# Valuing Morbidity Risks

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# Background

- The NRC prepares regulatory analyses for proposed actions that would impose requirements on NRC licensees
- NRC performs cost-benefit analyses(CBA) as part of:
  - Cost-justified substantial safety enhancements (i.e., backfit analysis)
  - Regulatory analyses
  - Environmental analyses
- The NRC's cost-benefit analyses rely, in part, on monetizing the health detriment of radiation exposure.
- MACCS provides inputs to cost-benefit calculations
  - Averted economic consequences
  - Averted dose

# Theoretical Foundations

- CBA is founded on principles of "welfare economics"
- According to welfare economics:
  - Each individual is best judge of their own welfare => benefit values should be based on preferences of those affected by policy
  - If an individual chooses to buy a good or service, he or she expects to derive more utility (well-being) from that good or service than others they could have used that money on. => An individual's willingness to exchange money can be used to make approximations about decision utility.
- Willingness- to- Pay (WTP): The largest amount of money that an individual would voluntarily pay to obtain an improvement in health risks.

# Office of Management and Budget  Circular A-4

- In monetizing health benefits, a WTP measure is the conceptually appropriate measure as compared to other alternatives (e.g., cost of illness or lifetime earnings)

- When monetizing nonfatal health effects, it is important to consider two components:

  - The private demand for prevention of the nonfatal health effect, to be represented by the preferences of the target population at risk

  - The net financial externalities in economic production that are not experienced by the target population

# Methods of Valuation

# Approaches to Valuation

- WTP
  - Stated Preference
  - Revealed Preference
- Cost of Illness
- Proxy Methods
  - Monetized QALYs
  - Jury Awards

# Revealed Preference

- Utilize individual's choices in real markets based on either consumer purchases or employment decisions
- Common Methods
  - Hedonic Wage
  - Averting Behaviors
- Advantages
  - Based on market data and observable choices that individuals make
- Disadvantages
  - Assumes workers are fully aware of the types of risks and their magnitudes associated with jobs or goods
  - Confounding factors necessitate large data sets and advanced regression techniques

# Stated Preference

- Stated preference methods usually involve surveying people about the value they place on a good or service in a hypothetical market
- Common Methods
  - Contingent Valuation
  - Discrete Choice
- Advantages
  - The analyst can construct surveys to analyze the specific risk of concern and can include those health risks that cannot be easily tied to consumer or labor market transactions
  - The surveys can provide participants with detailed information about the health risks they are valuing and include questions to gauge their understanding of this information
- Disadvantages
  - Due to hypothetical nature of surveys, participants have less incentive to carefully consider their choices
  - Subject to biases (e.g. warm glow effect, protest responses)

# Cost-of-illness

- Estimates the financial burden of a disease on an individual and society Measured benefits
- Cost components
  - Direct costs of medical treatment such as hospital stays, outpatient care, physician's fees, and medications
  - Indirect costs due to lost productivity and lost income
  - Indirect opportunity costs such as lost leisure time
- Advantages
  - Cost components based on market data
  - Relatively easy to explain and understand
- Disadvantages
  - Does not capture pain and suffering
  - May greatly underestimate WTP

# Quality-Adjusted Life Years

- The quality-adjusted life year (QALY) is a summary measure of a health outcome which incorporates the impact on both the quantity and quality of life.

- Used extensively in Cost-Effectiveness Analysis of medical interventions
- Health index
  - 1 = perfect health
  - 0 = health state equivalent to dead
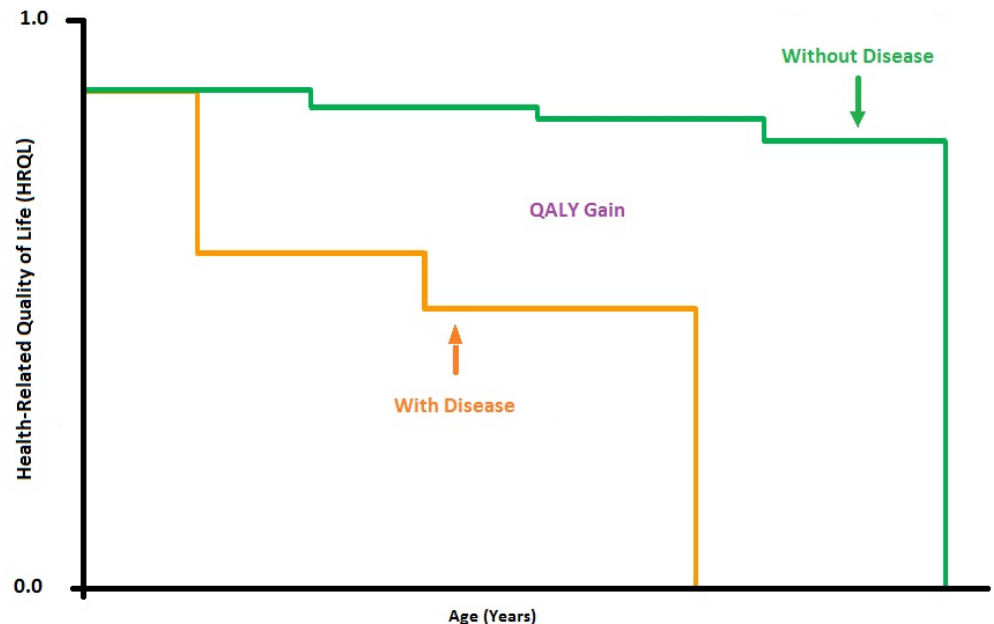
# Quality-Adjusted Life Years

- QALY monetization is typically done by dividing the VSL over the remaining life expectancy for an average-aged individual

- Advantage
  - QALY values exist for a vast number of illnesses

- Disadvantage
  - Methods used to develop QALYs are not consistent with welfare economics

# Quality-Adjusted Life Years

- A 2004 report by the National Academy of Sciences' Institute of Medicine (IOM) explicitly discouraged the practice of monetizing QALYs

    "willingness-to-pay and HRQL valuation and measurement have developed out of distinct disciplinary and methodological traditions. Given their different theoretical underpinnings and the different types of trade-offs they consider, it is misleading to combine them" (IOM, 2006)

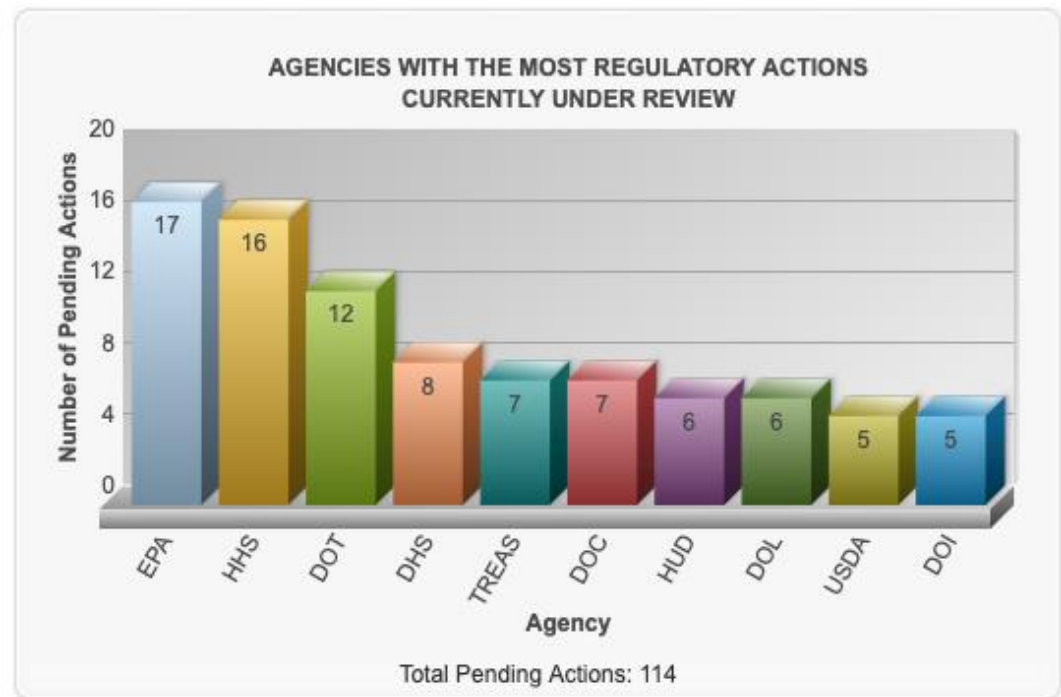- Questions as to whether the scales used to elicit QALY values reflect individual preferences

# Federal Agency Practices

# Federal Agency Practices

- Reviewed any agency-wide guidance
- Recent rulemakings that valued nonfatal health effects
- Agencies reviewed
  - Environmental Protection Agency (EPA)
  - Department of Health and Human Services (HHS)
  - Department of Transportation (DOT)
  - Department of Labor (DOL)
  - Department of Agriculture (USDA)



AGENCIES WITH THE MOST REGULATORY ACTIONS CURRENTLY UNDER REVIEW

Number of Pending Actions — EPA: 17, HHS: 16, DOT: 12, DHS: 8, TREAS: 7, DOC: 7, HUD: 6, DOL: 6, USDA: 5, DOI: 5

Total Pending Actions: 114

Source: Reginfo.gov, 2019. Accessed 6/8/2019.

# Environmental Protection Agency

- The EPA published "Guidelines for Preparing Economic Analyses" in 2010 to provide an overarching framework for economic analyses.

- Discusses different approaches to health valuation.

- Cautions against the practice of monetizing health-state indices citing the recommendations of the Institute of Medicine (IOM 2006) and Hammitt 2003.

# EPA Recent Analyses

- In a 2000 "Arsenic in Drinking Water Rule Economic Analysis," (EPA, 2000a) the EPA used the WTP to avoid chronic bronchitis estimated by a 1991 study (1991, Viscusi) as a surrogate for bladder cancer.

- EPA Science Advisory Board (SAB) Review Panel
  - Reviewed the analysis and expressed reservations about the valuation methods used for avoided cancer morbidity
  - Referenced a more recent study (Magat, et al. 1996) which estimated the WTP to avoid nonfatal lymphoma and noted that this may be more comparable with bladder cancer
  - Ultimately, the SAB recommended the use of the WTP and COI values for bladder cancer as upper and lower bounds in an uncertainty analysis with a discussion of the meaning and potential implications of these two estimates (EPA SAB, 2001).

- A more recent economic analysis dealing with the regulation of Methylene Chloride (EPA, 2019) in consumer paint and coating uses the same WTP for lymphoma estimate to value nonfatal liver cancer and lung cancer.

# US. Department of Health and Human Services

- HHS issued "Guidelines for Regulatory Impact Analysis" (2016)
  - First consult the WTP research to determine whether suitable estimates are available
  - If not, use monetized QALYs as a proxy, recognizing that we are uncertain whether the resulting values under- or overstate individual WTP for the risk reduction
- The Guidelines provide detailed guidance on the application of monetized QALYs

# HHS Recent Analysis

- The FDA published a "Smokeless Tobacco" Proposed Rule (2017) which utilized a monetized QALY approach to value changes in oral cancer risks.

- Estimated the present discounted value of QALYS gained of an individual 62 years old (median age of diagnosis)

- Assume for a case of oral cancer:
  - Upon diagnosis, assign HRQL of 0.68 (Downer et al., 1997) for first year during treatment
  - Recurrence risk within 5 years of diagnosis is 19.1% (Ermer et al. 2015) with HRQL of 0.68.
  - For cancer patients who remain cancer free for 5 years, HRQL is 0.75 (Rogers et al. , 2006)

# HHS Recent Analysis

- For the baseline case, age-specific HRQL weights are assigned in each year of life between 62 and 100.

- The value per QALY is estimated by dividing VSL by the present discounted QALYs remaining for an individual 40 years in age and averaged across gender.

| Mean HRQoL Scores (EQ-5D US) | | |
|---|---|---|
| Age | Male | Female |
| 20-29 | 0.928 | 0.913 |
| 30 - 39 | 0.918 | 0.893 |
| 40 - 49 | 0.887 | 0.863 |
| 50 - 59 | 0.861 | 0.837 |
| 60 - 69 | 0.84 | 0.811 |
| 70 - 79 | 0.802 | 0.771 |
| 80 - 89 | 0.782 | 0.724 |

Scores taken from Hamner et al 2006.

# Department of Labor

- Two recent final rules monetized benefits of decreased cancer risks:
  - Occupational Exposure to Respirable Crystalline Silica (OSHA, 2016a)
  - Occupational Exposure to Beryllium (OSHA, 2016b)
- Used the WTP approach and provided low and high estimates for valuation
  - Low value: value of statistical injury derived from an analysis of hedonic wage studies (Viscusi and Aldy, 2003)
  - High value: WTP to avoid non-fatal lymphoma as a fraction of VSL (Magat et al, 1996)
  - Did not designate a "best" estimate

# Department of Agriculture

- Within the USDA, the Economic Research Service (ERS) publishes and maintains costs of foodborne illnesses for 15 major pathogens
- Cost estimates
  - Medical costs due to inpatient and outpatient care
  - Opportunity costs of lost work days
- The willingness to pay to avoid pain and suffering associated with nonfatal illness risks is not monetized in these cost estimates
  - Lack of suitable WTP estimates
  - Cited two NAS committee's and EPA's SAB recommendations against monetizing QALYs (IoM, 2006; Cropper et al., 2007; National Research Council, 2008)

# Department of Transportation

- DOT publishes crash injury costs by severity on the Maximum Abbreviated Injury Scale (MAIS)
- The DOT establishes relative disutility factors, which represent a fraction of VSL, for non-fatal injury levels.
  - Each type of injury is rated on a scale of QALYs
  - Injury scores are grouped according to the MAIS scale
  - Coefficients are then applied to VSL to assign each injury class a value corresponding to a fraction of a fatality

Relative Disutility Factors by Injury Severity

| MAIS Level | Severity | Fraction of VSL |
|---|---|---|
| MAIS 1 | Minor | 0.003 |
| MAIS 2 | Moderate | 0.047 |
| MAIS 3 | Serious | 0.105 |
| MAIS 4 | Severe | 0.266 |
| MAIS 5 | Critical | 0.593 |
| MAIS 6 | Unsurvivable | 1.000 |

# Summary

| Approaches to Morbidity Valuation | | |
|---|---|---|
| **Method** | **Description** | **Strengths and Limitations** |
| **Revealed Preference**<br>- **Hedonic Wage**<br>- **Averting Behavior** | Estimates WTP based either wage differentials for jobs with varying degrees of safety-risk or for prices of safety-related products. | Based on observed behavior.<br><br>Requires advanced statistical techniques and large data sets. Assumes individuals have accurate knowledge of safety risks and their magnitudes. |
| **Stated Preference**<br>- **Contingent Valuation**<br>- **Discrete Choice** | Utilizes surveys to elicit individual WTP. | Surveys can be constructed to analyze the specific risk of concern and can provide participants with detailed information regarding health risks.<br><br>Due to the hypothetical nature of surveys there is less incentive to carefully consider responses. Surveys are subject to participant biases. |
| **Cost of Illness** | Estimates financial costs incurred by society and the individual attributed to the disease. Includes:<br>- Medical and treatment costs<br>- Lost productivity costs and lost wages<br>- Value of lost leisure time | Estimates are derived from actual monetary data.<br><br>Does not attempt to approximate WTP as it is not based on individual preferences. Does not value pain and suffering - may significantly underestimates WTP |
| **Monetized QALYs** | Assigns a monetary value to the existing QALY health utility metric which combines a health state's impact on quality of life and life expectancy. | QALY values exist for a vast number of illnesses and health states.<br><br>Methods used to monetize the QALY lack theoretical or empirical support |

23

# Summary

| Summary of Federal Agency Approaches to Morbidity Valuation | | |
|---|---|---|
| **Agency** | Recent Regulatory Analyses | |
| | Cancer Risk | Valuation Methodology |
| **Department of Health and Human Services (HHS)** | Oral Cancer from N-Nitrosonornicotine | Monetized QALYs |
| **Environmental Protection Agency (EPA)** | Liver Cancer and Lung Cancer from Methylene Chloride | Benefits transfer of WTP estimates |
| **Department of Transportation (DOT)** | N/A | Monetized QALYs |
| **Department of Labor (DOL)** | Lung Cancer from Beryllium and Respirable Silica | Benefits transfer of WTP estimates |
| **Department of Agriculture (USDA)** | N/A | Cost of Illness |

# Summary

- Willingness to pay is the theoretically correct method for the valuation of nonfatal health effects

- Very few if any WTP studies have been conducted for most nonfatal illnesses

- Cost of Illness estimates are believed to significantly underestimate WTP, but may serve as a lower bound estimate

- Monetized QALY approaches have been used in the absence of available WTP studies, however, this approach remains controversial

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