



Risk in Perspective

VALUING HEALTH: QUALITY-ADJUSTED LIFE YEARS OR WILLINGNESS TO PAY?



JAMES K. HAMMITT, PH.D.

"The QALY and WTP metrics offer sharply conflicting perspectives about the relative importance of reducing mortality risk to different people."

The public-health community can be a bit schizophrenic when it comes to calculating the value of improvements in health. The side of the field more closely allied with clinical medicine favors the metric of Quality-Adjusted Life Years (QALYs) and evaluates interventions in terms of their cost-effectiveness—the cost per QALY gained. The side more closely allied with environmental and regulatory economics uses the Willingness to Pay (WTP) metric and uses benefit-cost analysis to compare the value of health benefits with the cost of producing them. The US Office of Management and Budget, which oversees federal regulation, has recently proposed that regulatory agencies use both cost-effectiveness analysis (using QALYs or

other health measures) and benefit-cost analysis (using WTP) to evaluate rules intended to promote health and safety.

What are the differences between QALYs and WTP, and how should we choose between them? In this issue of *Risk in Perspective*, I suggest that part of the answer involves the degree to which each measure captures two kinds of (possibly conflicting) preferences: individuals' preferences for risks to their own health and society's preferences for the distribution of health risks across the population. I describe how QALYs and WTP fare against these criteria and examine what difference the choice between the two metrics makes for evaluating mortality risks.

Why Do We Need a Metric for Health?

As individuals and societies, we make decisions that affect our exposure to a wide variety of health risks. Some choices can have both beneficial and adverse effects for the same person. A man who bicycles to work, for example, improves his cardiovascular fitness and reduces his risk of heart attack, but simultaneously increases his risk of injury in a traffic accident. Sometimes a healthy choice for

one person imposes risks on another individual. By eating fish containing omega-3 fatty acids, a pregnant or breast-feeding woman reduces her chance of heart attack but may increase the risk that her child suffers developmental effects from low levels of methylmercury, dioxins, or other contaminants in the fish.

Such conflicting effects make it difficult to judge whether the overall health effect

For more information on HCRA visit our website at:
www.hcra.harvard.edu

of an action is desirable or not, and complicates the judgment about whether the health benefits are worth whatever costs must be incurred to produce them. Use of a formal method for valuing health effects can help to inform such choices, by individuals and governments.

Making decisions about health risks is difficult and confusing. There are a number of factors that can lead us to make choices that may conflict with our judgments, after further investigation and reflection. For example, people trying to value a reduction in the risk of a particular disease may not know what it is like to suffer from that condition. Those experiencing a health impairment often report it is not as bad as others without the impairment think it is—but does this difference reflect the affected person's better information or an admirable tendency to adapt and make the best of his or her situation?

People are notoriously poor at understanding probabilities, especially the small ones that are relevant to health choices. In a general-population survey, only about 60 percent of respondents correctly answered the question “Which is a larger chance, 5 in 100,000 or 1 in 10,000?” This “innumeracy” can confound people's thinking about their preferences.

The cognitive heuristics we often use in evaluating risks can also lead us astray. The perceived chance of an airliner crash seems to be much larger in the wake of a well-publicized incident than at other times. Judgments about health risks can also be sensitive to how a risk is described or framed. Patients and doctors may resist a life-saving treatment with potentially lethal side effects if they view harms of commission (side effects of treatment) as worse than harms of omission (the natural course of the disease).

Consistency with Individual Preferences

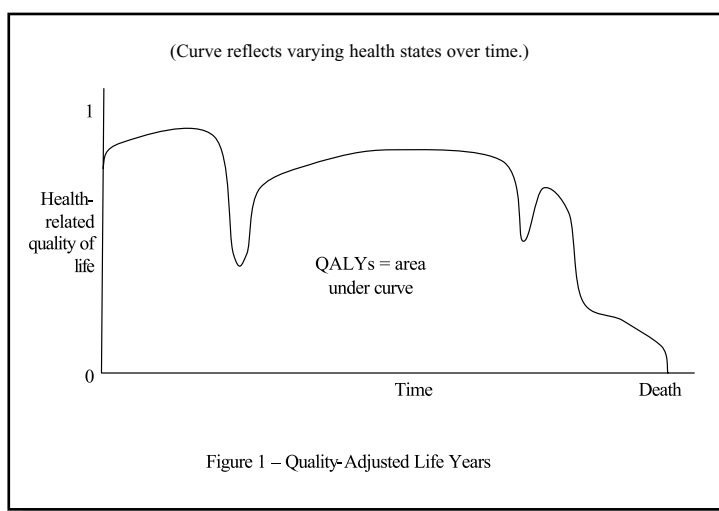
Both QALYs and WTP can be justified as measures of individual preferences over health risks. QALYs impose somewhat more restrictive conditions that, while seemingly reasonable, are

often violated by individuals. In contrast, WTP brings with it some features that many people find troubling when aggregating or comparing the value of health effects across people.

Quality-Adjusted Life Years

QALYs are used to measure an individual's future longevity and the quality of the individual's health during that time. As illustrated in Figure 1, they are calculated by weighting the amount of time an individual will spend in each future “health state” by an index that measures the “health-related quality of life” in that state.

If a person will live for T more years in a given state of health, the total QALYs he will experience is equal to $q \times T$, where q is the “health-related quality of life” associated with his health state. The value of q is scaled between one and zero, with one corresponding to perfect health and zero to health that is viewed as equivalent to dead (health states perceived as worse than dead can be accommodated by using negative values of q).



An individual's value of q for an impaired health state can be estimated by asking either of two types of questions, “time-tradeoff” and “standard gamble.” A time-tradeoff question asks the individual to compare living out his remaining

lifetime (T) in the impaired health state with living a shorter lifetime in full health. If he is indifferent between T years in the impaired health state and $y \times T$ years in full health, then the health-related quality of life (q) for the impaired health state must be equal to y, so that both alternatives offer $y \times T$ QALYs.

A “standard gamble” question asks the individual to compare living out his remaining lifetime in the impaired health state with a lottery that offers a probability (p) of surviving for the same period in full health, and a complementary probability (1 – p) of immediate death. Since the lottery offers an expected value of $p \times T$ QALYs, he will be indifferent between the lottery and the certainty of living in the impaired health state when p is equal to the health-related quality of life for the impaired health state (q).

If an individual always prefers the choice that offers a larger expected number of QALYs, then his preferences for health and longevity must be consistent with the following assumptions (among others):

1. When choosing among lotteries on length of life, holding health state constant, he always prefers the lottery with the highest life expectancy (risk neutrality on lifespan).
2. He is always willing to give up exactly the same fraction of remaining lifespan to live his remaining life in a better health state (constant proportional tradeoff of longevity for health).

While these conditions may seem reasonable, they appear to be inconsistent with many peoples’ preferences. Among my students, about 80 percent prefer a lottery offering a 50/50 chance of living to age 60 or 70 to a lottery offering a 50/50 chance of living to age 55 or 75. A slightly different 80 percent prefer a lottery offering a 10 percent chance of living 40 more years and a 90 percent chance of living 10 more years to living 13 more years for certain. The risk neutrality condition requires one to be strictly indifferent between the alternatives in both of these choices. The constant-proportional-tradeoff condition is inconsistent with evidence which suggests many people would be willing to give up some fraction of a long lifetime for better health, but they would not give up as large a fraction, or perhaps any time at all, if they had only a short lifetime remaining.

Because QALYs describe preferences only with respect to longevity and health, they do not answer the question of whether the health benefits of a policy justify its cost. The tradeoff between health and other goals must be set outside the QALY framework, often by comparing the cost per QALY gained by the policy under consideration with the cost effectiveness of other interventions.

Willingness to Pay

WTP measures the value of an improvement in health or a decrease in health risk by the maximum amount of money a person would willingly exchange for it. WTP depends on ability to pay, including an individual’s wealth and competing demands for his or her resources. Other things equal, wealthier people are likely to have higher WTP for health. Unlike QALYs, which depend only on the time spent in various states of health, WTP to reduce a health risk may also depend on other, “qualitative” attributes of the risk, such as whether it is viewed as uncontrollable, involuntary, or uncertain.

WTP for health can be estimated using “stated-preference” or “revealed-preference” methods. Stated-preference methods involve asking a sample

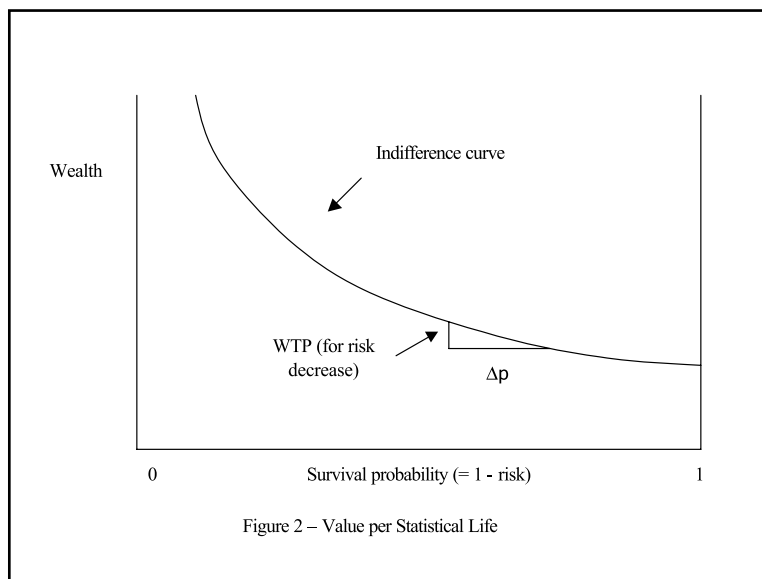
of people what choice they would make in a hypothetical situation involving a tradeoff between health risk and money. For example, individuals have been asked about whether they would purchase a hypothetical automobile safety device or a pneumonia vaccine if these were available at specified prices. Revealed-preference methods require observing the choices people make in real life and assuming they prefer the alternatives chosen to those that are foregone. Many studies have used workers’ job choices as a way to estimate WTP for health, since more dangerous jobs need to offer higher wages in order to attract workers. When selecting from among the jobs for which he is qualified, a worker must choose between higher pay and greater safety.

Although WTP for various changes in health have been estimated, most attention has focused on longevity and mortality risk. The “value per statistical life” (VSL) is defined as a person’s WTP to reduce his current mortality risk by a small increment. VSL is not equal to the amount of money an individual would pay to avoid certain death, nor to the amount of compensation he would demand to accept certain death. It is simply the rate at which he will trade money for small changes in mortality risk, as illustrated in Figure 2.

The term “value per statistical life” can be understood by noting that if a large number of people (N) are each willing to pay $\$V$ to reduce their own chance of dying this year by a small amount (Δp), then the group as a whole is willing to pay $\$(N \times V)$ so that $(N \times \Delta p)$ fewer of them die this year (on average). The average WTP per life saved is then $\$(N \times V)$ divided by $(N \times \Delta p)$ or, more simply, $\$V$ divided by Δp . For the US, the average VSL is estimated to be about \$7 million, which suggests a typical American would pay about \$70 to reduce his or her current mortality

risk by about one in 100,000.

Under economic theory, VSL can be represented as the anticipated gain in utility or well-being from surviving the current year, divided by the anticipated reduction in utility that results from having less money to spend on other goods (such as housing, food, travel, education, entertainment) after spending more on survival probability. This formulation can be used to predict how VSL will depend on individuals’ circumstances.



Relative Value of Reducing Mortality Risk

The QALY and WTP metrics offer sharply conflicting perspectives about the relative importance of reducing mortality risk to different people. These differences can matter when comparing programs that disproportionately affect different subpopulations, such as reducing the risk of automobile crashes (a leading killer of young adults) or levels of particulate air pollution (which is thought to be most lethal to older people with chronic heart and lung disease).

Under the QALY perspective, the value of reducing current mortality risk to a person is proportional to the future QALYs that person is likely to experience. This value is directly proportional to the person’s life expectancy and to the health-related quality of life he or she will experience. The QALY measure implies that it is more important to reduce mortality risk to people having higher life expectancy (typically, those who are younger), and to those who will be healthier.

Under the WTP perspective, the relative value of reducing mortality risk is less sensitive to life expectancy and health prospects, but is sensitive to wealth and income. While it seems intuitive that a person would be willing to spend more to reduce his current mortality risk if he has a long life in good health to look forward to, theory and limited empirical evidence suggest the opposite result is also possible. This follows because, although longer life expectancy and better future health clearly increase the benefit of surviving the current year, they may also increase the individual’s other demands for spending, and thus increase the utility that he or she gives up by having less to spend on other goods.

Consider a retired person living solely off her savings. If she anticipates living many more years, she may need to husband her resources more carefully than if she is not likely to survive as long. With respect to health, an individual who is

bedridden may have fewer opportunities than a healthier person for using his money in a way to promote his welfare, and so might be more willing to spend profligately to increase his chance of surviving the current year.

The following table summarizes how different factors affect the relative value of reducing mortality risk. The proportionate effect of life expectancy on the QALY value of reducing mortality risk is clear from the definition of QALYs, but the magnitudes of many of the other effects on both QALY and WTP values can only be determined by empirical estimation.

Relative Value of Reducing Mortality Risk

	QALY	WTP
Life expectancy	Increase	Ambiguous
Future health	Increase	Ambiguous
Wealth	No effect	Increase
Baseline risk	No effect	Increase
Competing risk	Decrease	Decrease
Qualitative attributes	No effect	May affect

Consistency with Social Preferences

A fundamental problem in calculating the value of changes in health risk to the population as a whole is how to compare health gains to different people, or gains to some with losses to others. While classic utilitarianism assumes that the effects of changes in health or other conditions on individual wellbeing can be compared between people, modern economics assumes it is not possible to determine whether one person or another gains more from a specified change. On this view, only a change that benefits some and harms no one—a “Pareto Improvement”—provides an unambiguous social gain.

Benefit-cost analysis, which relies on WTP, goes one large step further in counting “Potential Pareto Improvements” as social gains. A Potential Pareto Improvement is any change that can be transformed into a Pareto Improvement by the payment of compensation from those who benefit to those who are harmed. A Potential Pareto Improvement exists when those who benefit from a change could pay sufficient compensation to those who are harmed so that everyone would prefer the change (including the payment or receipt of compensation) to the status quo. By adopting this compensation test, benefit-cost analysis solves the problem of comparing gains and losses between people by defining purchasing power as the standard for comparison. In this way, benefit-cost analysis separates the question of efficiency (maximizing the economic pie) from that of distribution (cutting the pieces).

The QALY perspective solves the interpersonal

comparability problem in a very different manner. Under this perspective, one year of healthy life is the standard, and an additional year of healthy life counts the same, regardless of who receives it. This standard might be motivated by a theoretical social contract, in which individuals in what the late philosopher John Rawls described as an “original position” behind a “veil of ignorance,” not knowing their future wealth, health, and other characteristics, might agree to a system in which public policies are designed in order to maximize the number of QALYs produced in the population. Some survey evidence suggests that people’s preferences for allocating lifesaving efforts are at least roughly consistent with this perspective—it is often viewed as more important to save the life of a younger than an older person.

In weighing health consequences across a population, an important difference between QALYs and WTP is that they make different choices about how to compare changes in wellbeing between people. Both choices are arbitrary. Which we choose is both a social and a moral problem.

For many social decisions, we choose to rely on purchasing power as our standard. Beyond some minimum standards, access to food, housing, education, clothing, entertainment, and many other goods is based largely on willingness to pay. But in other areas we choose some other allocation. We prohibit the sale of votes, child labor, and body organs. In part, the question about which metric to use for valuing health is a question about whether

**Harvard Center for
Risk Analysis**
Harvard School of
Public Health
718 Huntington Avenue
Boston, Massachusetts
02115-5924
617 432-4497
www.hcra.harvard.edu

100% recycled paper,
all post-consumer fiber.

FOR FURTHER READING:

J.K. Hammitt, "QALYs versus
WTP," *Risk Analysis* 22(5):
985-1001, 2002.

J.K. Hammitt, "Valuing Mortality
Risk: Theory and Practice,"
*Environmental Science and
Technology* 34(8):
1396-1400, 2000.

"Appendix C. OMB Draft
Guidelines for the Conduct of
Regulatory Analysis and the
Format of Accounting Statements,"
Federal Register 68(22):
5513-5527, February 3, 2003.

Materials from the conference
"Valuing Health Outcomes:
An Assessment of Approaches,"
Resources for the Future,
Washington, DC, February 13-14,
2003, available at
[http://www.rff.org/
valuinghealthoutcomes.htm](http://www.rff.org/valuinghealthoutcomes.htm).

PEER REVIEWERS:

MILTON C. WEINSTEIN, PH.D.

PETER NEUMANN, SC.D.

we wish to treat health as a special good that we allocate with little or no regard to economic resources, or to treat health more like other commodities that we allocate using market forces. The tension

between these alternatives is reflected by the fact that, in practice, the effect of wealth on WTP is usually ignored and the same value of WTP is used for people with widely differing income.

Conclusion

Ideally, health metrics should rank changes in health risk in the same order that individuals would rank them for themselves, and that society would rank them across individuals. If the individual and social rankings differ, it is theoretically possible that every individual would prefer the health risks he faces under policy A to those he faces under policy B, even though policy B scores better on the social ranking.

There is some conflict between the goals of consistency with individual and with social preferences, and WTP and QALYs differ in their emphasis on satisfying each of them. WTP puts more emphasis on consistency with individual preferences, at the potential cost of less

consistency with social preferences. In contrast, QALYs seem to be more consistent with stated views about allocating health resources among people, but may be less consistent with individuals' preferences over their own health.

Empirically, neither QALYs nor WTP are measured with great precision, and the differences in how the two metrics rank different policies may not be as sharp in practice as they are in theory. Evaluating policies from both perspectives—as the Office of Management and Budget proposes—may help to develop greater insight about the difficult health choices that societies must make.

Upcoming Executive Education Courses:

Analyzing Regulations: Health, Safety and the Environment

Washington, DC, May 8 - 9, 2003

The Risk Communication Challenge

Boston, MA, May 14-16, 2003

Cost-Effectiveness Analysis for Medical Technologies and Pharmaceuticals,

Boston, MA, June 9 - 12, 2003

**FOR MORE INFORMATION ON
THESE COURSES, VISIT**

<http://www.hsph.harvard.edu/ccpe/>

*Would you prefer to
receive Risk in
Perspective electronically
as a PDF file? If so,
send your name and
email address to
Nkwazi Sabiti at
nsabiti@hsph.harvard.edu.
Thank you.*