

Valuing Nonfatal Health Risk Reductions in Global Benefit-Cost Analysis

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October 2017 Review Draft

Guidelines for Benefit-Cost Analysis
Working Paper No. 2

Prepared for the Benefit-Cost Analysis Reference Case Guidance Project

Funded by the Bill and Melinda Gates Foundation

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Preface

The Bill and Melinda Gates Foundation (BMGF) is supporting the development of guidelines for the economic evaluation of investments in health and development, particularly in low- and middle-income countries (“Benefit-Cost Analysis Reference Case: Principles, Methods, and Standards,” grant number OPP1160057). These guidelines will supplement the existing international Decision Support Initiative (iDSI) reference case, which provides general guidance on the overall framework for economic evaluation as well as specific guidance on the conduct of cost-effectiveness analysis. It includes 11 basic principles supported by a series of methodological specifications and reporting standards to guide their implementation.

This draft working paper is part of a series of methods papers and case studies being conducted to support the extension of the reference case to include benefit-cost analysis. These papers will be reviewed by selected experts, posted online for public comment, discussed in a November 2017 workshop at Harvard University, then finalized. Although these papers will provide the basis for the benefit-cost analysis reference case guidance, the reference case may ultimately deviate from their recommendations in some cases.

More information on the project is available at <https://sites.sph.harvard.edu/bcaguidelines/>.

Executive Summary

In the context of benefit-cost analysis, the approach for valuing nonfatal risk reductions and other policy outcomes is grounded in two basic assumptions. The first is that each individual is the best judge of his or her own welfare. This principle, often referred to as “consumer sovereignty,” means that values should be based on the preferences of those affected by a policy. The second is that these preferences are represented by an individual’s willingness to exchange income to achieve a beneficial outcome. Presumably, an individual’s willingness to pay (WTP) for a nonfatal risk reduction or other desired improvement indicates that he or she values that outcome at least as much as the other things that money could buy.

The first step in valuing nonfatal risk reductions is to review the WTP literature to determine whether studies of reasonably high quality are available that are applicable to the risk and population of concern. Presumably, this WTP accounts for both the pecuniary effects of the risk change (e.g., out-of-pocket medical expenses and earnings) and the non-pecuniary effects (e.g., pain and suffering). WTP is expected to vary depending on characteristics of the risk reduction (such as its duration and severity) and characteristics of those affected (such as income, age, and baseline health status).

For nonfatal risk reductions, relatively few WTP studies are available. Thus, at least in the near-term, the main challenge faced by analysts is to determine how to best value these risk changes given the available data. To approximate these values, analysts often apply monetized estimates of quality-adjusted life years (QALYs) or disability-adjusted life years (DALYs) and estimates of averted costs. Although QALYs and DALYs differ in concept and application, both translate the impact of nonfatal health effects into a life year measure, so that the years of life lived in different health states or lost to premature fatality can be combined into a single indicator. Both are nonmonetary measures, and their value is typically approximated based on an estimate of the value per statistical life year (VSLY). The VSLY in turn is typically derived from an estimate of individuals’ WTP to reduce their own mortality risks (i.e., the value per statistical life - VSL), often by dividing VSL by the (discounted) expected life years remaining for an individual at the mean age of the population studied.

Because these estimates reflect how an individual values changes in his or her own health, they often exclude costs borne by third parties. These costs may include direct medical costs that are averted as a result of the policy, as well as the opportunity costs associated with caregiving outside of the health care system. Adding these costs to estimates of monetized QALYs or DALYs more fully accounts for the impacts of the risk reduction on social welfare.

Given the available data, in the near-term, we recommend that analysts begin by searching the literature to determine whether reasonably high quality, suitable estimates of WTP are available. Otherwise, they should apply monetized DALYs or QALYs. Averted costs that would otherwise be incurred by third parties may be added to these estimates. More specifically, analysts should proceed as follows.

- 1) Conduct a criteria-driven review of the WTP literature.** This review should apply the benefit transfer framework, to determine whether estimates of reasonable quality are available for health risks similar to those associated with the policy. This review should include five steps.
 - a. *Describe the policy outcome:* Determine the characteristics of the risks and populations to be addressed by the policy options.
 - b. *Search the literature:* Identify potentially relevant existing valuation research
 - c. *Review studies for quality and applicability:* Assess the quality of the data and methods used, considering the extent to which they follow generally accepted best practices and provide evidence of validity and reliability. Also assess the applicability of the studies to the policy outcome including: (i) the similarity of the health risks; (ii) the similarity of the populations experiencing the risks; and (iii) the ability to adjust for differences between the scenario studied and the policy scenario, such as income or age.
 - d. *Transfer the estimate(s):* If applicable WTP estimates of reasonable quality are available, conduct the transfer, making any necessary adjustments to the primary research estimates. These may include, for example, adjusting for differences in the income level of the country where the country was conducted and the country addressed by the benefit-cost analysis. This transfer may rely on a single study or combine the results from several studies, and may involve transferring a point estimate or a valuation function that tailors the estimate to the policy outcome.

- 2) Use monetized QALYs or DALYs as a proxy if necessary.** If WTP estimates of reasonable quality and applicability are not available, rely on estimates of monetized QALYs or DALYs.
 - a. *Estimate the change in QALYs or DALYs attributable to the policy:* The selection of a QALY or DALY measure should follow the iDSI Reference Case methodological specifications and reporting standards, and also take into account the benefit transfer considerations noted above, including both the quality and applicability of the available estimates.
 - b. *Estimate the monetary value:* The monetary value per QALY or DALY should be derived from the VSL estimates used to value mortality risk reductions, using the approach recommended for calculating the VSLY recommended in our separate methods paper on valuing mortality risk reductions (Robinson, Hammitt, and O’Keeffe 2017).

- 3) Add costs incurred by third parties.** Regardless of whether estimates of WTP or monetized QALYs or DALYs are used, add costs that are averted by the policy and not already included elsewhere in the analysis, especially if these costs are expected to be significant. These costs are likely to include medical costs paid by government programs, private insurance, or donor organizations. They are also likely to include the opportunity costs of caregiver time, when such caregiving is provided by household members or friends outside of the formal health care system. When values are transferred across contexts, these costs must be adjusted to fit the policy scenario as well as to avoid double-counting.

- 4) Address uncertainty:** Assess uncertainties in the estimates both qualitatively and quantitatively; e.g., by conducting sensitivity or probabilistic analysis and discussing the implications for decision-making.

Over the long term, more research on the value of nonfatal risk reductions is needed. In the interim, more work on a valuation function for QALYs and DALYs would be useful.

- 1) Conduct additional research on WTP for nonfatal risk reductions:** More research is needed on the value of nonfatal risk reductions in high- as well as low- and middle-income settings. Because any individual study will have advantages and limitations, ideally a research program would be developed that includes the application of a variety of research methods to a range of risks and populations. This program could be designed, for example, to develop base values for a subset of nonfatal risks of concern in selected settings, as well as adjustment factors for applying these values to other risks and other settings. It could also include the conduct of more research on WTP per QALY and per DALY to support refinement of the valuation function described below.
- 2) Further develop valuation function for QALYs and DALYs.** A valuation function, based on the results of WTP per QALY (or per DALY) studies is likely to more accurately reflect the value of QALY or a DALY than the application of a constant value. Work is now underway to develop such a function for QALYs and to determine the extent to which QALY and DALY estimates for similar health effects are consistent. More work is needed, however, to further develop this function for application in low- and middle-income settings and to extend it to reflect the differences between QALYs and DALYs.

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1.0 Introduction

The approach for valuing nonfatal health risk reductions in benefit-cost analysis, regardless of whether they are associated with illness, injury, or another form of disability, is very similar to the approach for valuing mortality risk reductions. In both cases, estimates of individual willingness to pay (WTP) are generally the most appropriate approach for valuation, given the underlying conceptual framework. The main difference relates to the lack of high quality valuation research for many nonfatal conditions. Given the multitude and diversity of these effects, this deficiency is perhaps unsurprising; a large research program would be needed to provide valid and reliable estimates for all the potential effects of concern. The challenge is thus to determine how to best value these risk changes when estimates of individual WTP of reasonable quality are not available. This paper explores this challenge and evaluates approaches for addressing it.

This paper is one in a series of methods papers which will ultimately be used to develop guidance on the conduct of benefit-cost analysis in global health and development. It supplements and complements a separate paper on the valuation of mortality risk reductions (Robinson, Hammitt, and O’Keeffe 2017). More information on the overall project is provided in Robinson et al. (2017) and on the project website (<https://sites.sph.harvard.edu/bcguidelines/>).

This introductory chapter provides a brief overview of concepts and methods for estimating individual WTP, which are explored in more detail in the paper on valuing mortality risk reductions. In the next chapter, we focus on developing proxy measures when WTP estimates are not available. These proxies include estimates of averted costs (often referred to as the costs of illness or COI), alone or in combination with estimates of health-adjusted life year gains or losses; i.e., quality-adjusted life years (QALYs) and disability-adjusted life years (DALYs), valued in monetary terms. The concluding chapter summarizes our findings and recommendations.

In benefit-cost analysis, the starting point for valuing nonfatal health risk reductions is typically an estimate of the change in the likelihood of illness, injury, or other disability in a defined time period for those individuals affected by the policy. This risk change can be aggregated over the affected population to calculate the expected number of statistical cases the policy averts. The term “statistical” is used to emphasize the role of probability; most policies reduce the risk incurred by the affected population rather than preventing identifiable cases with certainty. For example, if a policy decreases the risk of a specific illness by 1 in 10,000 in a given year for each individual, and 10,000 such individuals are affected by the policy, the policy averts one statistical case of that illness ($10,000 * 1/10,000 = 1$).

Consistent with the benefit-cost analysis framework, the value of these risk reductions is based on individuals’ willingness to trade-off spending on other goods and services for reductions in their own

risks; i.e., the marginal rate of substitution between wealth and the probability of not suffering the specified health effect.¹ Presumably, individual WTP accounts for both the pecuniary effects of the risk change (including avoided out-of-pocket medical expenses and earnings losses) and the non-pecuniary effects (including averted pain and suffering).

These values are likely to vary across individuals (e.g., due to their income, age, or baseline health status) and also across types of health risks (e.g., due to their severity and duration). For example, the value of a chronic condition with lifelong effects, such as blindness, is likely to be quite different from the value of an acute condition with relatively short-lived effects, such as a fracture. Similarly, a health effect that occurs when one is very young may be valued differently than the same effect if it occurs when one is middle-aged or elderly. As is the case for mortality risk reductions and other outcomes, these values are likely to vary depending on income as well as on the characteristics of the society, such as cultural mores and the quality and accessibility of the health care system.

Averted costs that would be otherwise incurred by third parties can be added to these estimates, as long as they are not included elsewhere in the analysis.² These include, for example, the costs of medical treatment covered by government programs, private insurance, or donor organizations and of caregiving provided outside of the health care system (e.g., by family and friends).

For risks that accrue throughout a population, the value of the risk reduction is equal to the sum of each member of the population's WTP for the risk reduction he or she experiences. This sum can be divided by the total number of cases averted to estimate the average value per statistical case (VSC) within that population. For example, if a population of 10,000 is willing to pay, in the aggregate, \$600,000 in a given year for a risk reduction that is expected to result in 10 fewer illnesses in that year, the VSC would be \$60,000 (\$600,000 divided by 10 cases). VSC can also be defined for an individual as the marginal rate of substitution between money and risk, typically estimated by dividing WTP for a small change in risk by the risk change. For example, if an individual is willing to pay \$6.00 for a 1 in 10,000 reduction in his or her risk of incurring a particular illness in the current year, his or her VSC is \$60,000 ($\$6 \text{ WTP} \div 1 \text{ in } 10,000 \text{ risk change}$).

¹ Estimates of willingness to accept compensation (WTA) are also consistent with the benefit-cost analysis framework. However, WTP is estimated more frequently in empirical research and typically used to value improvements from the status quo.

² As discussed in more detail in our scoping report (Robinson et al. 2017), we suggest including those impacts (and any offsetting savings) associated with implementing the policy in the cost analysis, and those impacts that are an outcome of the policy (e.g., changes in health risks) in the benefits analysis. This requires carefully distinguishing between the types of medical costs included in each analytic component. For example, for a policy such as providing tuberculosis vaccinations, the costs associated with delivering the vaccine would be included in the cost analysis, and the cost-savings associated with the resulting reduction in disease incidence would be included in the benefit analysis. In the latter case, only the medical costs paid by third parties would be included in the benefit estimates, to avoid double-counting what is included in the WTP estimate.

As is the case for mortality risk reductions, estimates of individual WTP for nonfatal health risk reductions are generally derived using stated- or revealed-preference methods. Stated-preference methods typically employ survey techniques to ask respondents about their WTP for an outcome under a hypothetical scenario, while revealed-preference methods infer the value of nonmarket goods from observed behaviors and prices for related market goods.³ Because conducting new primary research using either method requires substantial time and expense, typically analysts rely on existing valuation studies. This approach is referred to as “benefit transfer” to indicate that the populations and policies studied are not necessarily identical to the population and policy considered in the benefit-cost analysis. Similar to the approach used to estimate almost any parameter in policy analysis, such transfers involve carefully reviewing the literature to identify high-quality studies that are suitable for application in a particular context and clearly addressing the implications of related uncertainties. In some cases, these uncertainties may have relatively little effect on the conclusion that a policy is, or is not, cost-beneficial. In other cases, these uncertainties may have a more profound effect.

Because estimates of WTP are the most appropriate valuation measure for benefit-cost analysis, analysts should first review the literature to determine whether WTP estimates of reasonable quality are available for the nonfatal risks of concern.⁴ Examples of criteria that can be used to evaluate the available studies are provided in our companion paper on mortality risk reductions (Robinson, Hammitt, and O’Keeffe 2017) but will need to be tailored to the policy context.⁵ Such tailoring may include, for example, adjusting an estimate from a high-income country to a lower-income setting.⁶ We expect that, in many cases, analysts will not be able to identify a high-quality WTP study that addresses a reasonably

³ Experiments may also be used to examine these values; in such cases, individuals are typically asked to make choices in an artificial (laboratory) environment. While these choices may have real consequences (e.g., involve monetary exchanges), the extent to which they indicate the decisions likely to be made in real-world environments is often unclear.

⁴ We are not aware of a recent, comprehensive review of the valuation literature globally for nonfatal risks. For nonfatal illnesses, respiratory and cardiovascular conditions associated with air pollution appear to have been subject to more study than other conditions; see, for example, Hunt and Ferguson (2010). For acute effects, a meta-analysis by Van Houtven et al. (2006) lists 17 stated preference studies from nine countries published from the late 1970s through the early 2000s. The European Chemicals Agency (ECHA, 2016) reviews several studies of health effects associated with chemical exposures, including skin sensitization, kidney failure and kidney disease, fertility and developmental toxicity, and cancer. For injuries, most WTP studies bundle a range of injuries into a few categories. For example, Viscusi and Aldy (2003) identify 40 wage-risk studies globally that define the nonfatal risk variable as either the overall injury rate, the rate for injuries severe enough to result in a lost workday, or the rate of lost workdays. For effects on children, see Gerking and Dickie (2013) for review. Whether these studies are applicable to a particular benefit-cost analysis will depend on the nature of the risks affected by the policy.

⁵ Numerous other sources discuss approaches for benefit transfer, often focusing on valuation of environmental effects in high income countries. See, for example, Söderqvist and Soutukorva (2006).

⁶ The relationship between WTP and income is not as well studied for nonfatal risk reductions as for mortality risk reductions, and hence is highly uncertain (see Robinson and Hammitt 2015 for discussion). As a default, analysts may wish to assume that WTP changes in proportion to income; i.e., an income elasticity of 1.0.

similar risk and population, in which case they will need to use proxy measures. Thus we focus on the development of these proxies in the discussion that follows. Because of the diversity of the health effects likely to be considered and the gaps in the research literature, this paper focuses on concepts and criteria that analysts should apply in developing estimates, rather than recommending specific values.

2.0 Methods for Approximating Individual Willingness to Pay

Because it is often difficult to identify WTP studies of reasonable quality that are applicable to the nonfatal risks and populations addressed by a particular benefit-cost analysis, analysts frequently use other measures as proxies. While at times estimates of averted medical costs and productivity losses are used for valuation, such estimates are incomplete measures of value because they do not address pain and suffering and other quality of life impacts. To address these nonpecuniary effects, analysts often estimate the monetary value of the change in QALYs or DALYs associated with the risk reduction. These estimates can then be supplemented by estimates of the averted costs not likely to be included in these measures. We discuss the implementation of this approach below, focusing on the valuation of nonfatal effects.

Regardless of whether WTP estimates or these proxy measures are used, the results should be accompanied by appropriate characterization of uncertainty and discussion of its implications for the analytic conclusions; i.e., the likelihood that the benefits of the policy will exceed its costs. For example, for many policies, the estimate of net benefits may be dominated by the value of mortality risk reductions and may not be significantly affected by the value placed on nonfatal risk reductions. In other cases, uncertainty in the latter values may substantially affect net benefits.

2.1 Health-Adjusted Life Year Measures

Although QALYs and DALYs differ in concept and application, both translate the impact of nonfatal health effects into a life year measure, so that the years of life lived in different health states or lost to premature fatality can be combined into a single indicator. Such estimates are relatively plentiful and easily accessible, addressing a wide range of health conditions. Our concern in this paper is with the use of these measures to estimate individual WTP for nonfatal risk reductions. We first provide a brief overview of the construction of QALYs and DALYs, referencing other sources for more information. We then describe their monetary valuation.

Quality-Adjusted Life Years: The QALY is a nonmonetary measure that integrates the duration and severity of various health conditions.⁷ QALYs are widely used to rank and prioritize public health programs, analyze the cost-effectiveness of health policy and medical treatment decisions, and compare health status across individuals or population groups. In these contexts, QALYs are generally not

⁷ For more information, including discussion of criteria to be considered in selecting among the available estimation methods and estimates, see Institute of Medicine (2006), Drummond et al. (2015) and Neumann et al. (2016a). A comprehensive database of cost per QALY studies is available in the Cost Effectiveness Analysis Registry maintained by the Center for Evaluation of Value and Risk in Health at Tufts Medical Center (www.cearegistry.org).

assigned a monetary value, but monetization is needed to apply these estimates in benefit-cost analysis.⁸

QALYs are derived by multiplying the amount of time an individual spends in a health state by a measure of the associated health-related quality of life (HRQL). HRQL is estimated using a scale anchored at zero and one, where one corresponds to full health and zero corresponds to a state that is as bad as dead (values cannot be greater than one but may be less than zero for states judged to be worse than dead). Once HRQL is determined for a particular health state, it is then multiplied by the duration of that state to estimate the associated QALYs.

HRQL can be estimated directly or indirectly. Direct methods include the standard gamble, time tradeoff, and visual analog scale, administered in individual interviews or surveys. Indirect methods typically apply one of several generic HRQL indices, examples of which include the EQ-5D, the Health Utilities Index (HUI), and the Quality of Well-Being (QWB) scale. Each employs a classification system with several dimensions to describe health, as well as a scoring system based on population surveys to estimate the associated HRQL. These indices have the advantage of standardizing the approach for describing health states. The results will vary, however, depending on which index is applied, given differences in the attributes they include and in the scoring functions.

QALYs are not entirely consistent with conceptual framework for valuation in benefit-cost analysis, which focuses on measuring overall welfare rather than solely health. Their construction is based on the assumption that how individuals value health states is independent of the duration of the state, the age at which it is experienced, the individual's remaining life expectancy, and his or her wealth and income (see Hammitt 2002, 2013).

Disability-Adjusted Life Years: The DALY is a similar measure that is commonly used in global health. It was developed by researchers associated with the World Bank and World Health Organization (WHO) as a generic measure of the global burden of disease (Jamison et al. 1993, Murray and Lopez 1996) and is often used when estimating the cost-effectiveness of health-related interventions.⁹

DALYs use a scale that inverts the QALY scale. They are framed as the loss from full health associated with disability, rather than as the gain in quality of life associated with improved health. For nonfatal effects, the disability is measured as a value between zero (for full health) and one (equivalent to dead).

⁸ Valuation is implicit in any decision that affects spending on health. In cost-effectiveness analysis, these values may be represented by monetary thresholds, that are compared to the cost-effectiveness ratio to determine whether an intervention is worth implementing.

⁹ A comprehensive database of cost per DALY studies is available in the Global Health Cost-Effectiveness Analysis Registry maintained by the Center for Evaluation of Value and Risk in Health at Tufts Medical Center (<http://healthconomics.tuftsmedicalcenter.org/ghcearegistry/>); see Neumann et al. (2016b) for more discussion.

For example, a health condition assigned a disability weight of 0.2 is equivalent to 80 percent of a year in full health. (In contrast, for QALYs, a condition equivalent to 80 percent of a year in full health would be represented by HRQL of 0.8.) The disability weight is multiplied by the duration of the condition to calculate years lived with disability (YLDs). For fatal effects, each year of life lost (YLL) is assigned a value of 1.0 DALY.

The methods for estimating DALYs rely on a set of standardized weights which were originally based on judgments from medical experts and are now based on population surveys (Murray et al. 1996, Salomon et al. 2012, Salomon et al. 2015). The discounting method used, the weighting of different age groups, and the assumptions regarding life expectancy have also evolved over time and vary across analyses (Fox-Rushby and Hanson 2001, Sassi 2006, Salomon 2014). Analysts using these approaches should be clear about the source of the disability weights and about the assumptions used in their analysis, as well as the limitations of the approach and associated uncertainties.

There has been some debate over whether DALYs are intended to solely measure health or to measure welfare more generally. In recent iterations of the DALY weights, the researchers have been clear that the intent is to measure health alone (Salomon et al. 2012). Thus neither DALYs nor QALYs are entirely consistent with the overall framework for benefit-cost analysis, which focuses on overall welfare.

2.2 Monetary Values per QALY or DALY

The monetary value of a QALY or a DALY is often based on an estimate of the value per statistical life year (VSLY). Because few empirical studies directly estimate VSLY, it is typically derived from an estimate of VSL, often by dividing that VSL by the (discounted) expected life years remaining for an individual at the mean age of the population studied. This concept, its derivation, and its application in global health and development is discussed in more detail in the methods paper on mortality risk reductions (Robinson, Hammitt, and O’Keeffe 2017).¹⁰

Using these VSLY estimates to value QALYs or DALYs is based on two simplifying assumptions. The first is that VSLY is constant. Both theory and empirical research suggest that this is not the case. As discussed in our paper on valuing mortality risk reductions, both VSL and VSLY are likely to depend on the characteristics of the population affected (such as income, age, life expectancy, and health status), the characteristics of the risk (such as whether it is associated with an injury or an acute or chronic illness, or is viewed as voluntary or controllable), and the physical and social characteristics of the society (such as the quality of its health-care system and cultural attitudes). In addition, theory suggests that VSLY will decrease with the quantity of life years (Hammitt 2013).

¹⁰ Sometimes the discounted expected life years are approximated by the present value of a series of years with length equal to life expectancy. See Jones-Lee et al. (2015) for more discussion of this approximation, and Claxton (2017) for more discussion of discount rates.

The second assumption is that the value of a QALY or DALY is equivalent to this constant VSLY. An increasing body of scholarship as well as theory suggests that this assumption does not hold. In particular, several studies suggest that individual WTP per QALY depends on the severity and duration of the health condition as well as other factors (e.g., Haninger and Hammitt 2011, Robinson et al. 2013, Thavorncharoensap et al. 2013, Pennington et al. 2015, Pennington et al. 2015, Ryen and Svensson 2015, Hammitt 2017, Hammitt and Haninger 2017). This work suggests that WTP per QALY is a decreasing function of the magnitude of the QALY gain. The value of a DALY, although less studied, is likely to vary for similar reasons.

A valuation function, based on the results of WTP per QALY studies such as those cited above, is likely to more accurately reflect the value per QALY or DALY, adjusting this value to reflect the characteristics of the health effect (and possibly also the characteristics of those affected). Work is now underway to develop such a function for QALYs and to determine the extent to which QALY and DALY estimates for similar health effects are consistent.¹¹ In the interim, valuation using a constant value per QALY or DALY, derived as recommended in the methods paper on mortality risk reductions, appears to be the most feasible and reasonable approach.

This approach merges nonmonetary measures of health status with monetary estimates of individuals' willingness to exchange income (which could be spent on other things) for the change in health represented by these measures. It approximates the effect of changes in health on overall welfare, consistent with the conceptual framework for benefit-cost analysis.

2.3 Averted Costs

Averted costs refer to changes in the real resource costs associated with incurred cases of illness, injuries, or other conditions. Such estimates are often used to compare the costs of different health conditions or of alternative treatments for a particular condition. The term "cost of illness" (COI) is frequently used to refer to these costs, particularly to direct medical costs and indirect productivity losses. We instead use the term "averted costs" to emphasize that, in the context of benefit valuation, we are generally interested in decreases in these costs. In addition, costs other than those associated with medical care and productivity may be included if they are affected by the policy. Such costs may relate, for example, to the processing of insurance claims, losses associated with the reallocation of leisure or work time, and other impacts.

Direct medical costs typically include expenditures for services from physicians and other health care providers, medication, hospital stays, rehabilitation, and other treatment-related activities. In COI studies, these costs may include those paid by the individual, the government, private insurers, donor

¹¹ The work on a valuation function is being undertaken by Robinson and Hammitt under a separate project; the work on the consistency of QALYs and DALYs is being undertaken by the Neumann et al. team at Tufts Medical Center as part of its Global Health Cost-Effectiveness Analysis Registry project.

organizations, or others. Averted costs may also include the indirect costs associated with lost productivity. These losses may stem from absence from work or from decreased productivity while at work, and may include other costs such as those associated with idling assets or training replacement workers. They may also include decreases in unpaid work, such as household services, agricultural labor for household consumption, or volunteer services. While losses in leisure time are not normally included in COI studies, they may be considered in benefit-cost analysis. In particular, those affected are likely to experience a welfare gain if the policy allows them to reallocate time from relatively unpleasant activities (such as caring for an ill relative) to more pleasant or productive activities (such as paid or unpaid work or recreation).

The estimation of these costs is discussed in detail elsewhere, and hence not addressed in this paper. In particular, to supplement the iDSI Reference Case guidance (Wilkinsen et al. 2016), cost estimation is being addressed in ongoing work by iDSI and the Global Health Cost Consortium (Vassall et al. 2017) as well as others.¹² In addition, as part of this benefit-cost analysis reference case guidance project, methods for valuing changes in productivity and other types of time use are discussed in two separate papers; one on the valuation of small changes in time use (Whittington and Cook 2017), and one on changes in lifetime productivity (Deolalikar 2017).

Averted costs are a different concept than WTP, and may be greater or less than the amount of income an individual is willing to exchange for a risk reduction. As noted earlier, an individual's WTP reflects effects on wellbeing in addition to the costs he or she incurs, and is thus likely to exceed the value of avoiding the out-of-pocket medical costs and productivity losses that accrue to the individual. Whether individual WTP is likely to exceed the total averted costs from a societal perspective is an open question.¹³ In his or her own decision-making, an individual may not take into account the medical costs paid by third parties or productivity losses that accrue to others; the total costs averted may be more or less than the value an individual places on that risk reduction.

When QALYs or DALYs rather than WTP estimates are used to value nonfatal risk reductions, the costs that accrue to the individual are presumably still included in the estimate used for monetization – i.e., in the VSL estimate from which the monetary value of a QALY or DALY is derived.¹⁴ Thus double-counting is

¹² For more information on these initiatives, see: http://www.idsihealth.org/knowledge_base/the-reference-case-for-economic-evaluation/ and <https://ghcosting.org/>.

¹³ Although it seems intuitive that using COI estimates alone for valuation would understate WTP, this is not necessarily the case. For example, the presence of insurance may lead individuals to receive more treatment than they would willingly fund themselves. COI studies vary significantly in the costs they include and how these costs are measured.

¹⁴ While it is unclear whether lost production is included in the QALY or DALY estimates, the value of lost production is presumably included in the VSL estimates from which the monetary values are derived. Thus adding lost productivity to a monetized QALY could lead to double-counting. However, the productivity loss associated with a year of life lost (and embedded in the VSL measure) may not be proportional to the productivity loss associated

likely to result if averted out-of-pocket medical costs and productivity losses (or changes in other types of time use) are added to monetized QALYs or DALYs. However, costs incurred by third parties are a real resource cost and can be added to these measures. These costs include medical expenses paid by others, such as the government, insurers, or donor organizations; they also include caregiving costs incurred outside of the health care system; e.g., by friends or family.¹⁵

Although averted costs can also be added to WTP estimates for mortality risk reductions, they may be more significant for nonfatal risk reductions for several reasons. First, the available evidence suggests that individual WTP for mortality risk reductions is much larger than individual WTP for nonfatal risk reductions, often by orders of magnitude. Any savings in third party costs may be small in comparison. Second, for some nonfatal conditions, the magnitude and duration of such third party costs may be relatively large in comparison to the effects on the individual. However, the allocation of these costs between the individual and third parties will vary depending on the societal and other factors as well as the characteristics of the health conditions, and should be examined within the context addressed by a particular policy. For example, countries differ significantly in the extent to which they provide health insurance and sick leave or workers compensation. Finally, and perhaps most importantly, in the case of mortality risks such costs are delayed rather than averted, since we all die eventually. While such costs may change if the individual dies from a cause other than that addressed by the policy, the value of this change may be relatively small compared to the VSL estimate.

with the change in HRQL for a particular illness, injury, or other disability. Analysts should discuss the associated uncertainties in presenting their estimates. If values are instead derived directly from WTP studies of the condition of concern, then the analyst should review the studies to determine the extent to which medical costs, lost earnings, or other pecuniary effects are included in the values.

¹⁵ Care provided by employees of the health care system is included in the medical cost component.

3.0 Summary and Recommendations

Ideally, in benefit-cost analysis the value of changes in nonfatal risks would be derived from estimates of individual WTP, that indicate the extent to which those affected by the policy are willing to exchange income for a reduction in their own risks. Presumably this WTP accounts for both the pecuniary effects of the risk change (e.g., out-of-pocket medical expenses and earnings) and the non-pecuniary effects (e.g., pain and suffering). These values will vary across individuals and across types of risks.

Because primary research is lacking on individual WTP for reducing many types of nonfatal risks, analysts often apply other measures to approximate these values. Such proxy measures include monetized QALYs and DALYs as well as estimates of averted costs. Although QALYs and DALYs differ in concept and application, both translate the impact of nonfatal health effects into a life year measure, so that the years of life lived in different health states or lost to premature fatality can be combined into a single indicator. Both are nonmonetary measures, and their value is typically estimated based on a VSLY. The VSLY in turn is typically derived from an estimate of individuals' WTP to reduce their own mortality risks (i.e., the VSL), often by dividing VSL by the (discounted) life expectancy of an individual at the mean age of the population studied.

Because these estimates reflect how an individual values changes in his or her own health, they typically exclude costs borne by third parties. These costs may include direct medical costs that are averted as a result of the policy, as well as the opportunity costs associated with caregiving outside of the health care system. Adding these costs to estimates of monetized QALYs or DALYs more fully accounts for the impacts of the risk reduction on social welfare.

3.1 Near-Term Recommendations

In the near-term, analysts should begin by searching the literature to determine whether reasonably high quality, suitable estimates of WTP are available. Otherwise, they should apply monetized DALYs or QALYs. Averted costs that would otherwise be incurred by third parties should be added to these estimates.

- 1) Conduct a criteria-driven review of the WTP literature.** This review should apply the benefit transfer framework, to determine whether estimates of reasonable quality are available for health risks similar to those associated with the policy. This review should include five steps.
 - a. *Describe the policy outcome:* Determine the characteristics of the risks and populations to be addressed by the policy options.
 - b. *Search the literature:* Identify potentially relevant existing valuation research
 - c. *Review studies for quality and applicability:* Assess the quality of the data and methods used, considering the extent to which they follow generally accepted best practices and provide evidence of validity and reliability. Also assess the applicability of the studies to the policy outcome including: (i) the similarity of the health risks; (ii) the similarity of the

populations experiencing the risks; and (iii) the ability to adjust for differences between the scenario studied and the policy scenario, such as income or age.

- d. *Transfer the estimate(s)*: If applicable WTP estimates of reasonable quality are available, conduct the transfer, making any necessary adjustments to the primary research estimates. These may include, for example, adjusting for differences in the income level of the country where the study was conducted and the country addressed by the benefit-cost analysis. This transfer may rely on a single study or combine the results from several studies, and may involve transferring a point estimate or a valuation function that tailors the estimate to the policy outcome.

- 2) Use monetized QALYs or DALYs as a proxy if necessary.** If WTP estimates of reasonable quality and applicability are not available, rely on estimates of monetized QALYs or DALYs.
 - a. *Estimate the change in QALYs or DALYs attributable to the policy*: The selection of a QALY or DALY measure should follow the iDSI Reference Case methodological specifications and reporting standards, and also take into account the benefit transfer considerations noted above, including both the quality and applicability of the available estimates.
 - b. *Estimate the monetary value*: The monetary value per QALY or DALY should be derived from the VSL estimates used to value mortality risk reductions, using the approach recommended for calculating the VSLY recommended in our separate methods paper on valuing mortality risk reductions (Robinson, Hammitt, and O’Keeffe 2017).
- 3) Add costs incurred by third parties.** Regardless of whether estimates of WTP or monetized QALYs or DALYs are used, add costs that are averted by the policy and not already included elsewhere in the analysis, especially if these costs are expected to be significant. These costs are likely to include medical costs paid by government programs, private insurance, or donor organizations. They are also likely to include the opportunity costs of caregiver time, when such caregiving is provided by household members or friends outside of the formal health care system. When values are transferred across contexts, these costs must be adjusted to fit the policy scenario as well as to avoid double-counting.
- 4) Address uncertainty:** Assess uncertainties in the estimates both qualitatively and quantitatively; e.g., by conducting sensitivity or probabilistic analysis and discussing the implications for decision-making.

3.2 Long-Term Recommendations

Over the long term, more research on the value of nonfatal risk reductions is needed. In the interim, more work on a valuation function for QALYs and DALYs would be useful.

- 1) Conduct additional research on WTP for nonfatal risk reductions:** More research is needed on the value of nonfatal risk reductions in high- as well as low- and middle-income settings. Because any individual study will have advantages and limitations, ideally a research program would be

developed that includes the application of a variety of research methods to a range of risks and populations. This program could be designed, for example, to develop base values for a subset of nonfatal risks of concern in selected settings, as well as adjustment factors for applying these values to other risks and other settings. It could also include the conduct of more research on WTP per QALY and per DALY to support refinement of the valuation function described below.

- 2) Further develop valuation function for QALYs and DALYs.** A valuation function, based on the results of WTP per QALY (or per DALY) studies is likely to more accurately reflect the value of QALY or a DALY than the application of a constant value. Work is now underway to develop such a function for QALYs and to determine the extent to which QALY and DALY estimates for similar health effects are consistent. More work is needed, however, to further develop this function for application in low- and middle-income settings and to extend it to reflect the differences between QALYs and DALYs.

In conclusion, this paper provides recommendations for valuing nonfatal risk reductions that can be feasibly implemented based on the research now available. It also identifies areas in need of more research. In the near-term, it recommends that – when WTP estimates are not available – analysts merge nonmonetary measures of health status with monetary estimates of individuals’ willingness to exchange income (which could be spent on other things) for the change in health represented by these measures. Over the longer term, more research on individual WTP for nonfatal risk reductions is needed.

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(Includes links for publications that are freely available online. Titles and authors for papers now being developed as part of this project are tentative; papers will be posted at the URL indicated as they are completed.)

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