy decisions were being made about the reform of workplace health and safety laws in the United States and Great Britain.

For policy purposes, the usefulness of cost of injury studies lies in their ability to place a monetary value on a health event of interest such as injury. This value can be used to compare the costs of the events of interest and to assess the relative benefit of investment compared to investment in something else of value.

Significant Issue Associated with Cost of Injury Estimates

A significant debate that occurs around cost of injury studies is the value attributed to the loss of a human life, or the value to be placed upon preventing the loss of a human life or a serious disabling injury. These "human costs" typically account for 50% to 70% of the total social and economic costs of injury.

Economists have developed two key approaches to valuing a human life: human capital and willingness-to-pay approaches. Of these, recent analysis of the international literature on the Value of Statistical Life (VoSL) by Access Economics (2008) indicates that willingness-to-pay stated preference or revealed preference methods dominate the literature. For many in the Health and Injury Prevention Sector, placing a monetary value on life is controversial because all human life is perceived to intrinsically have the same economic value irrespective of age, and other value systems should be applied to making investment decisions.

New Zealand VoSL Estimates

In New Zealand, the willingness-to-pay stated preference approach was first used by the Ministry of Transport in late 1990s to assess the New Zealand populations' willingness to pay for road safety prevention. From that work the Government of the day set the official VoSL for Transport Sector (comprising Road, Aviation and Maritime sectors) safety initiatives at $2 million in 1991 dollar terms; this now equates to $3.352 million at June 2008 prices, which is the price point used to calculate a human-cost estimate reported in this paper.

This Transport Sector VoSL has become widely accepted by policy makers, but a review of another Ministry of Transport VoSL survey in 1997/98, and work by BERL (2007) on behalf of the New Zealand Fire Service suggests that the official value established in 1991 for the Transport Sector may not be appropriate for other injury areas, nor even appropriate for road safety today.

Existing New Zealand Cost of Injury Estimates

While cost of injury studies have a well-established philosophical basis in welfare economics and a set of techniques to estimate costs, they are not an exact science. There is considerable debate about how costs should be categorised and what value should be placed on a human life, as well as differences in data sets over time, which all add to uncertainty around the accuracy of any given cost estimate. The review of the published New Zealand studies has exemplified this. The studies completed to date have either been focused on a specific area or made use of cost models developed for a different purpose, covered different time periods, and used different data sets to provide estimates of the frequency of the injury events. Consequently the studies are not readily comparable, nor can they be used to provide an estimate of the total cost of all injuries to New Zealand.

New Total Social and Economic Cost of Injury Estimate

The total social and economic cost of all injuries in New Zealand, at June 2008 prices, is conservatively estimated to be approximately NZ$9.7 billion, with a range from $7.4 billion to $13.6 billion, depending on the economic value attributed to a human life. Of the $9.7 billion, 53% is attributed to the human cost. The three highest cost areas are motor vehicle traffic crashes, suicide and falls, which account for approximately 63% of the total costs of all injuries. The six priority areas account for 84% of the total social and economic costs of all injuries. The estimate has been prepared by Des O'Dea, Health Economist, University of Otago, and Dr John Wren, Senior Programme Manager Research, ACC.

To calculate the costs, standard health economics methods have been used to provide robust and comparable cost estimates for each of the six priority areas. The approach is based upon calculating the number of Years of Life Lost (YLL) and Disability Adjusted Life Years (DALYs), which are then monetised using the official New Zealand Transport Sector VoSL at June 2008 prices to calculate the human cost of injuries. The economic costs of injuries have been calculated using ACC and other hospital-based data. Cost estimates for three categories have been prepared: treatment and rehabilitation; lost economic contribution; and human costs.

This new cost estimate is comparable to the $6 to $7 billion cost estimate that was originally calculated in 2002 for the External Expert Advisory Group, which informed the development of the 2003 Strategy.

The methodology used has the merits of being able to be replicated in future years in a routine manner, and to be used in cost-benefit analyses to guide injury prevention investment resource allocation decisions.

Prioritisation of Injury Prevention Expenditure

Making decisions about the economic prioritisation of injury prevention compared to other investments involves making other economic and social policy trade-offs.

Economic methods using monetised health measures can be used to undertake cost-benefit and other forms of economic prioritisation analyses at the national level to inform decisions. However, there are some significant barriers to undertaking robust analyses, including a lack of sound research about the effectiveness of many interventions in terms of the number of fatalities and serious injuries prevented by each intervention.

Alongside the use of cost-benefit studies, policy principles such as those promoted in the Health Sector on equity, effectiveness and value for money can help to inform balanced social policy decision making.

Recommendations on Future Cost of Injury Studies

It is recommended that future cost of injury studies aimed at informing national policy:

- should use a standardised approach, such as that recommended in this paper
- undertake a new study to update the official Transport Sector VoSL, and
- should robustly explore the extent to which New Zealanders place different values upon preventing fatalities and serious injuries in each of the priority areas.

Introduction

Purpose

This briefing paper is intended as a background-thinking piece to inform the evaluation of the *New Zealand Injury Prevention Strategy 2003*. The paper has several aims:

- to introduce to policy analysts and decision makers the health economic research methods and issues associated with undertaking cost of injury studies
- to present the results of a new comparative total social and economic cost of injury estimate for "all injuries" and the current six priority areas (road, work, assault, suicide, falls and drowning) respectively
- to introduce the main economic methods available to assist with making injury prevention investment prioritisation decisions – a framework for this is presented.

Background

In 2003 the *New Zealand Injury Prevention Strategy* set down the Government's vision and strategic direction for injury prevention that included the monitoring of national injury prevention strategies for six priority areas (Hon Ruth Dyson Minister for ACC, 2003). The Strategy's goals were to achieve a positive safety culture and to create safe environments. The six priority areas are:

1. motor vehicle traffic crashes
2. suicide and deliberate self-harm
3. falls
4. assault
5. workplace injuries
6. drowning.

To implement the Strategy the *New Zealand Injury Prevention Secretariat* (the Secretariat) was established in ACC in September 2003 to coordinate injury prevention activities across the whole of government. The Secretariat has overseen the preparation and implementation of three action plans covering the periods 2004/05, 2005/08 and 2008/11 (Hon Maryan Street Minister for ACC, 2008; Hon Ruth Dyson Minister for ACC, 2005b, 2005a). To aid the monitoring of progress the Secretariat commissioned a series of injury chartbooks measuring the trends over time in New Zealand's injury rates, and two small population level surveys measuring change in public perceptions about injury

prevention. The current implementation plan calls for an evaluation of the Strategy and its progress on achieving the stated goals to date.

Context to the Paper

A key component associated with evaluating the Strategy is a clearer understanding of the cost of injuries in New Zealand and what variables must be accounted for in determining these costs. Furthermore, a comparative total social and economic cost estimate is required in order to inform future national injury prevention prioritisation decisions using a cost-benefit analysis framework.

In New Zealand, the use of cost of injury studies has been accepted as one of the means of informing future injury prevention investment by the Government. However, historically government agencies used different cost methods to meet their various policy and operational requirements, as well as to inform economic and social decision making about:

- whether to invest in injury prevention, rehabilitation and compensation
- setting and evaluating outcomes and priorities for allocating resources between different injury types and population groups
- deciding who should bear the costs of injury (Department of Labour, 2004).

In addition, apart from the Transport Sector and Fire Service, little use has been made of cost-benefit analyses to inform injury prevention investment decisions at the national level. One of the reasons for this is the lack of comparative cost of injury information about what the costs are. Other barriers include a general lack of knowledge about how health economic methods such as monetising YLL and Quality Adjusted Life Years (QALYs) can be used to inform such decisions, and a lack of robust information about the effectiveness of many injury prevention interventions.

Introducing the Health Economic Methods, Terminology and Issues Informing Cost of Injury Studies

Introduction

The purpose of this section is to introduce the history of cost of injury studies, outline the main methods used to estimate the total social and economic costs of injury and the issues associated them. These points are important to understand, because they assist with understanding the wide variability that can occur across cost of injury studies and why this variability may occur in studies both now and in the future.

The key points covered in this section include:

- the history of cost of injury studies, and issues which drove the development of the methods currently used to understand the social costs of health events, such as injuries
- the types of costs which should be counted as an injury cost
- the VoSL, which is similar to and sometimes interchangeable with the term Value of Preventable Fatality (VPF), and the methods for calculating it
- how the VoSL can be used to measure health interventions
- applying an annualised VoSL in injury prevention investment decisions
- how other injury-related costs can vary between studies and over time.

Welfare Economics: The economic theoretical basis informing many cost of injury studies

Historical Background to Cost of Injury Studies

The first studies evaluating the economic costs and benefits of various health and medicine interventions emerged in the 1960s. These were followed by the first major injury cost studies appearing in the 1970s, which predominantly focused on the costs of industrial injuries, and took place in the context of regulatory reform of workplace health and safety legislation in the United States and Great Britain (Frick et al., 2000; Frick & Wren, 2000; Wren, 1997).

In New Zealand, shortly after the establishment of ACC, the first cost of injury study was undertaken in 1978 by Professor Berkowitz from Rutgers University, which focused on the

cost of work-related injuries and recommended the introduction of experience rating to set ACC levies (Berkowitz, 1979).

Internationally, the first cost of "all injury" study was undertaken by Rice et al. in the late 1980s for the US Congress, and took place in the context of debate about the need for decisions on road safety expenditure. The study was informed by the assumptions and methods employed by welfare economics (Rice, MacKenzie, Jones et al., 1989). "Welfare economics" is a branch of economics concerned with the development of principles for maximising social welfare and economic output. All subsequent cost of injury studies published internationally and in New Zealand have built upon this early body of work by Rice et al. (1989). Consequently, it is useful to have some understanding of the key assumptions, methods and terminology used by welfare economists.

Introducing Welfare Economics: Key concepts and issues

Welfare economics is a

> *"normative branch of economics concerned with the development of principles for maximising social welfare and economic output. It is based on the assumptions that individuals maximise a well-defined preference function and the overall welfare of society is a function of these preferences"* (Gold, Siegel, & Russell, 1996).

For government, welfare economics has the value of enabling policies to be evaluated in terms of their cost effectiveness for the community's well-being, in particular how well off people are, or feel themselves to be, under different sets of conditions (Gold, Siegel & Russell, 1996).

The Individual as the Main Unit of Interest and Measurement, and the Concept of Utility

The individual is the basic unit of measurement, and the welfare of society is the aggregation of individual beliefs and practices. Welfare economics assumes that individuals are the best judges of their own welfare and that people will prefer greater welfare to less welfare, and that welfare can be adequately measured either in dollars through a person's "revealed" or "stated" dollar "preference", or in terms of improved health or welfare status. An individual's preference may be researched by studying either their "revealed" buying behaviour or the monetary compensation they accept for a job, or through asking them about their "stated preference" for a particular good or service.

Welfare economists argue that individual and social preferences for a particular good or service can be stated in terms of "utility". Utility is defined as a measure of the relative satisfaction from, or desirability of, the consumption of various goods and services. A distinction is usually made between "cardinal" utility and "ordinal" utility.

A cardinal utility is defined as a utility of significant quantity either ethically or behaviourally; the utility gained can be measured and the magnitude of the measurement is meaningful. An important example of cardinal utility is the probability of achieving some target.

In contrast, ordinal utility captures only ranking and not strength of preferences. Ordinal utility theory states that while the utility of a particular good and service cannot be measured using an objective scale, an individual is capable of ranking the different alternatives available. Welfare economists commonly express utility values in units of measure called "utils". Utils are usually fictional in nature in that they are theoretically derived measures of value that are credited to a perceived level of benefit for a good or service (Gold, Siegel & Russell, 1996).

Welfare economists argue that the value of utility may increase or decrease over time, depending upon the choices made by the "rational" individual. In neo-classical economics, individual rationality is defined according to assumptions about the economic behaviour of individuals and the market they are operating in. The assumptions include: (i) people will always act in ways to maximise their own interest in the utility of the goods or services of interest; and, (ii) full information is available to enable consumers to make informed decisions. The degree to which these assumptions are true is a matter of considerable debate (Drummond, Sculpher, Torrance, O'Brien & Stoddart, 2005; Gold, Siegel & Russell, 1996).

Social Level Measures of Utility

Theoretically, by aggregating the dollar value of individual level utilities a social welfare measure can be calculated. However, there is little agreement over how individual level utilities should be combined into a social utility measure. To overcome this difficulty welfare economists have suggested the use of two types of decision-making criteria. The first is the concept of "Pareto optimality", which argues that if under the new policy at least one person is better off and no one is worse off, the policy solution represents a "Pareto improvement" and is worthy of implementation. Unfortunately, in reality such situations are rare. An alternative to Pareto optimality is to use the "compensation test" (Kaldor-Hick criterion) as an approximation of whether a "potential Pareto improvement" exists. Under the "compensation test" approach, an intervention is considered to be of benefit if the beneficiaries are willing to pay for the gains achieved by compensating those who lose at a price both will accept – assuming a mechanism for payment is available. The economic methods of cost-benefit, cost-effectiveness and cost-utility have been developed to give effect to the compensation test at the social level (Drummond et al., 2005; Gold, Siegel & Russell, 1996).

Trade-offs, Moral Hazard and Externalities

In the literature, there are several debates around issues such as the degree to which people trade off their health status utility for other goods and service utilities. For example, to what degree do people trade off paying for health insurance or a safety device or a visit to a GP in preference to paying for food and housing or recreational activity? A further topic of debate is to what degree does government welfare intervention, or regulatory frameworks, create distortions in the utility purchasing behaviour of people. For example, what effect does reducing the level of co-payment a person has to pay to receive treatment have on increasing the demand for such services, and does the increase in service provision actually result in improved rehabilitation?

Some economists argue government intervention creates a "moral hazard" that distorts individual purchasing behaviour in the market. For example, increasing workers compensation entitlements to physiotherapy treatment services, through regulatory reductions in the level of co-payment required by those purchasing the services, creates a "moral hazard" that distorts the demand for goods or services out of proportion to the benefit gained, with the result that costs are increased for little benefit (Butler, Gardner & Gardner, 1997; Butler, Hartwig & Gardner, 1997; Buttler, R.J., D.L., D. & N.M.H, 1996; Viscusi, 1983; Viscusi, 1994; Viscusi, 1996; Viscusi & Cavallo, 1994).

Another important assumption made by welfare economists is that when individuals make trade-offs about the utility value of a good or service, they are also aware of, and pay for, the full cost of their decisions. However, this is not necessarily the case because the total costs of many goods or services are "externalised" to other members of the community. This is particularly true in social welfare economies such as New Zealand, where the full cost of education, health, defence, infrastructure and other public-good services are never fully borne by the individual because the costs are shared across the whole of society (and across generations) through a range of cost mechanisms.

Typical Cost of Injury Categories, Issues and Methods for Calculating the VoSL

There are a wide range of social and economic models and factors that have been developed over the years in attempts to describe and measure what people accept as a cost of injury, what they would be prepared to pay for, and what they value. Debates that often occur in the literature regarding the cost of injury include:

- what types of costs should be counted?
- how should they be counted?
- what costs are appropriate to include in estimating total social costs?
- who really pays for the total costs – is it the individual, the employer, or the community?
- what share of the total cost should each type of payer bear?

Historically, three main injury cost categories have been used in cost of injury studies: direct costs, indirect costs and human costs (or sometimes referred to as intangible costs). In 2000, under the auspices of the Ministry of Research, Science and Technology, government agencies in New Zealand began to address these debates through an inter-agency process that led to the publication in 2004 of a Cost of Injury Matrix (Department of Labour, 2004). The matrix was intended to provide a framework to enable agencies to describe the various cost of injury categories in a way that met the competing needs of all agencies, and to provide a concise list of the types of costs associated with an injury and who pays for them.

The terms agreed by the agencies to describe the main types of injury cost categories were:

- Human costs (also known as intangible costs and measured using the Value of Statistical Life Year (VoSLY)[1] – the costs associated with the loss of life, life expectancy, quality of life, and physical and mental suffering resulting from an injury. These costs are sometimes called "intangible costs" because they tend to be very subjective and hard to measure.

- Direct resource costs – all goods, services and other resources directly consumed in dealing with the event, or in the provision of interventions aimed at preventing, limiting or compensating for the consequence of the event.

- Indirect costs – the output (resource) losses resulting from an injury event. The value of the costs arises from the person injured being unable to perform their usual activities at full effectiveness due to their premature death or loss of function.

However, in practice these categories and terms have proven to be conceptually difficult to define, and they have been used in different ways by researchers internationally and in New Zealand, which leads to confusion and impedes comparisons (Department of Labour, 2004; Gold et al., 1996; Goodchild, Sanderson & Arcus, 2003; Goodchild, Sanderson & Nana, 2002; Pezzullo, 2010).

Issues with Allocating Costs to Categories

Attempts to distinguish between direct and indirect costs have been particularly troublesome. For example, the cost of home care may be classified as a direct cost for someone who sustains a permanent disabling injury, while others might classify this as an indirect cost depending upon whether the care was provided by an unpaid family member or by a paid carer through ACC. A productivity loss may be counted as a direct cost if it is compensated for via insurance, or as an indirect cost if it isn't. This type of problem is particularly relevant in the context of weekly compensation. Using the direct and indirect distinction, the 80% compensation of lost earnings would be classified as a direct cost and the rest as an indirect cost. In policy terms, such distinctions are artificial and not particularly helpful when trying to estimate and describe the total social and economic cost of the events of interest.

In response to these sorts of problems, current international best practice is to move towards cost categories based around well-defined types of costs (Frick, Kymes, Lee, Matcher, Pezzullo, Rein et al., 2010; Pezzullo, 2010). For example, costs can be grouped into categories such as treatment and rehabilitation, lost economic contribution and human costs. This is the approach taken in preparing the new total social and economic cost of New Zealand injury estimate presented later in this report (O'Dea & Wren, 2010).

1. Full human cost calculation includes multiplying the VoSLY by the DALYs

Human Costs and the VoSL

Human costs often make up a significant percentage of the total social and economic injury cost, with a range of 50% to 70% being common (Access Economics, 2008). Human costs are typically measured through the calculation of a VoSL estimate. Internationally, VoSL estimates vary widely across studies. Reasons for this include national differences placed on the value of a human life and methodological differences in how the values are calculated.

What Does the VoSL Mean?

The VoSL is the economic value often used in current cost of injury studies to estimate the human costs of injury. The term VoSL is used because the human cost value is calculated using statistical methods and the value is applied to describe the economic value of the statistically average person in the population. More recently, the term VPF has been used internationally instead of VoSL, particularly when referring specifically to situations involving preventable fatalities – such as injuries (Mason, Jones-Lee & Donaldson, 2009).

Conceptually and methodologically the terms VoSL and VPF are similar. However VPF is more readily understandable in that it is defined as the value that people say, when asked in surveys, they would be willing to pay to prevent or minimise, by a certain level, the probability of an injury-related death or serious injury occurring to people (Iragüen & de Dios Ortúzar, 2004). In this paper, the term VPF is preferred; however, both terms are used interchangeably because of how they are used historically in the literature and policy papers.

Methods for Calculating the Value of Human Costs

Human Capital Method

The Human Capital (HC) method was the first method that was developed to quantify the human costs of an injury. In this approach, the value of a human life is related to the individual's estimated current and future economic output, valued at their market earnings and discounted for future earnings. Any lost productivity through mortality or morbidity arising from an injury results in direct and indirect costs to family members and society as a whole. In developing countries, or elsewhere if there is a large unemployment or underemployment pool, the worker may be immediately replaced, so in human capital terms there is no economic loss, although there remains the natural value of the life lost, which represents a human social cost that is not counted.

The HC method also does not measure the intangible costs of pain and suffering, or the loss of quality of life (Sanderson, Goodchild, Nana & Slack, 2007). The approach has also been criticised for underestimating the value of life of children and the elderly because it values life using market earnings, which are lower for these population groups. It has also been argued that imperfections in the labour market mean that earnings do not reflect the true contributions of a person (Dorman, 1996).

These limitations led to the development of the "willingness to pay" approaches to valuing an average human life.

Willingness to Pay Methods

The Willingness to Pay (WtP) method of valuing human life takes a different approach to the HC method. Instead of placing a price on a human life by calculating the cost to the economy of lost productivity or earnings, the WtP method puts a value on people's willingness to pay to reduce the probability of a fatality or a serious injury. A similar concept sometimes used is the "willingness to accept" approach. This approach aims to measure what people are willing to accept for a reduction in safety or health.

WtP Revealed Preference Methods

In the revealed preference method, people's preferences are measured by studying their real-world actions to pay for risk reduction. People's preferences can be measured in a range of ways. For example, by studying consumers' purchasing of safety or safer products, the price paid for land in areas that are toxic or suffer from other forms of pollution, or the level of compensation they will accept for increased risk (e.g. through higher wages) (Pezzullo, 2010; Sanderson et al., 2007).

However, there is some scepticism about the degree to which an increased product safety margin drives a purchase decision, and whether wage differentials really include a cost for the risk/safety into wages compared to other factors such as labour scarcity, union/management power relationships and knowledge of the real risks of injury by those negotiating wage rates (Dorman 1996).

WtP Stated Preference Method

The stated preference method is based upon measuring the answers of respondents to questions about the choices they would make, in a range of situations, to prevent or reduce the loss of a human life or consequences of a serious injury. The stated preference approach often gives rise to the situation where different risk events have different VoSL. For example, in New Zealand, BERL have found, in a VoSL for the New Zealand Fire Service,[2] that New Zealanders are prepared to spend less to prevent a home-fire-related fatality compared to a road-related fatality (Sanderson et al., 2007). Reasons suggested for this include that respondents believe that people have a greater responsibility and capacity to directly influence the risk of a home fire fatality occurring compared to preventing a fatality on the road, where, no matter what they personally may do, they remain at increased risk because of the actions of others.

Sanderson et al., (2007) argue that the stated preference method is preferable to the revealed preference method because it includes an implicit value for all intangible human costs, and it is also able to generate a VoSL that is directed at specific injury risks rather than a generic risk. However, the stated preference method is criticised for two main reasons.

- The estimates are generally based on relatively small population level surveys, which means there is often considerable variance around the mathematical

2. Survey size of 750 people, of whom 653 answered the questions related to estimating the VoSL for preventing a home fire related fatality compared to a road related fatality.

average (the mean) value of the VoSL, and therefore considerable uncertainty around what the true VoSL value is.

- The model relies upon capturing the respondent's hypothetical opinions and so is likely to be influenced by subjective issues associated with the respondent's perception rather than any measure of actual behaviour. In addition, survey design can have an important influence on how respondents answer questions.

Other issues associated with the stated preference approach are that the findings are difficult to validate externally, and the administrative overheads associated with traditional VoSL surveys are significant.

Despite these criticisms, in New Zealand the stated preference method is the approach that has been used to establish the official VoSL for the Transport Sector (comprising Road, Aviation and Maritime sectors), and to inform cost-benefit analyses of fire safety interventions (Department of Labour, 2004; New Zealand Government, 1991; Sanderson et al., 2007).

Using Injury Costs to Help Inform Investment Decisions

Once a cost estimate attributable to an injury event is established, the estimate becomes a key component when assessing what levels of investment should be applied through an intervention to prevent them.

Interventions can be implemented for the purpose of preventing a fatality or reducing injury severity. In these situations the VoSL can be used to calculate a monetary health measure that places an economic value on the human benefits in terms of life years saved or improved quality of life that is attributed to the proposed intervention or interventions. This can be done by using the VoSL to calculate a VoSLY, which can be used to value health impacts with health measures such as YLL, DALYs and QALYs. This approach of monetising a health benefit measure is sensitive and controversial to many in the Health and Injury Prevention Sector, who see all life as intrinsically having the same value.

YLL, QALYs and DALYs are measures developed by the World Health Organization (WHO) to estimate the burden of premature death and loss due to illness and disability in a population. This approach has been used by the New Zealand Ministry of Health to measure the health burden of various health events (Ministry of Health, 1999).

The measures were designed as one way of providing international comparisons of the effects of health events on different populations, and were not originally intended to be monetised. However, monetising health measures such as YLL, QALYs and DALYs is an accepted technique used by health economists to place an economic value on a range of health interventions. O'Dea first used the approach to prepare an estimate of the total social and economic costs of injury in an unpublished 2002 paper for the Expert Advisory Group on the development of the 2003 New Zealand Injury Prevention Strategy (O'Dea, 2002). The approach has also been used by the Ministry of Health to estimate the cost of

suicide and intentional self-harm to New Zealand society as part of the development of the New Zealand Suicide Prevention Strategy 2006–2016 (O'Dea & Tucker, 2005). O'Dea and Wren (2010) have used the same methods in the development of their new cost of injury estimates for the evaluation of the New Zealand Injury Prevention Strategy.

Understanding the Influence of Key Assumptions on Cost Estimates: The importance of sensitivity analysis

Sensitivity Analysis

Sensitivity analysis is a methodological tool used to assess the influence of key variables in shaping the size of the estimated costs of the issue of interest and the expected benefits of an intervention. This is done by changing the assumptions or decision parameters used in the cost/benefit model, and then observing how it changes the size of the cost or benefit estimate.

Key Issue – Influence of VoSL Value on Estimate of Human Costs

Given that human costs have been estimated as making up to 50% to 70% of the total social costs of injury, the VoSL value used to calculate the human cost estimate forms a crucial sensitivity analysis parameter.

Figure 1 on the following page shows the large variability around the VoSL estimates reported in New Zealand between 1991 and 2007 for road and fire fatalities (Guria, 1991; Leung & Guria, 2006; Sanderson et al., 2007). The values in the graph have been adjusted by the annual movement in the New Zealand Wage Index and to 2008 real prices. As can be seen, estimates of the New Zealand VoSL fluctuate between just over $2 million to nearly $5.5 million across the three studies cited. Consequently, depending upon the New Zealand VoSL estimate used, the estimated human costs could vary by at least 50%, which in turn significantly impacts on the total social and economic cost estimate.

Key Issue – Discount Rate

Another significant variable is the "discount rate". The discount rate is used to calculate the value in today's monetary terms of the future years of monetary loss associated with the premature YLL caused by the injury event, or expected YLL gained because of the injury prevention intervention. Discounting allows decision makers to compare and rank programmes with future costs and/or benefits against the present-day costs and/or benefits of alternative cost issues and investments.

The use of a range of different discount rates is not uncommon, and depends upon the assumptions informing the study, the cost components included in the study and the economic output of interest.

In the Health Sector there is significant debate about what the discount rate should be. Higher discount rates tend to penalise health interventions whose effects appear only over the longer term because the future returns are discounted year on year back to today's dollars. So to survive this, the future returns need to be significant compared to the investment required.

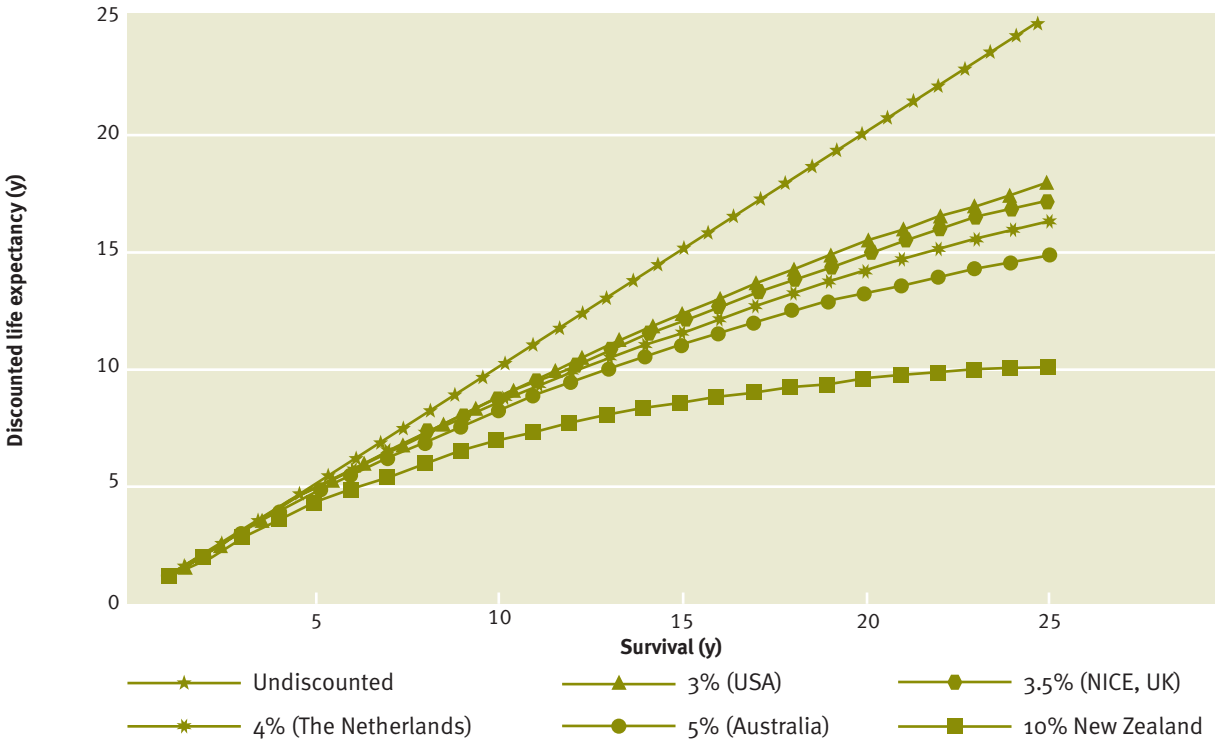
FIGURE 1: COMPARISON OF NEW ZEALAND VOSL (VALUE OF STATISTICAL LIFE) ESTIMATES FOR ROAD AND FIRE SAFETY RESPECTIVELY, ADJUSTED BY ANNUAL MOVEMENT IN THE NEW ZEALAND WAGE INDEX AND TO 2008 REAL PRICES

(Source: Data and graph prepared by O'Dea and Wren, 14 August 2008 for NZIPS.)

Internationally, the recommended health discount rates for injury prevention range between 3%, 3.5%, and 6% (Butchart, Brown, Khanh-Huynh, Corso, Florquin & Muggah, 2008; Gold, 1996; Gold et al., 1996). WHO recommends a 3% discount rate for health cost assessments, particularly for undertaking international comparisons. Current European practice is to present analyses using a range of rates from 3%, 3.5% and 6%. In 1999 the Ministry of Health used a discount rate of 3% in a study of the burden of disease and injury in New Zealand (Ministry of Health, 1999). However, the New Zealand Treasury's preferred discount rate of 8% is the default discount rate for "projects that are difficult to categorise", with a range of 6% and 10% (New Zealand Treasury, 2008).

Figure 2 on the next page shows how varying the discount rate between 3% and 10% for a health intervention changes the cumulative social economic benefit of a programme (Milne, 2005).

FIGURE 2: THE PRESENT VALUE OF SURVIVAL FOR UP TO TWENTY-FIVE YEARS, AT VARIOUS DISCOUNT RATES



(Source: Milne, R., (2005). Valuing prevention: discounting health benefits and costs in New Zealand. *New Zealand Medical Journal*, 118(1214).)

The figure shows how changing the discount rate for a health intervention, for example, preventing an infant's (i.e. less than one year of age) injury-related death through the use of a child restraint, changes perceptions about the cumulative social economic benefit of the intervention. In economic terms, using the 10% discount rate preferred by the New Zealand Treasury the estimated economic current value of social benefits of years of future life gained significantly decline after eleven years and "virtually cease … beyond 20 years". In contrast, at the 3.5% discount rate (NICE / UK) used by health economists in the UK and European Union, the current dollar value gained amounts to twenty-eight life years (Milne, 2005). In non-monetary terms, preventing the death of the infant results in eighty life years gained, which is much more than the approximate twenty years of economic gain.

As a result of the above issues, for comparisons to be made, or value of life to be understood, information about discount rates needs to be known; both have they been applied and, if so, at what rates, as variable rates can have significant impacts on present-day dollar returns.

In the new cost estimate prepared by O'Dea and Wren (2010) for the NZIPS Evaluation, a 3% discount rate was used in the calculation of their base-case estimate. However, analyses were also presented that assessed the effects of a range of discount rates from 3% to 10%, and of two VoSL estimates (the official Transport Sector value and the value reported by BERL (2007) for the Fire Service) on the cost estimates for each injury priority area and the total costs for all injuries. The authors found that higher discount rates made

little difference to the size of the total social and economic cost estimate, however, they did affect the relative rank importance of the various priority areas – in particular falls- and suicide-related injuries. In contrast to the discount rate, changing the value of the VoSL made a significant difference to the cost estimates, as would be expected (O'Dea & Wren, 2010).

Key Issue – Other Variables that Impact on Cost Estimates

The size of the cost estimate can also be affected by a variety of other issues, of which the following can make significant differences. Without consideration of these effects, injury cost estimates can be exposed to significant variation when either comparing studies that have superficially used a similar cost of injury category, or comparing figures drawn from similar studies that base their estimates on data from different years, and that have not been adjusted for change between the years being compared.

Change in Cost Values Over Time

Cost values change over time, and the prices of goods and services vary for a variety of reasons including wage demands, product and service competition, inflation, etc. Consequently, cost values for earlier years should be adjusted into current values to allow for these changes.

Counting the Incidence of Injury

Different studies typically use different administrative data sets over different time periods. For some injury priority areas, there can be significant differences between how agencies such as ACC, Police and the Ministry of Health count injury events (Cryer, 2006; Cryer, Gulliver, Langley & Davie, 2009). Snively & Coopers & Lybrand (1995) in their study of the cost of family violence in New Zealand noted that the costs could at least vary by up to five times, depending on which estimate of the incidence of assaults in New Zealand homes was used.

In the case of New Zealand health information, the national mortality and morbidity data sets routinely update previous years with new information, which means that counts of injury mortality and morbidity can change from one year to the next as annual updates of data occurs.

Counts of injury can also vary depending on the definitions used to describe an injury event and severity of injury. Different measures of injury severity can be found in a range of Police, Ministry of Health and ACC data sets. For example, the NZIPS Chartbooks use a medical-based definition for a serious injury of "6% Threat to Life" at time of hospital admission (Injury Prevention Research Unit, 2008). However, for ACC, serious injuries are those defined by a particular length of time on weekly compensation. Similarly, the incidence of injury may be measured either through only counting hospital admissions, or through hospital admissions and visits to the Emergency Department, or through ACC claims. Each can result in quite significant differences in the number of injuries counted, and the consequently the size of the cost estimate.

International comparisons, or use of international data, can be misleading as countries do not necessarily count injury events in the same way, and the price of products and services between countries can vary dramatically. It is possible for adjustments to be made to international pricing variations through the use of Purchasing Power Parity indexes[3] to adjust for differences in international currency units, and for adjustments to accommodate shifts in New Zealand prices for a wide range of goods and services using the range of statistical indexes compiled by Statistics New Zealand.

O'Dea and Wren (2010) used hospital data in their new cost estimate as the basis for counting injury events because it can be readily used to calculate YLL and DALY estimates, the injuries counted indicate a real social and economic cost of significance to the person seeking treatment, and the numbers reported are thought to be less susceptible to bias in claims reporting compared to ACC claims – particularly for minor injuries.

Summary

Cost of injury studies have been around for approximately thirty years, and first made their appearance when major policy decisions were being made about the reform of workplace health and safety laws in the United States and Great Britain. The economic methods used to cost injury have their origins in welfare economics.

The value of cost of injury studies lies in their ability to place a monetary value upon a health event of interest, such as injury. This monetary value can then be used to compare the costs of the events of interest against the costs other events of interest. The cost can also be used in other economic analyses to assess the relative benefit of investment compared to investment in something else of value.

A significant debate that occurs around cost of injury studies is the value attributed to the loss of a human life, or the value to be placed upon preventing the loss of a human life or a serious disabling injury. Economists have developed two key approaches to valuing a human life: human capital and willingness to pay approaches. In the WtP approach, three methods are used: stated preference, revealed preference, and willingness to accept. Of these, recent analysis of the international literature on the VoSL by Access Economics (2008) indicates that WtP stated preference or revealed preference methods dominate the literature.

While costs of injury studies have a well-established philosophical basis in welfare economics and a set of techniques to estimate costs, they are not an exact science.

There is considerable debate about how costs should be categorised, what value should be placed on a human life, as well as differences in data sets over time, which all add to uncertainty around the accuracy of any given cost estimate. The technique of sensitivity analyses has also been developed in the literature to test the size effects of the

3. Price Parity Points can be used to convert international currency units into an approximate New Zealand dollar unit (Schreyer & Koechlin, 2002; Statistics New Zealand, 2003, 2005)

assumptions underpinning a cost study. The aim of undertaking a sensitivity analysis is to assess the extent of variability around a cost estimate, and the degree to which various cost categories influence the size of the overall cost estimate. Apart from the VoSL, there is evidence to suggest that the discount rate used to adjust the value of future lives saved may have a significant impact upon the benefit attributed to health interventions such as injury prevention – particularly where the expected returns occur over long time periods.

Introducing the Published New Zealand Cost of Injury Studies

Introduction

The purpose of this section is outline the range of cost of injury studies that have been published in New Zealand, and to highlight the key studies and issues associated with them in the context of the points raised in the previous section.

The key points covered include:

- an overview of key/influential studies carried out in New Zealand and their findings, and
- a description of some of the issues these studies have exposed.

Appendix A outlines, in a table format, sixteen New Zealand cost of injury studies that have been published at different points in time. The studies were identified on the basis of expert knowledge of the primary author and the use of the "snowball" method. This method involves identifying a few key studies and through careful review determining further studies relevant to the topic. The table identifies the type of injury event costed (for example, road injuries, suicide, family violence, etc.), the authors of the report and year of publication, the VoSL method used, and a brief description of the range of costs reported. The cost estimates quoted are those published at the time of the report – they have not been adjusted to current dollar values.

Careful reading of the table shows that there is considerable variability within and between the studies about the cost of injury events, of the methods used to estimate the number of injury events occurring of interest, of different cost categories, of the methods to measure the human costs, and in reference to different time periods. For example, the study by Scuffham, Chalmers, O'Hare & Wilson (2002) on general aviation injuries highlights the size of effect of using the WtP approach compared to the HC approach. The WtP approach resulted in a cost estimate 3.5 times higher than the HC approach. The study by Snively et al. (1995) highlights that the cost estimate of family violence could be three to five times higher depending upon the assumptions about what the real incidence of family violence is in New Zealand. The cost of suicide study by O'Dea & Tucker (2005) noted that the "error range" (i.e. sensitivity) of the estimates could vary by plus or minus 25%. Ministry of Transport research on the VoSL has produced two separate mean estimates for the road safety VPF that differ by $2 million dollars.

Key Studies

Four key studies have been identified as important when considering cost of injury estimates in New Zealand. The studies are important because either they have been

influential in informing other New Zealand cost studies over time, or they illustrate the use of a particular economic method to cost injuries in a specific setting, or they provide New Zealand evidence for other findings reported in the international literature on the VoSL.

The Official New Zealand Transport Sector VoSL: Calculating human costs of Transport Sector injuries

In order to establish the total social costs of motor vehicle crashes, in 1989/90 the New Zealand Ministry of Transport (MOT) undertook a population level survey that included questions about people's willingness to pay for road safety compared to other health events (Miller & Guria, 1991). Of all the New Zealand cost of injury studies to date, this study has been one of the most influential.

Prior to this, the HC approach had been used to cost injury, however, the approach was no longer considered appropriate given its limitations, and internationally other road safety jurisdictions, such as Australia, the United Kingdom and the United States, had begun to use the WtP approach in their policy development and decision making (Guria, 1991; Guria, 1990; Miller & Guria, 1991).

The survey asked respondents to rank the comparative importance of reducing by "10 deaths" road safety fatalities in relation to drowning and work accidents, heart attack, and cancer-related fatalities", and to indicate the amount they were prepared to pay to reduce the risk of a road-related fatality to a family member. Five-hundred and sixty-eight responses were included in the analysis of the VoSL questions. Analysis of the results found:

- the most important fatalities to reduce were road deaths (45.9%), cancer (28.0%), work (4.6%), heart attack (4.5%) and drowning (2.4%)
- there was a willingness to pay, in 1990 prices, in the range of $1.4 million to $2.3 million (95% CI) with a mid-point of $1.9 million (1990 prices) for the prevention of road fatality to a family member
- less willingness to pay for the elderly
- 35% of respondents were willing to pay a small amount for increased "public safety" to others
- there was no difference in the stated willingness to pay between different demographic groups (age, sex and ethnicity)
- those with a higher income, those living in urban areas and people with small families were found to place a higher value on prevention of a fatality and injury than those with large families and low incomes

- the VoSL found was consistent with, but at the low end of, the range reported in the international literature
- on average respondents thought it was worth spending the same amount of money on preventing thirty serious injuries as it was to prevent one death
- the value of preventing a very serious disabling head injury was the same as preventing a death (Miller & Guria, 1991).

Based upon the survey results, in 1991 the Government set the VoSL for all Transport Sector safety evaluations at $2 million (New Zealand Government, 1991). Since that decision, the figure has been adjusted annually by indexing the original value to movements in New Zealand average hourly earnings (ordinary time). The current VoSL value is $3.352 million at June 2008 price levels (Ministry of Transport, 2008).

The publication of the official Transport Sector VoSL in 1991 formed a pivotal point in injury costing in New Zealand, and the value it arrived at has been cited and used as a benchmark in all subsequent New Zealand cost of injury studies (Access Economics, 2006; Guria, Jones, Jones-Lee, Keall, Leung, & Loomes, 2003; Leung & Guria, 2006; Miller & Guria, 1991; New Zealand Institute of Economic Research, 2008; Price Waterhouse Coopers, 2008; Sanderson et al., 2007; Scuffham et al., 2002; Snively et al., 1995; Taylor & Scuffham, 2002). As a consequence, the official Transport Sector VoSL has become the de-facto official VoSL for all injury events, even though the research evidence suggests that the people place different values on preventing some injury events over others.

A repeat of the 1989/90 survey was undertaken by the MOT in 1997/98 to update the road VoSL, and measure WtP for the prevention of "serious" and "minor" injuries (Guria et al., 2003; Ministry of Transport, 2006). The analysis found a WtP higher than the original 1989/90 survey, with a new mid-point which approximates $5.6 million at June 2008 prices compared to the official value of $3.352 million.

Analysis of the results also found that a WtP for preventing a serious injury to be between 7% and 13% of the VoSL, and for minor injuries 0.4% of the VoSL (Guria et al., 2003; Ministry of Transport, 2006). Based on this, and the earlier survey work, since 2006 the social cost and value of preventing road-crash- related "serious" and "minor" injuries has been set at 10% and 0.4% of the VoSL respectively (Ministry of Transport, 2006).

Serious injuries are defined by the Ministry of Transport as those recorded on Police Traffic Crash reports as likely to involve a hospitalisation, while minor injuries are those thought not to result in a hospitalisation by the attending police officer. However, there is very good research showing that recording injury severity in this manner is not a reliable indicator of actual medical injury severity. In addition, research has shown that the length of stay in hospital has little relationship to injury severity (Cryer, 2006; Cryer, Gulliver, Langley & Davie, 2009; Ministry of Health, 2007).[4] This research clearly indicates that

4. For these reasons, the Secretariat has funded the development of the injury chartbooks, which use a medical diagnosis method to count the number of severe injuries, which are defined as those involving a "6% Threat to Life".

the Ministry of Transport approach should be revised to reflect current understanding of administrative data sets and the statistical methods now available to agencies.

Work Related Disease and Injury (NOHSAC) (Access Economics, 2006)

The first comprehensive total social and economic cost estimate of workplace injury and disease was prepared in 2005 by Access Economics under contract to the New Zealand National Occupational Health and Safety Advisory Committee (Access Economics, 2006). NOHSAC commissioned Access Economics to undertake quantitative estimates of the economic and social costs of occupational disease and injury in New Zealand. The researchers drew upon earlier NOHSAC reports to provide information about the incidence of work-related disease and injury in New Zealand and upon other government agency research into a framework for undertaking cost of injury studies (Department of Labour, 2003, 2004; Driscoll, Mannetje, Dryson, Feyer, Gander, McCracken & et al., 2004).

This work is important because it is the first comprehensive cost estimate of work-related injury and disease; it is also notable because of the non-use of the Transport Sector VoSL to estimate human costs. The authors used a 3.8% discount rate.

Access Economics estimated that the total social cost of workplace injury and disease was $20.9 billion for the March 2004/05 year. These costs were split into two principal categories: economic (financial costs) and non-economic costs.

The non-economic cost (i.e. human cost) was based upon a VoSL of $3.9 million, and a discount rate of 3.8% over forty years. The VoSL was not based upon the New Zealand Ministry of Transport study, rather it was informed by the review work by Viscusi & Aldy (2003) of international VoSL studies that have used the WtP revealed preference method. The discount rate was based on analysis of long-term returns on ten-year New Zealand government bonds and adjusting for inflation. While this approach is consistent with the literature on setting discount rates, and it is in the region recommended by international health economists, it is significantly less than that preferred by the New Zealand Treasury.

Questioning the Applicability of the Official Transport Sector VoSL to Drowning and Home-fire-related Fatalities

In keeping with the theoretical underpinnings of the WtP approach to estimating the value of human life, there is New Zealand research that suggests the application of the official Transport Sector VoSL to other injury areas may not be appropriate. This research suggests that the New Zealand population places different dollar values upon preventing the loss of human life depending upon the type of injury event. Comparisons between road-, drowning- and home-fire-related injuries are available.

The original Transport Sector VoSL survey found respondents rated the importance of preventing a drowning fatality at 2.5%, compared to preventing a road fatality at 45.9% (Miller & Guria, 1991). This suggests that a significantly lower VoSL value might be applied to estimating the value of preventing human loss due to drowning events compared to road injuries.

Similarly, a 2007 VoSL survey for the New Zealand Fire Service found that there was a statistically significant preference for saving lives from road injuries compared to home fire injuries (Sanderson et al., 2007). When asked how many of twenty lives to be saved from a safety intervention they would prefer to be saved from reduced car and fire accidents respectively, the respondents average preference was for 12.4 lives to be saved from road injuries and 7.6 from fire. This suggests a VoSL relativity ratio for preventing a home fire fatality of 56% to 62% of the road safety VoSL. The value was found to be consistent with, but at the low end of, fire-safety-related values reported in the international literature, particularly Great Britain. As a consequence, Sanderson et al. (2007) recommended to the New Zealand Fire Service that for cost-benefit assessment purposes the VoSL for preventing a home-fire-related fatality should be set at two-thirds the official Transport Sector VoSL.

One explanation, consistent with the international literature on VoSL estimates, suggested by Sanderson et al. (2007) for the lower home fire VoSL was that respondents perceive the level of home fire fatality risk as being lower and more controllable by home owners compared to fatality risks to motor vehicle drivers.

The same rationale could be applied to drowning. For example, if it is perceived the risk of a drowning fatality to family members and others can be minimised by taking individual responsibility for swimming at lifeguard patrolled beaches and between the flags, or by wearing life jackets and not consuming alcohol when on the water, people may be willing to pay less to reduce such risks compared to the perceived risks of driving on the road.

Conceivably, one implication of this is that a more appropriate VoSL for drowning might be the home fire VoSL, which would mean the total social cost of drowning would be significantly reduced. The same rationale could be applied to suicide and assault, which are formally classified as “intentional injuries” as opposed to “unintentional injuries”. However, to justify such an approach, a new VoSL survey should be undertaken to identify the choices people would make in a range of situations.

Total Cost of All Injuries to New Zealand: New Zealand Institute of Economic Research (2008) Estimate

In spite of the range of studies undertaken, there had been no published estimate of the total social costs of “all injuries” to New Zealand, until 2008. In 2008 the Secretariat commissioned the New Zealand Institute of Economic Research (NZIER) to provide a “scoping” estimate of the social cost of “all injuries” and the costs of each of the six priority areas in the Strategy.

In response to the request, NZIER prepared a rudimentary set of estimates that divided the total social costs into two cost categories: direct costs and indirect costs. NZIER used the official Transport Sector VoSL, and Ministry of Transport traffic cost methods to apportion the indirect costs of fatalities and injuries respectively. The incidence of injury was estimated using ACC claims data and Ministry of Health hospitalisation data. Using this approach, NZIER estimated that the total social cost of “all injuries” to New Zealand in 2006 was approximately $60 billion, of which $3 to $3.5 billion were direct costs (New

Zealand Institute of Economic Research, 2008). Of these costs, the human costs of injury accounted for 90% to 95% of the total costs.

The report is important because it is the first published report of the cost of "all injuries". It is also important for illustrating how wide cost of injury estimates can be, depending how key variables are counted.

In contrast to the NZIER estimate, an unpublished 2002 estimate of the total social and economic costs of injury by O'Dea, for the Expert Advisory Committee advising on the development of the Strategy, found that the total social and economic costs of injury was between $6 and 7 billion dollars in 2002 prices. In developing this estimate, O'Dea used the official Transport Sector VoSL to calculate a monetised YLL estimate of the cost of "all injuries" and for the proposed six injury areas respectively. In addition, a 3% discount rate was applied to the YLL values, and used the frequency of hospitalised injury events to count the number of injuries occurring. In comparison, the NZIER scoping estimate valued all fatalities as the same irrespective of the age of death, did not apply any discounting, and used a mix of hospitalisation and ACC claims data to count the number of injury events occurring. In addition, no comment was made as to why the size estimates reported by NZIER for the cost of suicide- and work-related injury differ significantly from those reported by O'Dea & Tucker (2005) and Access Economics (2008), or that the cost of assault was of the same size as that reported in the mid-1990s by Snively et al. (1995) and Fanslow et al. (1997). The comparison between approaches highlights the very significant cost difference that can occur between studies depending upon the methods used.

Summary of New Zealand Studies

The history of cost of injury studies in New Zealand reflects the history and issues associated with undertaking cost of injury studies outlined earlier. Many of the studies were undertaken in periods when policy debate was taking place about the injury event of interest.

The first cost of injury study appeared in 1978 and examined the cost of workplace injuries; it used the HC approach to estimating the human costs of injury. This approach is a feature of estimates of workplace injuries.

Following the use in the late 1980s by the Ministry of Transport of the WtP (stated preference) approach (Miller & Guria, 1991), and the official setting of the VoSL for all Transport Sector safety evaluations at $2 million in 1991 prices, the Transport Sector VoSL has become the de-facto VoSL in many subsequent cost of injury studies.

However, a review of the literature suggests that the 1991 Transport Sector VoSL may not be appropriate for other injury areas or even appropriate for road safety today as it was estimated more than twenty years ago. The international research clearly suggests that VoSL values are highly susceptible to a range of factors, including methodological differences in how they are calculated, the wealth of the population, normal change over

time, and the populations understanding and perceptions of the risks associated with the events of interest, as well as the level of individual responsibility and ability to minimise the risks.

Cost of injury estimates are highly volatile, depending on the VoSL estimate used, and other factors such as the choice of discount rate and estimate of the frequency of injury events of interest. Other factors that influence the size of the cost estimates include whether a monetised health measure was used that allows for the different experiences of age groups in the population. These can significantly influence the cost estimates associated with particular injury events or population groups and the value of interventions – for example, children, the elderly and falls. Options exist to accommodate age variations through the use of YLL and DALY approaches, but in many instances this approach has not been used for a variety of reasons.[5] For these reasons, cost of injury studies should include a sensitivity analysis that tests influence of key assumptions – however, they rarely do.

5. Reasons could include a lack of understanding about how to calculate such health measures such as YLL, DALYs and QALYs; philosophical resistance to placing a monetary value on health measures; and lack of knowledge or resistance to using a different VoSL other than the Transport Sector value for other injury events.

New Total Social and Economic Cost Estimate of "All Injuries" and Each of the Six Priority Areas Respectively

Introduction

Des O'Dea, Health Economist, University of Otago, and Dr John Wren, Senior Programme Manager Research, ACC, have prepared a new estimate of the total social and economic costs of all injuries and the six national priority areas comprising:

- road injuries – motor vehicle traffic crashes
- suicide and intentional self-harm
- falls
- assault
- workplace
- drowning

The estimate has been designed to address many of the issues raised in this paper about previous New Zealand cost of injury estimates.

In 2008 the Accident Compensation Corporation (ACC) spent in the order of $2.5 billion on injury treatment and rehabilitation, income maintenance, and other benefits and support. However, ACC spending is not the largest part of the burden of injury. The largest component is the human cost. That is YLL because of premature mortality from injury and the effects of injury-caused disability on quality of life. DALYs are the measure used in this estimate to combine these two consequences. The value of the DALY is based on the official Transport Sector VoSL and a 3% discount rate.

O'Dea & Wren uses an injury incidence approach, utilising information from Ministry of Health and ACC statistics. Because a monetised health measure (DALYs) has been used, the results can be made use of in future cost-benefit studies about the prioritisation of investment in injury prevention.

It should be noted that using the monetised DALY approach as the basis for financial investment decisions is not necessarily well supported across the Health and Injury Prevention Sector. The debate centres not on the acceptance of measuring increased life years but whether these years should then be costed and priced against other investments. However, the monetised approach does provide a means of guiding

investment decisions and tends to weight investments in favour of maximising life years gained rather than generically reducing lives lost. While cost-benefit analysis has historically not been widely used in the Health Sector, cost effectiveness is an alternative that has been used in the Health and Injury Prevention Sector. For cost effectiveness to work, a benchmark or threshold is required to ascertain what is cost effective or not. The VoSL can provide such a benchmark, and it commonly relates well to WHO's recommendation for three times per capita domestic product as a suitable return[6] (Pezzullo, 2010).

Sensitivity analysis has been undertaken that tests the influence of key assumptions about the VPF (i.e. VoSL), which is used to place a monetary value on a DALY, and different discount rates. Three cost estimates are presented derived from a base case using the Official New Zealand Transport Sector VoSL, and a high and low estimate using the other New Zealand VoSL estimates reported by BERL in 2007 for the fire service and the Ministry of Transport in 1997/98 respectively.

The full technical report is available as a separate report. Access Economics in Australia, the NZIER, and the Ministry of Health have subjected the analysis to external peer review.

Key Results

In 2006 there were 1,681 injury-related deaths, and in 2008 there were 9,865 first admissions to hospital for "serious non-fatal" injuries, and of the order of 60,000 first admissions for "non-serious" injuries. Many more injuries did not require hospital treatment but did require care from other health-care providers.

Total Social and Economic Cost

The total social and economic cost of all injuries in New Zealand, at June 2008 prices, is conservatively estimated to be approximately NZ$9.7 billion, with a range from $7.4 billion to $13.6 billion depending on the economic value attributed to a human life. The $9.7 billion figure represents the base-case estimate, which uses the official Transport Sector VoSL to measure human cost and a 3% discount rate.

Of the $9.7 billion, 53% is attributed to the human costs of injury. The three highest cost areas are motor vehicle traffic crashes, suicide and falls, which account for approximately 63% of the total costs of all injuries. The six priority areas account for 84% of the total social and economic costs of all injuries.

Table 1 on the following page summarises the cost contribution of each cost category to total costs for each priority area and all injuries. The numbers are the base-case estimates for the total social and economic cost of injury in New Zealand at June 2008 prices.

In the table, treatment and rehabilitation costs of $1.4 billion represent the economic costs for the purchase by ACC of these services.

6. http://www.who.int/choice/costs/CER_thresholds/en.index.html

The lost economic contribution cost of $2.07 billion has two components, approximately equal in size. The first is lost production from those still suffering consequences of their injury and not yet able to return to paid employment. This is estimated as 125% of Income Maintenance payments by ACC (which are based on 80% of employment income before suffering injury). The second component is the lost future economic contribution of those who die because of their injury.

The final component, the human cost of $6.2 billion, is worked out by first calculating the DALYs incurred from premature mortality and from disability associated with injury. The second step is to place a value of NZ$150,000 on each DALY. Justification for this is given in the detail of the technical report. In brief, the value of a life year is linked to the official VPF (or VoSL) used in the Transport Sector, and derived from WtP surveys. The VPF in 2008 dollars is $3.35 million.

TABLE 1: SUMMARY TABLE – INJURY COSTS BY COST CATEGORY AND PRIORITY AREA. BASE-CASE ESTIMATE USING THE OFFICIAL TRANSPORT SECTOR VPF, 3% DISCOUNT RATE, NZ $ JUNE 2008 PRICES

Priority Area / Cost Category	Treatment and Rehabilitation	Lost Economic Contribution	Human Costs	Total Social and Economic Cost	% of Total Social & Economic Cost – All Injuries
Assault	$2.5	$49.5	$327.5	$379.6	4%
Falls	$535.7	$270.8	$928.7	$1,735.2	18%
Drowning	$0.8	$48.2	$246.4	$295.5	3%
Motor Vehicle	$253.5	$464.5	$1,477.0	$2,195.0	23%
Suicide/Self-harm	$1.6	$380.1	$1,787.4	$2,169.1	22%
Workplace	$349.5	$640.3	$357.8	$1,347.5	14%
Subtotal – Six Priority Areas, $ millions, (Excl. GST)	$1,143.6	$1,853.5	$5,124.8	$8,121.8	84%
Estimated "Non-priority" Cost, $ millions (Excl. GST)	$251.7	$216.6	$1,087.1	$1,555.4	16%
All Injuries, $ millions (Excl. GST)	$1,395.2	$2,070.1	$6,211.9	$9,677.2	100%

(Source: O'Dea, D. and Wren, J. (2010). New Zealand Estimates of the Total Social and Economic Cost of "All Injuries" and the Six Priority Areas Respectively, at June 2008 Prices: Technical report prepared for NZIPS. Accident Compensation Corporation, Wellington, New Zealand. 16 February 2010.)

Rank Orders for the Priority Areas

The "rank order" of the different priority areas in terms of total cost is shown by comparing the percentages in the summary table. First comes motor vehicle traffic crashes, followed by suicide, followed by falls, and then workplace injuries.

The human cost component is influential in determining this rank order. It will be observed that workplace injuries, and also falls injuries, rank highly or relatively highly for the first two cost components, but less so for human costs, particularly for workplace injuries. This is because actual fatalities from workplace injuries are relatively low, at 88, compared with (in 2006) more than 500 from suicide, and nearly 400 for each of falls and motor vehicle injuries. (The precise numbers are given in the report).

The relatively low ranking of falls in the final column has a different cause. Although fatalities are relatively high in number, these occur much more among the aged than do fatalities from other causes of injury.

This means that a relatively much smaller number of life years are lost because of falls-caused fatalities, than is the case for other causes of injury, and, consequently, this lowers the human cost. A measure of human cost based on the value of a life rather than the value of a life year, or DALY, would see a considerably higher cost total for falls.

Sensitivity Analysis: Influence of key assumptions

Sensitivity analysis tests for the influence of key cost assumptions upon the size of the cost estimate. The sensitivity analysis for this estimate shows that the choice of VPF has a significant impact on the total cost estimate. Depending upon the VPF chosen, either a lower estimate based upon the BERL (2007) results (i.e. $2.2 million) for home fire injuries or an upper estimate based upon the 1998 Ministry of Transport survey results (i.e. $5.7 million), the base estimate total costs either reduces by 23% or increases by 41% respectively. This variation results in a total social and economic cost range from $7.4 billion to $13.6 billion, around the base case $9.7 billion.

In contrast to the choice of VPF, the choice of discount rate has very little influence on the total cost; however, it does influence the rank order of the six priority areas. For the higher 8% and 10% discount rate cases, falls move from ranking third behind motor vehicles and suicide to first place. This shifting in rank is explained by the fact that most falls fatalities occur in the older age groups. This means the remaining average YLL are considerably smaller than for other categories. Consequently, a higher discount rate has less impact on these nearer-term lost life years than it does on the longer-term lost life years for other categories.

Cost-benefit Evidence for Injury Prevention Investment

Introduction

This section:

- briefly summarises the available cost-benefit evidence for a range of injury preventions
- introduces the three major economic decision-making tools available to assist with decision making about injury prevention investment, at the national and government agency levels respectively, and their applicability to injury prevention
- proposes a prioritisation framework for making injury prevention resource allocation decisions from a national perspective that combines the use of economic cost-benefit analysis with three policy principles adopted from the Health Sector.

Why Prioritise Injury Prevention Interventions, and What Are the Policy Trade-offs?

From the New Zealand Treasury perspective, because the public sector is a major user of economic resources, there is a need to ensure that any proposal for government intervention clearly sets out the business case for investment (New Zealand Treasury, 2005). One tool for doing this is cost-benefit analysis.

In the Health Sector, economic prioritisation is about making decisions about what health and disability services or interventions to fund, within the resources available (Health Funding Authority, 2000). Prioritisation is also about managing existing services effectively.

Underpinning the need for economic cost-benefit analysis are the assumptions that resources are finite, and investment in one activity imposes an opportunity cost on other social and economic investments. The following two examples illustrate the social and economic opportunity cost trade-offs that occur in injury prevention.

Road Safety Example

Lowering speed is an effective road safety intervention that reduces the risk and severity of road-related injuries and associated costs. However, the trade-off is increased travel times, which have other economic and social costs.

Child Safety Example

Lowering the heights of forts in playgrounds is known to reduce the risk and severity of a serious fall injury. However, it can be argued the trade-off is that the intervention is possibly detrimental to children's physiological development, and limits their outdoor life experience, which has some importance to many New Zealanders.

Ideally, investments should only be made in the opportunities that maximise economic and social return. In order for this to occur, the New Zealand Treasury expects that any proposal for government intervention clearly sets out:

- what the problem is
- what the outcomes sought are
- why government should intervene
- what options exist to address the problem, and
- of the options available, which ones are likely to return the greatest benefit for the cost involved from a national perspective (New Zealand Treasury, 2005).

Evidence for the Cost Benefit of Different Types of Injury Prevention Intervention

There are a limited number of cost-benefit and -effectiveness studies of injury prevention interventions in the research literature. In New Zealand, the best cost-benefit studies are in road and fire safety, where there has been considerable and sustained research investment over time by the responsible government agencies.

In general, engineering, enforced regulation and comprehensive targeted safe community programmes work, along with programmes that are well informed by research evidence about the causes of the injury event of interest, target the most at-risk population groups, and are well planned and implemented (Dowswell, Towner, Simpson, & Jarvis, 1996; Miller & Levy, 2000; Miller, Romano & Spicer, 2000).

Miller & Levy (2000) in their review of eighty-four injury prevention interventions found half returned a positive cost benefit. They concluded that injury interventions can reduce medical costs and save lives, and that wider implementation of proven measures is warranted; however, there is also a need for significant research investment in assessing the effectiveness of interventions in a wide range of injury prevention areas because the evidence is missing (Miller & Levy, 2000; Miller et al., 2000).

Economic Methods Available to Assist with Prioritisation Decisions

Effectiveness can be measured in a number of ways: cost-benefit analysis (CBA), cost-effectiveness analysis (CEA) and cost-utility analysis (CUA). Each of these has their uses for injury prevention. Of these three methods, the New Zealand Treasury expects that any funding proposal that affects all sectors of the economy should be subjected to an "economic cost benefit analysis", which adopts a "national perspective rather than a government or departmental perspective" (New Zealand Treasury, 2005).

Table 2 below outlines how each of these methods can be used as an injury prevention investment decision-making aid.

TABLE 2: COMMON TYPES OF ECONOMIC PRIORITISATION METHODS AND ASSOCIATED UNIT OF MEASURE, AND OUTCOME EFFECTS ASSESSED OF THE INTERVENTION

Type of Economic Method and Measurement Approach	Measurement / Valuation Method of Intervention Outcomes / Benefit	Measurement / Valuation Method of Intervention Costs	Outcome Effects Assessed
Cost-benefit Analysis	Dollars	Dollars	Single or multiple effects, not necessarily common to alternatives being assessed
Cost-effectiveness Analysis	Natural units (e.g. life years gained, disability days saved, number of injuries reduced, etc.)	Dollars	Single effect of interest, common to both alternatives, but achieved to different degrees
Cost-utility Analysis*			
	Health years (typically measured as QALYs)	Dollars	Single or multiple effects, not necessarily common to both alternatives being assessed

(Source: Adapted from Drummond, Sculpher, Torrance et al., 2005.)

*Sometimes seen as a subset of cost-effectiveness analysis.

Cost-benefit Analysis (CBA)

Cost-benefit analysis is an economic method for estimating in dollar terms the anticipated total social benefit gained, less the total social cost of the proposed intervention (Gold et al., 1996). From the New Zealand Treasury perspective there are three key forms of CBA available to policy analysts and decision makers in government: economic, financial and fiscal.

Economic CBA is the broadest form, and is the one most applicable to national level investment decisions. Financial CBA is applicable at the organisational level, and fiscal CBA is appropriate for Cabinet paper funding proposals.

Economic CBA

Economic CBA is the broadest form of economic analysis. The aim of an economic CBA is to estimate the total social costs and total social benefits of an intervention to the nation, irrespective of who pays or benefits individually or as an economic sector from the intervention (Drummond et al., 2005; Gold et al., 1996; New Zealand Treasury, 2005).

In economic CBA, all costs and benefits are measured in dollar terms. The results of the analysis are always expressed as having either a positive or negative dollar value.

Where the costs and benefits of a programme accrue over several years, the future dollar value of the costs and benefits has to be adjusted to reflect current dollar values. When this is done the benefit is expressed in terms of "net present value" (NPV). The NPV is the sum of the incremental net social benefit over the time of the intervention, less the incremental net social cost over the same period (Drummond et al., 2005; Gold et al., 1996).

Undertaking the adjustment is important because, generally, people place more value on receiving the good or service now than in the future, and choices between options are made based on the current value of the goods or services.

Interventions with a high positive NPV are typically prioritised over those with a lower or negative benefit, because the calculation suggests they add more economic value compared to other options.

Economists argue that such allocation of decision making offers the opportunity to make the most efficient use of limited economic resources.

Financial CBA

In contrast to economic CBA, financial CBA takes a narrower perspective and focuses only on the benefit and costs of an intervention to the organisation directly concerned. An example of where this approach would be appropriate is for prioritising agency specific injury prevention programmes – for example, ACC injury prevention programmes targeting injuries associated with poor return to work rates or high levy costs.

Fiscal CBA

Another type of cost analysis is fiscal CBA. This form of analysis is required for Cabinet papers requesting approval of new funding (New Zealand Treasury, 2005). Fiscal impacts/costings and economic CBA differ in four key respects:

- economic CBA includes effects on all sectors of the economy, while fiscal costings focus upon the government sector only
- economic CBA uses discounting and often looks beyond the five-year horizon that is reported in the Crown financial statements

- economic CBA reflects real resource use, while fiscal costings can include resource transfers and accounting items such as depreciation and capital charge
- economic CBA does not distinguish between capital and operating costs (New Zealand Treasury, 2005).

Cost Effectiveness Analysis (CEA)

In contrast to CBA, health-based cost-effectiveness studies often use non-monetary measures (i.e. natural units) to quantify the benefits of the intervention (such as number of injuries prevented or QALYs).

Where natural measures are used, it is assumed that all the units are of equal intrinsic value and are worth saving in their own right. The result of a CEA is typically presented in the form of a ratio of cost per unit saved/gained (for example, $1000 cost for each injury-related hospital admission prevented, or $10,000 cost for preventing one YLL). From such an analysis, an assessment is made about which intervention is more effective compared to the alternatives (Drummond et al., 2005; Gold et al., 1996).

Cost Utility Analysis (CUA)

CUA is used interchangeably with CEA, or is seen as a special case of CEA. In health-related CUA studies, a comparison is made between different interventions using a common measure that may or may not be monetary based (for example, a QALY). The results of the analysis are expressed by the ratio between the cost of a health-related intervention and the benefit it produces in number of years lived in full health by recipients of the benefit (e.g. cost per QALY). In this form of analysis, CUA is a more sophisticated version of CEA and CBA; however, it does consider wider social costs and benefits, and it is quite difficult to undertake because QALY estimates for many health conditions do not exist (Drummond et al., 2005; Gold et al., 1996).

How Useful are Economic Methods to Inform Injury Prevention Prioritisation Decisions?

Making sound investment decisions using tools such as CBA requires accurate estimates of the costs of injuries and the benefits of their reduction (Fischhoff, Furby, & Gregory, 1987).

Good cost-benefit or -effectiveness analysis for injury prevention depends upon being able to estimate the size of the predicted reduction in number of fatalities/hospitalisations or other desired outcome, and the degree to which:

- X intervention will reduce fatalities by Y amount
- Z intervention will reduce fatalities by T amount

- B intervention will result in a positive shift in safety culture by A amount.

However, as outlined above, with the notable exception in New Zealand of road and fire safety, robust evidence is lacking to inform the above variables.

The concept of CBA is attractive and appears simple. In practice, constructing plausible measures of the costs and benefits of specific actions is often very difficult and controversial for non-economists. It is particularly problematic for health programmes such as injury prevention when attempting to place a dollar value on the lives saved or improvements made to the quality of life. For example, what dollar value should be placed on preventing the loss of a child's life in a road crash compared to that of an older person? Is the value of preventing a loss of a life in a home fire worth more or less than preventing the loss of a life from a road crash or a suicide? Is the value of preventing a fatality, the same as preventing a serious injury such as a disabling brain injury? In addition, injury prevention interventions with long time periods before expected return will tend to rate poorly compared to other interventions and social expenditure opportunities with shorter periods of return. These sorts of questions have been well addressed by economists in the road and fire safety areas, where a lot of research has been done over time to address the issues. It is not clear, though, whether the solutions for those areas are equally applicable to other injury areas.

Consequently, a number of leading economists have concluded that:

- "Economic analysis can inform an injury policy debate, but it cannot provide conclusive answers, nor can it serve as a substitute for the political decision-making process" (Warner, 1987).

- "Benefit-cost ratios and cost per QALY saved are helpful guides, but other factors – notably political feasibility, government cost, and overlapping effects – become relevant in the selection of a package that yields the maximum safety gains at the lowest possible price" (Millar & Levy, 2000).

- "Cost-effectiveness estimates are a decision aid, not a decision rule" (Grosse, Teutsch, & Haddix, 2007).

Policy Principles and CBA

One way to address the above issues is to combine policy principles with the use of economic methods. Both the Ministry of Health and Land Transport New Zealand have used this approach to inform decision making. Table 3 presents the principles each agency has used in the past. Either approach could be relevant to injury prevention.

TABLE 3: PRINCIPLES OF FUNDING PRIORITISATION USED BY MOH AND LTNZ

Principles of Funding Prioritisation	
Ministry of Health	Land Transport New Zealand
Effectiveness – Extent programme produces desired health outcome	Seriousness and Urgency – Clarity about problem being addressed. Importance of problem in relation to relevant strategy
Urgency of problem in relation to other problems	
Equity – Extent programme reduces disparity on health status and/or health service experience	Effectiveness – How well does proposal address the problem? Is it the best option? How well is it integrated with other initiatives? Is it a sustainable solution?
Value for Money – Extent programme represents best value for effectiveness and equity possible (Health Funding Authority, 2000; Ministry of Health, 2005)	Efficiency – Consider monetised and non-monetised benefits; national economic costs and costs to public sector

Conclusions and Recommendations

Conclusions

Cost of injury studies have a well-established philosophical basis in welfare economics and a set of techniques to estimate costs; however they are not an exact science.

There is considerable debate about how costs should be categorised and what value should be placed on a human life, as well as differences in data sets over time, the sensitivity analysis applied and discount rates used. Variations in the use of all these factors, has resulted in considerable variation both nationally and internationally in the assessment of what the total social and economic cost of injury is. The same is true for applying economic prioritisation methods to injury prevention.

The most influential cost of injury study in New Zealand was completed by the Ministry of Transport in the late 1990s, which set the official VoSL for transport safety initiatives at $2 million in 1991 dollar terms, which in June 2008 prices equates to $3.352 million. This VoSL has become widely accepted by policy makers, and has been used as the basis for valuing human life as part of the wider estimation of social costs across a number of injury-related sectors. However, given the more recent research available, there is doubt about the ongoing relevance of this figure today and its use for pricing injury both to the Road Sector and outside of it.

The best New Zealand estimate of the total social and economic cost of injury available is that prepared for this report. The researchers estimate that the total social and economic cost of all injuries in New Zealand, at June 2008 prices, is in the region of $7.4 billion to $13.6 billion per annum, with an estimate of $9.7 billion using the official Transport Sector VPF and a 3% discount rate. The three most costly injury priority areas are motor vehicle traffic crashes, suicide/intentional self-harm and falls. Sensitivity analysis, which tests the influence of key cost assumptions, shows that single most important cost factor is the value attributed to the human costs of an injury. Changes in the discount rate have little influence on the size of the total cost estimate for all injuries; however, it does influence the rank importance of fall-related injuries compared to other injury events.

CBA has a place in assisting with making injury prevention resource allocation decisions. However, the evidence needed to inform such analyses is missing for many injury prevention interventions. Where such evidence is lacking, the use of policy principles, such as equity, effectiveness and value for money, may assist with decision making.

Recommendations

It is recommended that:

1. policy principles such as those used by the Ministry of Health be utilised in association with economic CBA to inform national level decision making about investment in injury prevention.

2. in order to improve the robustness and utility of future cost of injury and cost-benefit estimates, a new VPF survey should be undertaken. The aim of the research would be to provide an up-to-date quantification of people's willingness to pay for injury prevention across a range of injury sectors, and to help make more explicit from an economic perspective the social and economic trade-offs that must be made with the limited resources available.

3. in preparing future cost of injury estimates, government agencies should:

    3.1. undertake a sensitivity analysis exploring the influence of assumptions about the VPF as a measure of human costs using:

        3.1.1. the official Transport Sector VPF ($3.4 million)

        3.1.2. the Home Fire VPF reported by Sanderson et al. (2007) ($2.2 million)

        3.1.3. Ministry of Transport 1997/98 survey VPF ($5.7 million)

    3.2. include a discussion covering which VoSL measure is most appropriate to use as a measure of human cost for the injury event of interest

    3.3. indicate whether an incidence or prevalence approach to counting injuries is used, and consider using a 95% confidence interval or three-year moving averages to adjust for normal variation in the annual incidence of injury. Report of a multi-year moving average has increasingly become common in government agency reporting of suicide and motor vehicle traffic crash rates

    3.4. apply a real discount rate, consistent with international health approaches (range of 3% to 6%) to estimate the current value of future benefits

    3.5. consider adopting a monetised health measure such as YLL and DALY as a measure of injury severity rather than using the Ministry of Transport measures of severity, or other approach such as length of stay in hospital

    3.6. adopt a cost of injury category matrix, reflecting current best practice as outlined by Frick et al. (2010) and by O'Dea & Wren (2010) as the basis for promoting greater consistency in the reporting of injury costs between different injury events.

Appendix A: Summary Table Of Published New Zealand Cost of Injury Studies (Prepared by John Wren)

TABLE 4: SUMMARY OF PUBLISHED AND "GREY" NEW ZEALAND COST OF INJURY STUDIES (PAPERS IDENTIFIED ON BASIS OF EXPERT KNOWLEDGE OF AUTHOR, AND USE OF SNOWBALL TECHNIQUE)

The table is intended to only provide an introduction to and overview of the range of New Zealand cost of injury studies that have been undertaken over time, the methods used, the results reported, and the range of issues commonly associated with undertaking analyses of this type.

* In the VoSL column: HC = Human Capital; WtP = Willingness to Pay; SP = Stated Preference

Injury Area / Short Title	Author / Year of Publication	VoSL Method*	Report Findings ($ estimates are those reported in the study, they have not been adjusted to current values)
The Economics of Work Accidents in New Zealand	(Berkowitz, 1979)	HC	Case-study estimates of the cost of work injuries in the freezing industry, a rubber company, and the Tongariro Power Development.
The Value of Statistical Life in New Zealand: Market Research on Road Safety	(Miller & Guria, 1991)	WtP, SP	In 1989/90 the MOT undertook a survey of people's willingness to pay for road safety. Analysis of 568 responses to six questions showed that there was a willingness to pay for road safety (VoSL) for direct family members in the region of $1.4 million to $2.3 million (95% CI) with a mid-point of $1.9 million. Based upon the survey results, in 1991 the Government set the VoSL at $2 million, at 1 April 1991 prices, for all Transport Sector evaluations (New Zealand Gazette, 1991). This figure has been annually adjusted by the MOT in line with changes in average earnings.
The New Zealand Economic Cost of Family Violence	(Snively & Coopers & Lybrand, 1995)	WTP, SP (MoT VoSL)	In 1994 the MSD commissioned Coopers & Lybrand to undertake a study of the social cost of family violence. The study was informed by the 1991 NSW (Australia) "Costs of Domestic Violence" study. The cost of family violence was estimated to be annually "at least" $1.2 billon (1993/94 prices) based upon police callouts for family violence (including homicide) and direct costs to individuals and government, and indirect cost of value of lost income estimated from annualising the 1991 MOT VoSL. The authors noted that if one assumes the police callout numbers significantly under count the actual experience of family violence, then the costs for family violence would be substantially higher with a range of $3 to 5 billion.
The Economic Cost of Homicide	(Fanslow, Coggan, Miller, & Norton, 1997)	HC	Total annual cost estimated to be $82.9 million (in 1992 prices). Costs comprised the estimated cost associated with homicide victims of NZ$37 million and the estimated total cost associated with homicide perpetrators of NZ$45.9 million.

Injury Area / Short Title	Author / Year of Publication	VoSL Method*	Report Findings ($ estimates are those reported in the study, they have not been adjusted to current values)
Economic Costs Associated with Suicide and Attempted Suicide in New Zealand	(Coggan, Fanslow, Miller, & Norton, 1997)	HC	Total annual costs of suicide in the early 1990s were estimated to be $202.8 million, and $11.8 million for attempted suicide respectively. Cost included direct costs of emergency service attendance, and coronial, funeral and health-care services. Indirect costs covered loss of potential working life and productivity from hospital treatment.
The direct and indirect costs of work injuries and diseases in New Zealand	(Head & Harcourt, 1998)	-	This study estimated the cost of workplace injuries in 1995 to be $1.23 billion. The report suffers from a number of weaknesses that were noted at the time. One notable lack is any allowance for the human cost of pain and suffering, or attribution of cost due to premature mortality.
More money or more effectiveness and efficiency?	(Wren, 1999)	-	This study argued that the cost of workplace injuries was in the region of 2.5% of GDP based upon international research at the time.
Direct and Indirect Cost of General Aviation Crashes	(Scuffham, Chalmers, O'Hare, et al., 2002)	HC, WtP, SP (based on MOT VoSL)	This study estimated and compared the annual costs of aviation crashes over the period of 1988 to 1997, using the HC and WtP methods. The study found that using the HC approach the average annual cost in 2002 prices was $22.7 million. In contrast, using the WtP approach the average annual cost was $58.4 million. Indirect costs from premature deaths were the key cost drivers, and indirect costs using the WtP approach were 3.5 times greater than those estimated using the human capital approach. A sensitivity analysis showed that the cost values were relatively robust to changes in parameters.
New Zealand bicycle helmet law – do the costs outweigh the benefits?	(Taylor & Scuffham, 2002)	WtP, SP	The average social cost of a bicycle fatality was estimated to be $2,228,000 in the financial year 1993/94. A total cost for all bicycle injuries was not given. The study focuses upon a cost-benefit evaluation of the effectiveness of the introduction of compulsory bicycle helmet laws in New Zealand in 1994. The law was found to have a cost benefit for adults, but not children.
The New Zealand Values of Statistical Life and of the Prevention of Injuries	(Guria, Jones, Jones-Lee et al., 2003; Leung & Guria, 2006)	WtP, SP	In 1997/98 the MOT undertook a new WtP survey for road safety. Based upon the survey responses a revised VoSL mid-point of $4 million at January 1998 prices was estimated. In June 2008 prices, this VoSL would equate to approximately $5.1 million. The 1998 revised estimate was not adopted by the Government. Further analysis of the survey data also found no conclusive evidence for a higher VoSL for children. There was evidence to suggest a lower VoSL for aged people.
The Cost of Suicide to Society	(O'Dea & Tucker, 2005)	WtP SP (MOT VoSL at 2004 prices)	The report aimed to update the estimates provided by Coggan et al. (1997), and adopted the MOT VoSL. Two main types of cost category were used: economic costs and non-economic costs. The total cost of suicide to society was estimated to be $1.4 billion for the 2001/02 financial year in 2004 prices. The report has several other features of note including the calculation of YLL and DALYs, which were then monetised as a measure of human cost, and a sensitivity analysis using a range of discount rates. The report found that the economic costs of lost productivity dominated other economic cost categories, while the human cost associated with YLL and DALYs dominated all cost categories. The discount rate had little impact upon the total cost estimate, and there was a "likely error range" of plus or minus 25% with the cost estimate.

Injury Area / Short Title	Author / Year of Publication	VoSL Method*	Report Findings ($ estimates are those reported in the study, they have not been adjusted to current values)
The economic and social costs of occupational disease and injury in New Zealand	(Access Economics, 2006)	HC for direct costs, and MOT VoSL (meta-analysis estimate) for indirect costs (pain and suffering)	This is the first comprehensive New Zealand analysis of the social cost of occupational disease and injury in New Zealand. The total costs were estimated to be $20.9 billion (in 2004/05 prices) (3.4% of GDP) Six cost categories used to calculate compensated costs: • Production costs: $573 million • Human capital: $3.05 billion • Health and rehabilitation costs: $694 million • Admin costs: $55 million • Transfer costs: $238 million • Other costs: $293 million
The VoSL for Fire Regulatory Impact Statements	(Sanderson, Goodchild, Nana et al., 2007)	WtP, SP (Relative ratio to MOT VoSL)	The report of a 2007 New Zealand telephone survey of 750 people exploring respondents WtP for fire safety prevention compared to road safety prevention. It was found that respondents stated a significantly less WtP for preventing a home-fire-related fatality compared to a road-related one. Respondents were, on average, only willing to pay a VoSL of 56.6% to 66.2% for a fire- related fatality compared to a road-related fatality. The report recommended the VoSL for fire safety should be set at two-thirds of that of the road VoSL (i.e $2.04 million in 2006 prices).
The Social Cost of Road Crashes and Injuries: 2008 Annual Update	(Ministry of Transport, 2008)	WtP, SP (VoSL MOT)	The total social cost of 2007 road-related injury crashes was estimated to be $3.87 billion ((June 2008 prices), of these costs 91% were associated with the loss of life/permanent disability. The average cost of a road injury fatality was estimated to be $3,352,400, and the average cost per serious and minor injuries (as defined by the MOT) were estimated to be $591,000 and $62,000 respectively.
Scoping Report: Economic and Social Costs of Injuries in New Zealand	(New Zealand Institute of Economic Research, 2008)	WtP (MOT VoSL)	This report provides approximate estimates of total social costs of injury in each of the NZIPS's six priority areas. Estimates of direct (resource costs) and indirect (intangible) costs are outlined. Indirect costs are based upon the MOT VoSL. Total social costs in 2007 are estimated to be in the region of: • 60 billion for "all injuries", of which $3 to $3.5 Billion is direct cost • $13.5 billion for "workplace injuries", of which $1.4 billion is direct cost • $3.4 billion for "motor vehicle injuries", of which $1.4 billion is direct cost • $440 million for "drowning injuries", of which $11 million is direct cost • $17.1 billion for "falls injuries", of which $839 million is direct cost • $1.2 billion for "violence injuries", of which $42 million is direct cost • $3.5 billion for "suicide/intentional self-harm injuries", of which $11 million is direct cost. The report did not involve any original research; rather it relies upon existing research findings and gross analysis of agency data about the incidence of injury. There is little critical analysis of the cost estimates, nor comment about how or why these estimates may vary considerably from other estimates for the same injury events.
Review of The Economic and Social Costs of Drowning and Water Related Injuries Compared to Prevention	(Price Waterhouse Coopers, 2008)	WtP, SP (Application of MOT VoSL)	As part of a larger report for ACC on cost benefits on water-related injury prevention, the authors estimated that the annual average total social cost of drowning and water-related injuries over the period 2004–2008 was approximately $570 million (range $460–$580 million) at December 2008 prices. The average cost of drowning fatality was estimated to be $2.3 million, and $228,403 and $9,136 for serious and minor injuries respectively. These costs were based upon adoption of the road safety VoSL and MOT estimates for the average cost of serious and minor injury to drowning fatalities and water-related injuries.

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New Zealand Government

Published in February 2010 by the Accident Compensation Corporation (ACC)
This document is available on the New Zealand Injury Prevention Strategy website www.nzips.govt.nz
NZIPS Secretariat ACC PO Box 242 Wellington New Zealand Email: nzips@acc.co.nz

ACC5423 • ISBN: 978-0-478-31472-4