The Value of Life and Health for Public Policy

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Abstract

Expenditure on health and safety is a substantial part of GDP, but public agencies in many countries, including Australia, have only qualitative views about the value of life and health. Also, despite considerable work by economists on the value of life and health in recent years, some important issues, such as the value of a healthy life year, remain unresolved. This paper presents a framework for valuing life and health. It then draws on international and Australian research to estimate possible values for life, healthy life years, and various chronic and acute health states for public policy purposes in Australia.

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I Introduction

In developed countries, health care expenditure usually accounts for at least 8 per cent of GDP. Safety expenditures in the home and workplace, the transport sector, environmental protection and in provision of law and order account for several more percentage points of GDP. Are these expenditures on health and safety appropriate? To a large extent, the answer depends on the value we attach to health and safety compared with other goods.

Over the last two decades, economists in many countries have devoted considerable expertise to valuing life and health. However, important issues are unresolved, including how the value of life may vary with age and health status, and the relationship between the value of life and the value of a life year. Also the range of proposed values both for life and for health states is large. In Australia there have few attempts to estimate monetary values for life and health. Some transport agencies include estimated values of life in investment appraisals. However, there is no agreed value of life in public policy fora and no basis for consistent public policy towards safety. Courts award damages for loss of health, but there appears to be no basis other than precedent for the awards for pain and suffering.

This paper presents a framework for valuing life and health and estimates values for life and health for Australian public policy purposes. Section II presents the valuation framework. Section III discusses individual valuations of life and healthy life years and the implications for public policy purposes. Section IV discusses possible values for various acute and chronic health states. A short final section summarises the main findings.

II A Valuation Framework

As Carter and Harris (1998) point out, economic evaluation in the health sector encompasses three main techniques—cost-benefit analysis (CBA), cost-effectiveness analysis (CEA) and cost-utility analysis (CUA). In CBA, the benefits as well as the costs of health policies are expressed in monetary units and therefore can be readily compared (providing that the valuations are well based). In CEA, policy outputs are expressed in physical units such as life-years saved, cases diagnosed or symptoms avoided. CEA is a limited evaluation technique because the different outputs are (i) not comparable and (ii) in a different unit of account to the costs. In principle, CUA overcomes (i) because health states are estimated using a quality of life (QoL) index that gives weights to health states (typically 1 for perfect health and 0 for a health state equivalent to death). These numbers may be added to produce an aggregate measure of health states or health states improvement. However, the problem of comparing an improvement in a health state index with the cost of achieving it remains.

Consistent with standard CBA (Boardman et al., 2001), in this paper we estimate what individuals are willing to pay (WTP) for health. These WTP values can be compared directly with the value of goods foregone when health expenditure is incurred. WTP is an ex-ante measure of the (maximum) amount that individuals are WTP to prevent an impaired health state, inclusive of all impacts of that state. This ex-ante measure is the appropriate value of health for most policy purposes. By contrast, the traditional cost of illness approach to valuing health as the ex-post sum of identifiable costs, such as loss of output and medical expenses, does not account for pain and suffering and cannot account for changes in lifestyle.

For the purpose of valuing health, it is convenient to classify health in terms of acute or chronic morbidity and premature mortality (see Table 1). Of course there is a range of states in each category. Acute morbidity may cause only minor discomfort or be serious enough to affect a person’s activities. Chronic morbidity varies from broken fingers to paralysis. Premature mortality includes unforeseen instant death and early death following a period of chronic morbidity. Table 1 also shows the consequences of various health states. Thus for heavier symptoms of acute morbidity, an affected person may not only suffer some pain, but also lose work time, change leisure activities, and incur medical and other expenses to prevent, mitigate or cure the symptom. The costs of chronic morbidity are similar, but generally greater.

Table 1 A framework for valuing health

Health states	Values of health states reflect
Acute morbidity	
Light symptoms	Minor physical and mental discomfort
Heavier symptoms	Pain and suffering
	Loss of productive time
	Changes in lifestyle activities
	Medical expenditures
	Cost of averting behaviour
Chronic morbidity	
Increased incidence of non-fatal chronic morbidity	Larger degrees of all of the above
	Expenditure on long-term care and support
Aggravation of existing chronic morbidity	Individual's health status already low
Premature mortality	
Unforeseen instant death	Risk of loss of life years
Early death often following chronic morbidity	Risk of loss of life years
	Plus costs of chronic morbidity

Where possible economists estimate WTP for heath using direct survey or revealed preference methods (see Sections III and IV). If WTP values for a health state are not available, health states may be valued indirectly based on estimated QoL indices. If a QoL index ranges from 1 for a state of full health to 0 for an impaired state judged equivalent to death, a QoL of 0.8 would be a health state with 80 per cent of the value of full health. Using the indirect method to value a health state, we first require a value for a year in full health (often referred to as quality adjusted life year or QALY). If the value of a QALY is $100,000, the value of a year with a QoL equal to 0.8 is $80,000. Conversely avoiding the impairment for a year would be worth $20,000. This approach can also be used to value acute morbidities. Suppose that someone has an acute condition for seven days which if experienced for a year would correspond to a QoL of 0.8, the cost of the acute morbidity would be $384 ($20,000 multiplied by 7/365).

The value of a QALY is often described as the value of a life year (VOLY). How is VOLY estimated? Although there have been a few attempts to estimate VOLY directly from revealed or stated preferences, it is usually derived indirectly from the estimated value of a statistical life (VOSL). The term 'statistical life' is used because most safety policies aim to reduce the risk of death rather than to avert specific deaths. Suppose that individuals are WTP an average of $x for a one in 1000 reduction in the probability of their death, collectively they are WTP 1000 times $x to prevent one statistical death. If $x is $2000, VOSL would be $2.0 million.

Most often VOLY is taken to be the constant annual sum which, taken over a remaining life span, has a discounted value equal to the estimated VOSL. If the estimated VOSL for a healthy person is $2.0 million, and the average remaining life span for victims of unforeseen accidents is say 40 years (which is approximately the case for traffic accidents), with a 5 per cent discount rate VOLY would be about $120,000. As we will see, there are some difficulties with this approach. Here we note that this method of deriving VOLY values a year in average health, rather than a year on full health. Thus a VOLY elicited in this way may be viewed as a minimum value for a year in full health (i.e. for a QALY).

In summary, economists either value health states directly or, if direct methods are not available, infer values for health states from estimates of QoL indices, VOLY and VOSL. Of course, health values are not unique—they may vary with preferences and income. However, whatever variations are allowed for, estimated health values should be internally consistent. Holding the discount rate constant, VOSL and VOLY cannot both be constant with age. If VOSL is constant with age, at least up to a certain age, VOLY rises with age. On the other hand, if VOLY is constant with age, VOSL falls with age. Moreover, to ensure consistency between values of health states, estimated VOSL should fall with declining health status.

From private to public values for health states

In CBA, values for public policy are derived from individuals' own valuations. Thus, if average VOSL is $2 million, society should be willing to invest up to $2.0 million to save a life. Several questions arise. Are own valuations a complete guide to social values for loss of life? Should the social value of life be an average VOSL or vary with income, age, and type of risk? If VOSL exceeds average income, can society afford to base public policy on VOSL?

The use of individual WTP values for public policy is typically justified on two grounds. First, these values are a good guide to the *relative* values of goods. Second, if total benefits exceed total cost, the outcome is potentially Pareto efficient. However, when goods are supplied free, it is generally regarded as inequitable to supply them to those who are WTP the most for them rather than to those who are believed to be in most need (in so far as these groups are different). In these circumstances cost-benefit analysts often adopt *average* WTP values for such goods as environmental goods and life itself, at least within any one country. However, there is an efficiency argument for varying VOSL with the type of risk, increasing VOSL for the risks that individuals are most anxious to avoid, notably risks over which they have little or no control.

In moving from private to public values of health, we must be careful about what is being valued. As Table 1 shows, morbidity costs have many components, including pain and suffering, loss of productivity, changes in lifestyle, medical and morbidity averting expenses. Thus WTP values for health may include not only WTP for health and productivity but also WTP to avoid various private expenses. These expenses vary with circumstances, including the provision of private health insurance and public health care support. Even within a particular health care system, some people may bear higher health care expenses for the same morbidity than do other people. The various value components of a health state and the precise policy context need to be borne in mind when placing values on health states.[1] This caveat is particularly important when transferring values from one context to another. It is necessary and common to employ benefit transfers. However, valuations reflect demand and supply conditions and benefit transfers should allow for any major difference between contexts, including differences in institutional arrangements.

[1] Also, individual WTP may not allow fully for losses to families. Jones-Lee (1992) suggests that to obtain full social values, individual values should be should be multiplied by 1.1 - 1.4.

Finally, it may be questioned whether it is feasible to allocate large amounts of public resources to life and health based on individuals' WTP for marginal changes in safety? If we are concerned only with marginal public decisions, it does not matter that VOSL exceeds individual budget constraints. But, in aggregate, groups of individuals cannot spend more than their total income on saving lives. The aggregate budget implications and feasibility of basing all public policy for safety and health on individual marginal valuations may require consideration, but as far as I am aware such a study has not been done.

III Values of Life and Healthy Life Years

Most estimates of VOSL are based on what individuals are WTP for a reduction in the risk of death in a one period model. In this model, an individual either dies immediately with a probability of p or survives to enjoy a lifetime consumption of C, with a probability of $1-p$. An individual's expected utility E(U) is given by:

$$E(U) = (1 - p)\, U(C) \qquad (1)$$

Holding expected utility constant, an individual's WTP for a lower probability of death (p^1) is given implicitly by:

$$(1 - p)\, U(C) = (1 - p^1)\, U(C - WTP) \qquad (2)$$

Individuals are willing to trade off lower consumption for a higher probability of survival.

Equation (2) implies

$$\delta WTP/\delta p = U(C - WTP) / [(1 - p^1)\, \delta U/ \delta C] \qquad (3)$$

where $\delta WTP/\delta p$ is the *marginal* rate at which individuals are willing to exchange wealth and risk. Equation (3) states that WTP is a function of lifetime utility divided by the expected marginal utility of consumption.

WTP to reduce the risk of death depends on many factors, including age, income, and type of risk and death. Jones-Lee (1974) argues that this WTP is an increasing function of the current probability of dying and of endowment. Also WTP for safety rises for risks over which individuals have little control and for deaths preceded by painful chronic conditions (see below). Given that VOSL equals the amount that individuals are WTP for a change in risk divided by the change in risk, estimated VOSL also varies with preferences and circumstances.

Johansson (2002a, 2002b) discusses lifecycle models in which the value of life is the present value of future discounted consumption, which depends in turn on the probability of survival. This model is relevant when the aim is to increase life expectancy rather than to save life now. However, Johansson concludes that VOSLs generated from these models are biased unless consumption is constant over the remaining lifecycle or the risk reduction occurs at the start of the lifecycle, in which case VOSL can be estimated as in the one-period model.

WTP values for safety are derived mainly from contingent valuation (CV) surveys and wage-risk studies.[2] In CV surveys, individuals are asked what they are WTP in exchange for a risk reduction. This approach goes directly to the wealth-risk trade-off and elicits individual valuations of safety. However, respondents may not give accurate answers to questions involving small risk reductions and answers may depend on how questions are presented (Miller, 2000). CV studies have produced a wider range of results than revealed preference studies. On the other hand, some recent studies represent sophisticated attempts to deal with these known problems, for example the study by Krupnick et al (2000) in Ontario, Canada.

In wage-risk, studies, workers are assumed to be willing to forego income for improved workplace safety or to require (accept) income for taking on more risk. The wage-risk equation is typically of the following kind:

$$W_i = \alpha_0 + \alpha_1\pi_{fi} + \alpha_2\pi_{nfi} + \alpha_3 SE_i + \varepsilon_i \quad (4)$$

[2] WTP values are also derived from consumer behaviour studies. For example, Blomquist et al. (1996) estimate the value of risk reduction implied by the use of safety belts, child restraint systems and motorcycle helmets.

where W is the wage of worker i, π_{fi} and π_{nfi} are the probabilities of a fatal or non-fatal injury for worker i, SE_i are socioeconomic characteristics of each worker (such as age and level of education), and ε_i is an error term. The α_i are coefficients; α_1 shows the impact of an increased risk of a fatality on the wage. The value of α_1 may be viewed as a WTP or willingness to accept (WTA) compensation estimate. When changes in risk are small, there is little difference between WTP for safety and WTA risk. Either way, the wage-risk method presumes that workers understand risk differentials, that the model distinguishes between premiums for fatal and non-fatal accidents (which are often correlated), and that the results are not statistical artefacts of the way the model is specified. These are questionable assumptions that have led some analysts to question the results (Dorman and Hagstrom, 1998).

The results of a large number of VOSL studies are shown in US dollars in Table 2 (the values relate to the study year unless otherwise cited). The studies include several meta-analyses mainly of wage-risk studies in the US, CV studies from several countries, and one Australian wage-risk study. A meta-analysis typically uses least-squares regression to explain the findings of studies in terms of underlying causes and research contexts and techniques. Note that the meta-analyses draw on some of the same studies. The results range from under US$1.0 million to nearly US$10 million, with best estimates from both CV and wage risk studies usually in the US$2 million to US$4 million range (equivalent to about A$3.3-6.6 million). However, some recent studies find lower values. For example, Mrozek and Taylor (2001) conclude that, if all factors are taken into account, VOSL for an unforeseen death is about US$2.0m.

A feature of these results is that average VOSL exceeds the net wealth of most individuals or the present value of their future earnings. This may appear inconsistent with budget constraints, but it is not. Individuals can sacrifice marginal consumption, which typically has a low *marginal* utility, in order to increase the probability of consuming a lower income, which has a higher *average* utility. However, this does raise the question whether society can afford to base all its resource allocation decisions for health and safety on marginal WTP values.

Table 2 Surveys of VOSL Results

Report	Year	Original studies	Estimated VOSL (US $s)
Kneisner and Leith	1991	Wage risk study, Australia	About $2.2m in 2000 prices
Viscusi	1993	24 wage-risk studies, 4 CV studies[a]	Most estimates in $3m-$7m range Range 1.2m-$9.7m
Jones-Lee	1994	13 wage-risk studies, 7 other revealed preference studies, 8 CV studies	$1.9m-2.2m are the median and mean for most reliable results
Jones-Lee et al	1995	CV study in UK	$2.7m
Schwab-Christe	1995	CV study in Switzerland	$7.5m
Desaigues and Rabl	1995	CV study in France	$3.4m
Van den Burgh et al.	1997	10 US and 1 UK wage-risk studies	$3.9m 'most reliable estimate'
Johannesson et al.	1997	CV study in Sweden	$3.8m in 1995 prices
Desvouges et al.	1998	28 wage-risk studies and 1 CV study, US	VOSL of $3.6m, with confidence interval of $0.4m-$6.8m
Day	1999	16 wage-risk studies, 10 US, 2 Canada, 4 UK	$5.6m is best estimate
Guria et al.	1999	CV study in New Zealand	$2.1m
Krupnick et al	2000	CV study in Canada	$0.5m - $2.0m
Mrozek and Taylor	2001	40 wage-risk studies	Approximately $2.0m

(a) Excludes two early study outliers with very small samples and extreme results.

As we have seen, VOSL may vary with income, type of risk, type of death, age and health status, and other factors. Jones-Lee et al. (1998) cite several cross-section studies which show that income elasticities for safety expenditure range from 0.3 to 1.1, with most estimates lying towards the bottom of the range. However, they note that estimates from cross-section studies are likely to be lower than they are in time series data and argue that because safety is an (environmental) quality of life variable the income elasticity is unlikely to be less than one. In a cross-country study of VOSLs, Miller (2000) estimates that the income elasticity is 0.96.

Jones-Lee et al (1998) also cite studies that show WTP for safety depends on the type of risk, principally on the degree of control and responsibility. Average WTP to reduce risks of death in the London underground is 50 per cent higher than WTP to reduce road fatalities. Pearce (2000) argues that people are WTP a high premium to reduce the risk of nuclear disasters. On the other hand, research indicates a 25 per cent discount for prevention of fatalities from domestic fires, which are held to be the responsibility of the household.

Not surprisingly, WTP to reduce the risk of death varies significantly with the type of death. Individuals are willing to pay more to avoid painful, drawn-out death. Tolley et al (1994) estimated that the mean WTP to avoid an unforeseen instant death was US$2.0 million (in 1994), compared with $2.75 million for avoiding death by heart disease and $4.0 million for death by lung cancer. In these cases WTP values include willingness to pay to avoid the pain and suffering of chronic morbidity before death as well as premature mortality.

The relationship between VOSL and age is less clear. Drawing on models of lifetime consumption, theoretical studies tend to find that the VOSL rises until about age 40 and then falls (for example, Cropper and Sussman, 1990). However, it is possible to construct models in which individual WTP for safety continues to increase with age as the marginal utility of consumption rises (with reduced life expectancy) and there is a positive discounting effect as the high value years are closer to the present (Johansson, 2002a).

Most VOSL estimates are derived from occupational risk contexts where the average age is about 40 years. However, some studies have attempted to discover the impact of age on VOSL. Table 3 shows some ratios of age-specific VOSLs to mean VOSL, with an index of 1.00 for age 40. Based on these and other empirical studies, Pearce (2000) concludes that WTP for life falls with age but only after age 70.

Table 3 Estimated ratios of age-specific VOSL to mean VOSL

Age	Jones-Lee et al. 1989	Jones-Lee et al. 1993	Jones-Lee et al. For Dept of Health, UK 1999[a]	Krupnick et al. 2000
40	1.00	1.00	1.00	1.00
50	0.98	0.99	1.00	1.13
60	0.86	0.97	1.00	1.13
65	0.76	0.95	1.00	1.13
70	0.62	0.92	0.80	0.72
75	0.46	0.89	0.65	0.72
80	0.28	0.85	0.50	0.72
85	0.07	0.82	0.35	0.72

(a) Results quoted by Pearce (2000).

The value of a healthy life year

As noted, a VOLY is commonly regarded as the annuity which, when discounted over the remaining lifespan of the individual at risk, would equal the estimated VOSL. Formally:

$$\text{VOLY} = \text{VOSL}/A \qquad (5)$$

where $A = [1-(1+r)^{-n}]/r$, n is years of expected lifetime remaining and r is rate at which future utility is discounted. The estimated VOLY is highly sensitive to the discount rate. If estimated VOSL is $2.0 million and the average remaining life span is 40 years, with a discount rate of 5 per cent the VOLY is $116,556. With a utility discount rate of 1.5 per cent, VOLY falls by nearly 50 per cent to $66,854.

Estimated VOLYs can in turn be used to estimate VOSLs that allow for age.

$$\text{VOSL}(a) = \sum \text{VOLY}/(1+r)^{t-a} \qquad (6)$$

where a is current age and t is life expectancy. For example, if estimated VOLY is $116,556, the current age is 65 and life expectancy is 15 years, the VOSL at age 65 would be $1.21 million. This implies of course that VOSL falls steadily with age.

As we will see, a constant VOLY has some attraction for public policy. However, a constant VOLY is a special case where the utility of consumption is constant for all ages. This may not be the case; VOLY may vary with age. Nor is there reason to suppose that someone's WTP for an additional life year equals the constant annual value which when discounted over the remaining lifespan happens to equal the estimated VOSL. Ideally, researchers should investigate what people are WTP for an extra life year. However, there has been little such research. Johannesson and Johansson (1995) appears to be an exception.

Values for public policy

Most official VOSLs are based on an average value for death of a healthy person at age about 40 years. Drawing on 21 wage-risk studies and 5 'high quality' CV studies, the United States Environmental Protection Agency (USEPA, 2000) recommends general use of a VOSL of US$6.1 million in 1999 dollars. The Agency notes that some studies indicate that VOSL peaks in middle age and declines thereafter and that VOSL may vary with health status and type of risk. However, it concludes that, given the uncertainties about the determinants of VOSL, general use of a single value is preferred along with sensitivity tests, until more is known about how VOSL varies with individual and environmental factors.

Official European VOSLs are lower, typically about US$1.5 million.[3] The UK Department of Environment and Transport employs a figure of £850,000 in 1996 prices, equivalent to about £1.0 million or US$1.5 million in 2002 (Jones-Lee et al., 1998). Allowing 39 further years of life, a 1.5 per cent utility rate of discount used by UK Treasury, and a constant VOLY, the estimated value of a health life year is just over £30,000. This rises to £54,000 with a 5 per cent discount rate. In either case, VOSL would decline with age. The European Union (2001) recommends a VOSL in the range of ε0.9-3.5 million with a best estimate around ε1.4 million (equivalent to about US$1.4 million) in 2000 prices. The EU also argues that VOSL is likely to decline with age and proposes that for elderly persons likely to be affected by environmental pollution a VOSL of around ε1.0 million in 2000 prices be adopted. A cancer premium may be

[3] Krupnick et al (2000) note that Health Canada uses an age adjusted VOSL of Cnd$4.3 million in 1999 prices.

added to allow for pain and suffering before death. On the other hand, the EU recommends that all members adopt a common VOSL irrespective of income differences.

There is no general VOSL in use in Australia. Here, road agencies have been the main users of VOSL estimates. For example, the NSW Roads and Traffic Authority (2002) recommends that in CBA studies a VOSL of A$1.26 million be used for fatalities avoided. This figure includes two costs: $862,000 for the estimated present value of loss of income and $397,000 for non-economic costs and loss of quality of life. This VOSL is applied to fatalities of all ages and to all future deaths, with no allowance for changes in earnings. To estimate the national cost of road crashes, the Commonwealth Bureau of Transport Economics (2000) adopted $1,359,000 for loss of life. This included $540,000 for loss of workplace labour, $500,000 for loss of home and community labour, and $319,000 for loss of quality of life. This is an ex-post cost of illness value rather than a WTP value. The loss of quality of life was based on court damages in cases of extreme health impairment. It is not clear that this is relevant to a fatal accident.

In lieu of Australian research on VOSL, we draw on overseas studies and values. These studies indicate that most likely VOSL values are in the range of A$3.3-6.6 million. The official USEPA VOSL is above $A6.6 million, whereas European values at about A$2.5 million are below the lower end of this study range. Taking a conservative view of estimated VOSLs, and given the broad similarity between European and Australian incomes, it appears that, for policy purposes in Australia, a VOSL of about A$2.5 million for a healthy prime-age individual would be an appropriate (conservative) value.

Turning to age related VOSLs and VOLYs, the choices are unattractive, the arguments are inconclusive, and there are few data to draw on. If VOLY is constant, VOSL declines significantly with age. On the other hand, if VOSL is constant with age, VOLY rises with age. The latter proposition implies that an increase in a given number of years is more valuable to an old person than to a young one. Likewise a given improvement in health status would be more valuable to the older person.

On balance, a constant VOLY seems more attractive than a constant VOSL.[4] This implies that, other things such as health status being equal, saving more life years is better than saving fewer years. It also means that the value of an improvement in health status is the same at all ages. Cropper et al. (1994) found that people generally favour safety programs that save the lives of young people and it seems likely that most people would favour programs that maximise life years rather than lives saved. This is also a practical approach because it allows a consistent valuation for health state improvements. Allowing 40 years of life lost and a utility or consumer discount rate of 3 per cent, a VOSL of $2.5 million implies a VOLY of $108,000.

Consistent with this approach, age-specific VOSLs would equal the present value of future VOLYs of $108,000 discounted by an appropriate discount rate, say 3 per cent per annum. For example, with a VOLY of $108,000, at age 60 and a life expectancy of say 20 years, VOSL would fall to $1.6 million. As life expectancy falls to 10 years, VOSL would fall to $927,000. This approach appears consistent with broadly held value systems, but more research on these issues is needed.

Some analysts propose that a higher value should be attached to avoiding painful death. Alternatively, the analyst may account for this pain and suffering separately (in addition to the cost of premature mortality) by drawing on values for impaired health states shown below. This latter approach is more transparent and explicit.

[4] Of course, permutations other than a constant VOLY or VOSL could be considered.

IV Values for Health States

Estimates of health state values draw mainly on three valuation methods: (i) consumer behaviour studies, (ii) stated preference surveys of WTP to avoid morbidity, and (iii) QoL indices in conjunction with an estimated WTP value for a healthy life year.

Consumer behaviour studies derive values from household expenditures to avert particular morbidities. In principle, the observed expenditure shows the minimum value that a household places on avoiding the morbidity. For example, Gerkin and Stanley (1986) and Chestnut et al (1988), infer the value the morbidity effects of air pollution from the estimated costs of averting behaviour. Harrington et al (1989) estimate the value of avoiding giardiasis due to water contamination by estimating the value of averting and mitigating expenditures from purchasing bottled water and otherwise avoiding use of contaminated water, as well as from lost work time. Two problems deserve note. One is the valuation of household time. The other is the joint nature of some products. For example, bottled water may be a preferred quality product as well as a safer one. Thus not all expenditure is designed to avoid the morbidity.

CV studies are the main source of WTP values derived from stated preference surveys. In CV studies, subjects are typically asked what they would be WTP for relief from an acute morbidity such as earache or asthma, often for relief from an additional day of the morbidity (see for example, Loehman et al., 1979, Harrison et al., 1992). It is important that what is being measured is clear, with regard to the amount and timing of relief and to averting behaviour. In particular, is WTP for relief before or after averting behaviour? If someone is asked what she would be WTP for relief from a headache for a day, she may estimate the value of the relief as $50. On the other hand, she could view a headache as a more minor problem because she can be rid of the symptom with a few pain killing pills.

QoL indices are usually derived from surveys in which subjects are asked to evaluate health states in utility rather than dollar values.[5] A simple method is the rating scale. Typically respondents are presented with a scale running from 100 for perfect health to 0 for states equivalent to death and asked to indicate where other health states would rank. More complex methods involve gamble, time and person trade-offs (see Mathers et al., 1999, p.10). For example, in a time trade-off, the QoL is the ratio of healthy years to less healthy years between which the individual is indifferent. Subjects are asked to choose between an impaired health state for a specified period (say 10 years) and a shorter life in full health. The length of life in full health is varied until the respondent is indifferent between the two. If the life in full health is say 4 years, on a scale of 0 to 1 the QoL index of the impaired state is 0.4 (because 10 less healthy years $\times$ 0.4 = 4 healthy years). The annual value of life in this impaired health state is the product of the estimated QoL and VOLY.

Possible average health state values for Australia

We draw on two sources to develop health state values. One is Tolley at al. (1994), who drew on several CV and QoL-based studies to estimate daily values for a range of acute health states and annual values for chronic states in the United States, in both cases in 1991 US dollars. The estimated values are based on a VOLY of US$120,000.[6] To convert the estimated 1991 US values to 2002 Australian values, we multiply them by the ratio of our proposed Australian VOLY in 2002 to the US VOLY adopted by Tolley et al, which is 108/120, subject to rounding as footnoted in Table 4. *This procedure implicitly retains the same QoL values* (table footnotes explain the derivation). Because our proposed VOLY is 10 per cent less than the Tolley et al. VOLY in absolute numbers, the A$ values for health states for Australia in 2002 are 10 per cent *lower* than the US$ values for the US in 1991. If, instead, we estimate the 2002 A$ values by

[5] Some QoL indices are based on expert opinions rather than on individual valuations. Other indices, for example the Monash Assessment of Quality of Life Instrument), are based on valuing and weighting the components of well-being, such as illness, independent living, social relationships, physical senses and psychological well-being (Hawthorne et al., 2000).
[6] The VOLY was derived from a VOSL of $2.0 million, 39 years of life expectancy and a discount rate of 6 per cent.

allowing for differences in the exchange rate, inflation since 1991, and differences between US and Australian per capita income, we would *increase* the Tolley et al numbers by about 33 per cent rather than reduce them by 10 per cent. Thus the value estimates in Table 4 conservative.

Our second source of health state values is Mathers et al. (1999), which estimated disability weights for 720 disease/injury conditions for Australia. They defined disability as a departure from health in any important domain including mobility, self-care, pain and discomfort, anxiety and depression, and cognitive impairment. The estimated disability weights, which range from 0 for no disability to 1 for states equivalent to death, are mirror images of QoL indices. Mathers et al. derived their weights from the *Global Burden of Disease* study by Murray and Lopez (1996), a major Dutch study of weights for 53 diseases including estimates for 175 disease stages, sequelae and severity levels (Southard et al. 1997), and their own study of health status indices. Clinical views of health status were the primary source in each case. Mathers et al claim that the expert views were close to those that would be obtained from the public.

To estimate dollar values for chronic health states, we multiply the QoL indices implied by the Mather et al study (QoL = 1 – the disability weight) by our proposed VOLY of $108,000. To estimate daily values for acute health states, we multiply the implied QoL values by the estimated value of a healthy day in Australia in 2002, which is $296 ($108,000/365).

Table 4 shows the QoL indices implied by our two main sources and our estimated (rounded) values of health states. Table footnotes explain the derivations. The QoL values for acute morbidities are *annual* equivalents (i.e. the quality of a health state if experienced over a full year). Given the derivation of the estimated health state values in Table 4, the values may be viewed as mean amounts per day or year that individuals are WTP to avoid acute and chronic conditions respectively. For policy purposes we may wish to distinguish between the average and marginal values of health states. Tolley et al (1994) suggest that the marginal value may be greater than the average value, but more research on the relationship is required.

Table 4 Estimated medium values for acute and chronic health states

Health state	QoL index implied by		Estimated value derived from	
	Tolley et al.[a]	Mathers et al.[b]	Tolley et al.[c]	Mathers et al.[d]
Acute morbidity			**$/day**	**$/day**
Headache	0.80		60	
Earache	0.83		50	
Eye irritation	0.83		50	
Sinus	0.86	0.94	40	18
Throat	0.89		32	
Influenza episode		0.95		15
Acute bronchitis episode		0.87		40
Asthma	0.86	0.97-0.77	40	10-70
Mild food poisoning	0.76	0.91	70	25
Severe food poisoning	0.60	0.58	120	125
Severe rash	0.76		70	
Measles episode		0.85		45
Chronic morbidity			**$'000/year**	**$'000/year**
Broken lower leg	0.95	0.73	5	30
Broken upper leg		0.33 – 0.73		30-40
Arm fracture		0.82		20
Head injury		0.57-0.65		38-46
General tiredness/weakness	0.87		14	
Medium angina	0.88	0.82	13	19
Severe angina	0.70	0.60	32	43
Bronchitis	0.75	0.83-0.47	27	18-60
Blindness	0.63	0.57	40	45
Renal dialysis	0.49		55	
Emphysema	0.58		45	
Lung cancer	0.30		75	
Primary therapy, operable		0.56		50
Non-operable		0.24-0.07		80-100
Breast cancer (non-invasive)		0.76		25
Breast cancer (disseminated)		0.21		85
Partial paraplegia	0.49		55	
Complete paraplegia	0.30		75	
Injured spinal cord		0.28		80
Quadriplegia	-0.11		120	
Severe brain damage	-0.16		125	
Stroke (mild permanent impairments)		0.74		30
Symptomatic HIV		0.69		65
AIDS		0.44		35
Heroin dependence		0.73		30
Manifest alcoholism		0.45		60
Moderate dementia		0.37		70

(a) Estimated from data in Tolley et al. (1994), using medium health state values. An estimated acute QoL = 1 – (the estimated cost of the morbidity × 365/108,000). A chronic QoL = 1 - (the estimated cost of the morbidity / 108,000).
(b) Estimated as one minus the disability weight for the relevant health state in Mathers et al. (1999, Annex Table B).
(c) Equal to the medium value in Tolley et al. (1994, Table 15.2) times 0.90, rounded to nearest 5 if 40 or more.
(d) The estimated QALY times $296 for acute morbidities and times $108,000 for chronic morbidities, rounded to nearest 5 if the resulting number is 25 or more.

After allowing for the differences in the VOLY, the health state values derived from the US and Australian sources are similar, implying similar QoL values. The quoted Australian values sometimes have a wider range. This reflects mainly the greater detail in the Mathers et al. study. However, for ease of exposition, I cite the medium values in the Tolley et al. (1994) study rather than the range of values reported in that study.[7]

The estimated values for the selected acute morbidities shown in Table 4 range from $10 per day for mild asthma up to $125 for severe food poisoning. Typical values for relief from acute morbidities such as earache, throat discomfort, eye irritation, and moderate asthma, are around $30 - $50 per day.

The estimated values for the chronic morbidities range from around $20,000 for a year of relief from mild bronchitis or medium angina up to $120,000 plus for a year of relief from quadriplegia or severe brain damage. Again, there are many health states in the middle of this range, valued at $60,000 to $80,000 a year, including symptomatic HIV, manifest alcoholism, moderate dementia, severe bronchitis, several forms of cancer, and an injured spinal cord. It may be noted that a morbidity cost in excess of $108,000 implies that a health state is worse than death. Premature death may be better than quadriplegia (for some people). In this situation, the cost-benefit policy implication is euthanasia.

V Conclusions

Many studies of the value of a statistical life have now been carried out, mainly using wage-risk or CV approaches, though apparently only one substantive study for Australia. The average VOSL to emerge from these studies is in the order of A$3.5 to A$4.0 million. However, some recent reviews suggest that these results might be on the high side. Moreover, the relationship between VOSL and age and the value of a life year are not well established. VOLY is usually

[7] I have also adopted the imprecise term 'medium' in preference to the more precise but misleading terms

taken to be constant annual sum which, taken over a remaining life span, has a discounted value equal to the estimated VOSL. Although this assumption lacks strong theoretical or empirical support, it provides a plausible and consistent basis for valuing both life years and health states.

Drawing on our review of research into VOSL and VOLY *and* international guidelines for life and health values, this paper proposes that, in 2002 prices, public agencies in Australia adopt:

- a VOSL of $2.5 million for avoiding an immediate death of a healthy individual in middle age (about 40);
- a constant VOLY of $108,000 which is independent of age;
- age-specific VOSLs equal to the present value of future VOLYs of $108,000 discounted by 3 per cent per annum.

The paper also reviews WTP values for health states and indicates possible values for 12 acute conditions and 26 chronic conditions, drawing on both WTP values and QoL indices together with an estimated value of a full health year. Typically acute conditions such as asthma, earache or eye irritation, are valued at about $40-$50 per day. The cost of chronic conditions ranges from $20,000-$30,000 per annum for mild bronchitis and broken arms up to $100,000 plus per annum for various forms of paralysis and brain damage. These proposed values are consistent with economic theory, international research and international practice.

As we saw at the outset, many policies in the industrial, environmental and transport sectors, as well as in the health sector itself, are designed to improve health. The value of the policy equals the change in health due to the policy × the value per unit of health. Estimates of these health values are basic to efficient resource allocation. These values are also at the heart of the current debate about the appropriate level of compensation for third party damages in workplace accidents, motor vehicle accidents and public liability cases. As shown in Abelson (2002), court

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'median' or 'mean'.

awards for damages are consistent with the health values estimated in this paper, whereas political moves to cap these awards are inconsistent with our findings in this paper.

Needless to say, the suggested values of VOSL, VOLY and health states in this paper imply important value judgements (as would any proposed values) for public policy, have unclear implications for people of different ages, and have unknown budget implications. These issues and others, such as the relationship between VOSL and types of risk, require further research, debate and analysis.

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