What Does the Value of Modern Medicine Say About the $50,000 per Quality-Adjusted Life-Year Decision Rule?

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Background: In the United States, $50,000 per Quality-Adjusted Life-Year (QALY) is a decision rule that is often used to guide interpretation of cost-effectiveness analyses. However, many investigators have questioned the scientific basis of this rule, and it has not been updated.

Methods: We used 2 separate approaches to investigate whether the $50,000 per QALY rule is consistent with current resource allocation decisions. To infer a lower bound for the decision rule, we estimated the incremental cost-effectiveness of recent (2003) versus pre-"modern era" (1950) medical care in the United States. To infer an upper bound for the decision rule, we estimated the incremental cost-effectiveness of unsubsidized health insurance versus self-pay for nonelderly adults (ages 21–64) without health insurance. We discounted both costs and benefits, following recommendations of the Panel on Cost-Effectiveness in Health and Medicine.

Results: Our base case analyses suggest that plausible lower and upper bounds for a cost-effectiveness decision rule are $183,000 per life-year and $264,000 per life-year, respectively. Our sensitivity analyses widen the plausible range (between $95,000 per life-year saved and $264,000 per life-year saved when we considered only health care's impact on quantity of life, and between $109,000 per QALY saved and $297,000 per QALY saved when we considered health care's impact on quality as well as quantity of life) but it remained substantially higher than $50,000 per QALY.

Conclusions: It is very unlikely that $50,000 per QALY is consistent with societal preferences in the United States.

Key Words: cost-effectiveness, QALY, decision rule, decision analysis

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Cost-effectiveness results are often accompanied by a simple decision rule intended to guide their interpretation. In a review of 338 cost-effectiveness analyses of pharmaceutical interventions, Neumann et al found that investigators in 34% of studies refer to a $50,000 per quality-adjusted life-year (QALY) decision rule when discussing the implications of their findings.[1] Because more sophisticated interpretation methods[2] are complex and require data that are commonly unavailable, simple decision rules, such as $50,000 per QALY,[3] or 3 times the gross domestic product per disability-adjusted life-year,[4] are invoked regularly. However, these simple decision rules have little theoretical or empirical grounding,[5–8] and have not been updated regularly.

Although decision rules are unlikely to evolve as the sole decision criterion in health care resource allocation, increasing numbers of thorny allocation decisions may force a move toward decision rules with demonstrable validity.[9] In particular, a decision rule must reflect society's willingness to pay for health benefits, and should be neither excessively restrictive nor inclusive. The $50,000 per QALY decision rule has not changed nominally since it came into use in 1982,[3] at which time it was equivalent to $121,000 per QALY in 2003 dollars. Therefore the nominal figure has been either too restrictive or too inclusive for a substantial proportion of this time.

Investigators have long called for additional research to improve the methodological bases of decision rules.[9,10] However, published reports have had significant limitations, asking individuals about their willingness to pay for hypothetical health purchases (in which case people may be far more willing to spend hypothetical dollars than real ones) or inferring willingness to pay based on choices that involve greater health risks along with greater financial compensation, such as unsafe occupations (in which case confounding factors, such as job satisfaction, may also impact the decision). The limitations of these studies combined with their substantial variation ($21,000 per QALY to $1,180,000 per QALY, in 1997 US dollars) have prevented them from having great policy impact.[6]

We aim to make inferences about cost-effectiveness decision rules in the United States using 2 separate approaches to estimate society's willingness to pay for health care. To inform a lower bound for the decision rule, we note that most Americans favor expanding rather than constricting the share of national expenditures that are spent on health care.[11–13] We infer that most individuals are willing to pay the incremental costs of prior health care advances to receive their incremental benefits. Consequently, we reason that society's willingness to pay for health care is likely to meet or exceed the incremental cost-effectiveness of the advances that together comprise "modern" health care. To inform a higher bound for the decision rule, we estimate the incremental cost-effectiveness of health insurance for nonelderly adults in the United States without employer- or government-subsidized health insurance. Because most of these individuals decide not to purchase insurance (even when they have sufficiently high income levels),[14] this preference may reveal costs and benefits that society is not willing to pay for, and therefore may guide an upper-bound estimate for the decision rule.

METHODS

We discuss our 2 approaches in sequence, first quantify the incremental costs and benefits of modern health care, and then quantify the incremental costs and benefits of unsubsidized health insurance.

Quantify the Incremental Costs and Benefits of Modern Health Care

A majority of Americans have consistently believed that the United States is spending too little rather than too much on health care.[11] In the 2006 General Social Survey,[12] a sample of 2992 adults living in households in the United States, 74% thought we were spending "too little" on health care, 19% thought spending was "about right," and only 7% thought spending was "too much." It is noteworthy that this survey simultaneously queries preferences regarding more than 20 spending domains (eg, defense, foreign aid, etc.), many of which elicit preferences for lower spending, and therefore competing spending priorities (ie, opportunity costs) are likely to have been considered by respondents. These results are reinforced by a separate nationwide poll in which health care was most frequently identified as the economic sector that should have the highest priority for future growth.[13]

Because most individuals in the United States favor expanding rather than constricting the share of national expenditures that are spent on health care, we infer that most individuals are willing to pay the incremental costs of prior health care advances to receive the resulting incremental benefits. As a consequence, we argue that society's willingness to pay for health care is likely to meet or exceed the incremental cost-effectiveness of the advances that comprise "modern" health care.

We estimated the incremental cost-effectiveness of modern health care by first estimating the impact of health care improvements since the start of the "modern" medical era (approximately 1950)[15] on age-stratified mortality rates, and then comparing the resulting survival benefits with the associated additional medical costs over the lifetime of a US birth cohort.

Estimating the Impact of Health Care Improvements on Mortality

Several published reports have estimated the impact of medical advances on life expectancy in resource-rich nations.[16–18] Although the majority have lacked a solid empirical basis, 2 used a more rigorous methodology, in which they first identified decrements in the disease-specific mortality rates of common illnesses with treatments of proven benefit (ie, coronary artery disease, pneumonia, diphtheria immunizations), estimated what portions of those decrements were attributable to medical care rather than to other causes, and then aggregated those attributable mortality rate decrements to produce an estimate of how medical care impacted life expectancy overall. Bunker et al[16,17] estimated that approximately one-half of the life expectancy gains in the United States since 1950 were attributable to medical care rather than to other causes. Extrapolating Bunker's estimate (3.8 years), which was based on 1994 life expectancies, to 2003 life expectancies yields an estimate of 4.7 years. Mackenback[18] performed a similar analysis in a different resource-rich country (The Netherlands). His similar conclusion (3.9 years, performed at approximately the same time) offers further evidence of the plausibility of this estimate.

We estimated mortality rates in the absence of modern health care by determining the extent to which age-stratified mortality rate reductions observed between 1950 and 2003 would need to be reversed to reduce current life expectancies by 4.7 years (our extrapolation of Bunker's estimate) in a simulated US birth cohort. We based all mortality rates on US Census Bureau estimates,[19,20] and we used life-table methods to estimate the life expectancy impact of mortality changes (Table 1).

Comparing the Costs and Benefits of "Modern" Health Care

We alternatively exposed a US birth cohort to the costs and benefits of 1950 health care and to the costs and benefits of 2003 health care. Mortality in the presence of modern health care was based on US Census Bureau estimates, and mortality in the presence of 1950 health care was based on our estimates above (Table 1). Note that mortality in the presence of 1950 health care is considerably lower than 1950-era mortality, because a substantial proportion of the improvements in survival has not been attributable to health care.

Health care was assumed to induce age-stratified costs based on the analysis of data by Meara et al from the 2000 Medical Expenditure Panel Survey (N = 34,459) (Table 2).[21] Although there are no published data on 1950 medical costs that are stratified by age, we do know that per-capita spending on health was 13% of current expenditures in inflation-adjusted dollars, and that the age distribution of those costs has changed little.[22] To estimate age-stratified medical costs in 1950, we therefore assumed a similar age distribution to 2003 costs, and multiplied costs by 13% (Table 2). We applied a 3% discount rate to both costs and benefits, as recommended from the US Panel on Cost-Effectiveness.[23] We inflated all costs to US $ 2003 using the consumer price index for all goods and services.

Quantify the Incremental Costs and Benefits of Unsubsidized Health Insurance

The utilization of health insurance is low (20%) among nonelderly adults who did not have access to employer- or government-subsidized insurance, based on a published anal-

TABLE 1. Mortality for Selected Ages by Type of Health Care

Age (yr)	Mortality Rate, 2003*	Mortality Rate, 1950†	Mortality Rate, 2003 Assuming 1950 Health Care	Mortality Increase Attributable to 1950 Health Care	
				%	Absolute
<1	0.0070	0.0318	0.0198	183	0.0128
10	0.0002	0.0008	0.0005	150	0.0003
20	0.0009	0.0013	0.0011	22	0.0002
30	0.0010	0.0018	0.0014	40	0.0004
40	0.0021	0.0037	0.0029	38	0.0008
50	0.0044	0.0084	0.0065	48	0.0021
60	0.0098	0.0186	0.0144	47	0.0046
70	0.0239	0.0433	0.0341	43	0.0102
80	0.0593	0.0959	0.0786	33	0.0193
90	0.1540	0.2430	0.2007	30	0.0467

Using life table methods and data from the US Census Bureau, we estimated the extent to which mortality rate declines observed between 1950 and 2003 would need to be attenuated to increase life expectancy by 4.7 years (the estimated life expectancy increase attributable to modern medical care) rather than 9.3 years (the overall observed increase in life expectancy). This proportion (53%) was then added to 2003 mortality rates to estimate what the mortality rate in 2003 would be in the setting of 1950 health care. For example, the observed decrease in mortality rate between 1950 and 2003 for individuals aged 0–1 was 0.0248 (0.0070 subtracted from 0.0318). Fifty-three percent of this mortality reduction was estimated to be attributable to health care, and therefore the mortality rate in 2003, assuming 1950 health care, would be 0.0070 + 0.0248 × 0.53, or 0.0198. Similar calculations were made for other ages. Modern medical care had the greatest relative impact at younger ages, and the greatest absolute impact at older ages.

*Yearly estimates were used in simulation.

†US Census data did not stratify data for ages over 85. Values were assumed to be bounded by 2003 data.

TABLE 2. Per-Capita Annual Expenditures for Health Care, Stratified by Age (Based on Meara et al[19])

Age (yr)	Annual Per-Capita Spending, 2003	Annual Per-Capita Spending, 1950	Incremental Change in Spending, 1950–2003
0–5	$2190	$284	$1905
6–64	$4148	$539	$3609
65–74	$13,062	$1698	$11,364
75+	$22,630	$2942	$19,688
All age groups	$5698	$741	$4957

All expenditures were inflated to US$ 2003 and further adjusted to consider excluded administrative expenses by multiplying them by that constant (1.26) which minimized the discrepancy between expected and observed national health expenditures, based on the age distribution of the US population. As no data were available to describe the age distribution of health expenditures in 1950, we assumed an identical age distribution to Meara et al.[19] However, because health expenditures in 1950 were only 13% of expenditures in 2003, it is unlikely that the results of our analysis would vary greatly if the age distribution in 1950 were different from our assumptions.

ysis of the US Census Bureau's Current Population Survey, a sample of 60,000 households among the civilian noninstitutionalized population.[14] This analysis was stratified by income, and even in the highest stratum (≥400% poverty line), fewer than half elected to pay for health insurance. Because most of these individuals decided not to purchase insurance (even when they have high income levels), we reasoned that this unwillingness to pay may be used to infer an upper-bound estimate for a cost-effectiveness decision rule. Correspondingly, we sought to estimate the incremental cost-effectiveness of unsubsidized health insurance.

We estimated the health benefits that would accrue to nonelderly adults (ie, ages 21–64, before the age criterion for Medicare coverage) purchasing unsubsidized health insurance, and compared these benefits with the corresponding costs that would be incurred. Because health insurance is commonly purchased in yearly time intervals, we evaluated a 1-year purchase. Benefits could accrue because of a decrease in the probability of death during the year in which the insurance was purchased. Costs could accrue because of the price of the health insurance above and beyond likely out-of-pocket medical expenses during that year in the absence of insurance.

Estimating the Benefits From Nonemployer-Subsidized Health Insurance

Although absence of health insurance has been associated with poorer survival in observational studies,[24–28] no experimental evidence directly suggests that the absence of health insurance results in poorer health outcomes.[29] However, experimental evidence shows that absence of health insurance decreases utilization substantially and comparably across a wide spectrum of health services, including those for which there is greatest evidence of benefit.[30] Therefore, we reasoned that this relationship is likely to hold for those health services that impact mortality.

The only randomized controlled trial examining the impact of health insurance status on health service utilization was the RAND Health Insurance Experiment,[30] which randomized 5809 individuals to varying levels of copayments for medical services (0%, 25%, 50%, and 95%) up to a yearly out-of-pocket spending cap. Based on this experiment, investigators estimated the arc elasticity of medical service utilization (the quantity by which utilization would decrease if health care prices were to increase by a particular amount) to be −0.31.[31] Individuals with health insurance pay 18% of full costs[32] whereas individuals without health insurance risk paying 100% of full costs; applying the RAND elasticity estimate to this difference using the standard formula

$$\text{Arc elasticity} = [(Q_2 - Q_1)/(P_2 - P_1)] \times [((P_1 + P_2)/2)/((Q_1 + Q_2)/_2)]$$

where Q_1 and Q_2 are the earlier and later utilization quantities, and P_1 and P_2 are the earlier and later prices suggests that the uninsured would use 35% fewer medical services compared with insured individuals. This estimate is corroborated by observational studies showing that the utilization of a broad spectrum of lifesaving medical services is reduced without health insurance by 22–43%.[24–28]

Based on these results, we assumed that individuals who purchased health insurance would have a decrement in mortality equal to 35% of the mortality benefit from health care (Table 3). Individuals who died were assumed to forgo a life expectancy typical for their age (on average 21.019 years, discounted; 34.360 years, undiscounted; based on the age distribution of nonelderly adults in the United States).[33] The resulting impact (17% reduction in probability of death) was broadly consistent with the observational analysis (25% mortality reduction) cited by the Institute of Medicine's report on the impact of uninsurance.[34,35]

Estimating the Costs of Nonemployer-Subsidized Health Insurance

We approximated the costs of health insurance using the Kaiser Family Foundation's telephone survey of 2995 randomly selected public and private nonfederal employers in 2003.[36] We assumed that the incremental cost for an individual purchasing health insurance would be the average annual premium for employer-subsidized coverage ($3383). We did not assume that purchasing insurance would reduce out-of-pocket expenses because the Medical Expenditure Panel Survey suggests that out-of-pocket expenses in 2003 did not vary greatly by insurance status (mean annual expenses; $509, any private health insurance; $443, uninsured).[32]

TABLE 3. Mortality for Selected Ages by Access to Health Insurance

Age (yr)	Mortality Rate, 2003*	Mortality Rate, 2003 Without Health Insurance	Increase Compared With Health Insurance	
			%	Absolute
<1	0.0070	0.0115	64	0.0045
10	0.0002	0.0003	53	0.0001
20	0.0009	0.0010	8	0.0001
30	0.0010	0.0011	14	0.0001
40	0.0021	0.0024	13	0.0003
50	0.0044	0.0051	17	0.0007
60	0.0098	0.0114	16	0.0016
70	0.0239	0.0275	15	0.0036
80	0.0593	0.0661	11	0.0068
90	0.1540	0.1703	11	0.0163

Individuals without health insurance were assumed to forgo that portion of the mortality benefit from health care (35%) that was only delivered in the presence of health insurance. These benefits varied greatly by age, having the greatest relative impact at younger ages, and the greatest absolute impact at older ages. Only results for nonelderly adults (between ages of 21 and 64) were used in our analyses.

*Yearly estimates were used in simulation. Estimates collapsed into 10-year intervals for readability.

†US Census data did not stratify data for ages over 85. Values were assumed to be bounded by 2003 data.

Sensitivity Analyses

We performed several sensitivity analyses. Because the age distribution of medical care's benefit is not entirely certain, we alternatively assumed that the benefit accrues at the earliest and latest possible age ranges. Because it may be argued that the preference of "modern" medical care is a supposition that regards adults rather than children, we performed analyses omitting children from our cohort. We performed analyses using the Institute of Medicine's estimate of the mortality attributable to uninsurance (25% increase) rather than our own (17% increase). Because some cost effectiveness analyses choose not to discount costs and benefits, we performed a sensitivity analysis in which we did not apply discounting.

Finally, we also performed a sensitivity analysis that considered quality of life as well as quantity of life [ie, estimating a decision rule in terms of QALYs rather than life-years (LYs)]. Although some data suggest that cost per LY and cost per QALY are highly correlated,[37] this assertion remains controversial. It may be argued that individuals sometimes purchase health care to gain quality of life improvement that is unrelated to life expectancy changes (in which case QALYs gained would exceed LYs gained) or that mortality reduction often confers additional LYs that are of low quality (in which case LYs gained would exceed QALYs gained). Accordingly, we performed sensitivity analyses to estimate QALYs attributable to modern health care both with a pessimistic assumption (health care confers no quality-improvement aside from mortality reduction, in which case people often purchase "quality-impaired" years) as well as with an optimistic assumption (health care abrogates one-half of the age-associated decrement in quality of life).[38]

RESULTS

We estimated that "modern" health care is responsible for 53% of the mortality decrease between 1950 and 2003, has added 4.7 years to life expectancy, and has increased the lifetime cost of care by $452,000. When these figures are discounted to reflect the lower value of future compared with current costs and benefits, modern health care has added 0.65 years to life expectancy at an additional cost of $118,000.

When nonelderly adults purchase health insurance, we estimated that they receive 35% of the overall benefit from medical care, which reduces their 1-year probability of death by 17% (from 0.368% to 0.307%) at a cost of $3383. This mortality reduction increases their life expectancy by 0.021 years (0.013 years when discounted).

Cost-Effectiveness

Based on these costs and benefits, we estimated that the incremental cost-effectiveness of US health care improve-

TABLE 4. Incremental Cost-Effectiveness From (A) Modern Health Care Over Lifetime of US Birth Cohort and (B) Health Insurance Over 1 Year for a Cohort of Nonelderly Adults

A. Incremental Cost-Effectiveness From Modern Health Care

	Lifetime Care Costs, 1950 Medical Care	Life Expectancy, 1950 Medical Care	Lifetime Care Costs, 2003 Medical Care	Life Expectancy, 2003 Medical Care	Incremental Cost-Effectiveness, 2003 Health Care Compared With 1950 Health Care
Base case	$16,600	29.70 LY	$135,000	30.35 LY	$183,000/LY
Health benefit accrues at earliest possible age	$16,700	29.48 LY	$135,000	30.35 LY	$137,000/LY
Health benefit accrues at latest possible age	$16,500	29.88 LY	$135,000	30.35 LY	$253,000/LY
Analysis excludes children	$18,700	19.45 LY	$169,000	21.02 LY	$ 95,000/LY
Incorporates IOM estimate	NA	NA	NA	NA	NA
Analysis does not discount	$56,700	72.60 LY	$509,000	77.30 LY	$ 96,000/LY
Optimistic assumption, QALYs conferred	$16,600	28.68 QALY	$135,000	29.77 QALY	$109,000/QALY
Pessimistic assumption, QALYs conferred	$16,600	29.19 QALY	$135,000	29.77 QALY	$204,000/QALY

B. Incremental Cost-Effectiveness From Health Insurance

	Costs, No Health Insurance	Life Expectancy, No Health Insurance	Costs, Health Insurance	Life Expectancy, Health Insurance	Incremental Cost-Effectiveness, 2003 Health Insurance
Base case	$443	21.006 LY	$3826	21.019 LY	$264,000/LY
Health benefit accrues at earliest possible age	NA	NA	NA	NA	NA
Health benefit accrues at latest possible age	NA	NA	NA	NA	NA
Analysis excludes children	NA	NA	NA	NA	NA
Incorporating IOM estimate	$443	21.000 LY	$3826	21.019 LY	$178,000/LY
Analysis does not discount	$443	34.339 LY	$3826	34.360 LY	$182,000/LY
Optimistic assumption, QALYs conferred	$443	18.688 QALY	$3826	18.718 QALY	$113,000/QALY
Pessimistic assumption, QALYs conferred	$443	18.707 QALY	$3826	18.718 QALY	$297,000/QALY

We argue that the incremental cost-effectiveness of modern health care is a plausible lower bound for society's willingness to pay (WTP) for health care, and the incremental cost-effectiveness of health insurance for those without employer- or government-subsidized insurance is a plausible upper bound. Our base case analyses suggest a range of $183,000/LY to $264,000/LY for society's WTP, whereas our sensitivity analyses suggest broader ranges ($95,000/LY to $264,000/LY and $109,000/QALY to $297,000/QALY). Individuals without health insurance are assumed to forgo the proportion of health benefits (35%) that arise from having insurance. All costs are inflated to 2003 US$.

LY indicates life-year; QALY, quality-adjusted life-year; IOM, Institute of Medicine, NA, not applicable.

ments between 1950 and 2003 was $183,000 dollars per LY saved (Table 4A). Because most individuals would likely prefer the costs and attendant benefits of "modern" health care to the costs and attendant benefits of 1950 health care, we argue that this is a plausible lower bound for society's willingness to pay (WTP) for health care.

In contrast, we estimated that individuals who purchased health insurance without an employer subsidy would be paying $264,000 per LY gained (Table 4B). Because only a minority of individuals is willing to pay this amount for health benefits, even in higher income ranges, we view this as a plausible upper bound for society's WTP for health care.

Sensitivity Analyses

We performed sensitivity analyses to explore the uncertainty resulting from particular assumptions of our method. We tested the impact of altering 5 assumptions on the overall outcomes: (1) assumed that the benefit from medical care was concentrated in the early or later part of life, rather than equally distributed, (2) restricted the age distribution of the analysis to people who are capable of influencing health policy (ie, voting-age adults), (3) used the Institute of Medicine (IOM) estimate of the mortality associated with lack of insurance (25%), (4) considered undiscounted costs and benefits, and (5) recalculated the analyses using quality of life rather than life expectancy alone.

Age Distribution

When we assumed that the entire mortality benefit from health care accrued during the earliest possible ages, our lower-bound estimate decreased to $137,000 per LY. When we assumed that the benefit accrued during the latest possible ages, our lower-bound estimate increased to $253,000 per LY. This assumption did not impact our upper-bound estimate greatly, as most individuals in this analysis were in the middle of the age range.

Omitting Children

When we omitted children from our birth cohort, our lower-bound estimate decreased to $95,000 per LY. This assumption did not impact our upper-bound estimate because that analysis involved nonelderly adults.

Using the IOM's Estimate of Mortality From Uninsurance

Using the IOM's estimate did not impact our lower-bound estimate because it was based on the overall impact of medical care, not on the portion of medical care that is only delivered to insured individuals. Using the IOM's estimate lowered our upper-bound estimate to $178,000 per LY.

Discounting

When we discounted neither costs nor benefits, our lower bound estimate decreased to $96,000 per LY, and our upper bound estimate decreased to $182,000 per LY.

Considering Quality of Life

With a very optimistic assumption about the quality benefit that individuals could receive our lower and upper bound estimates for societal WTP were $109,000 per QALY and $113,000 per QALY, respectively. With a pessimistic assumption (health care confers no quality-improvement aside from mortality reduction, and therefore people purchase "quality-impaired" years), our lower- and upper-bound estimates were $204,000 per QALY and $297,000 per QALY, respectively.

DISCUSSION

Our base case analyses suggest that societal WTP for health care in the United States is between $183,000 per LY saved and $264,000 per LY saved. Our sensitivity analyses suggest that the plausible range may be wider (between $95,000 per LY saved and $264,000 per LY saved when we considered only health care's impact on quantity of life, and between $109,000 per QALY saved and $297,000 per QALY saved when we considered health care's impact on quality as well as quantity of life).

How our results are interpreted will likely vary with individual perspectives regarding the desirability of a cost-effectiveness decision rule. Those who discourage the use of any cost-effectiveness decision rule may view our wide plausible range as an additional argument against using one, whereas those who view cost-effectiveness decision rules as expedient tools for informing policy may use our results to argue for a higher threshold or "band" of thresholds (eg, $100,000 per QALY to $300,000 per QALY). However, regardless of perspective, our results suggest that it is highly unlikely that a cost-effectiveness decision rule of $50,000 per QALY is consistent with societal WTP for health care.

It is perhaps noteworthy that the lower bound of our plausible range ($109,000 per QALY saved) resembles both the inflation-adjusted $50,000 per QALY decision rule (ie, $121,000 per QALY) and the World Health Organization 3-times per-capita gross domestic product decision rule ($113,000 per disability-adjusted-LY), and that the upper bound of our plausible range ($297,000 per QALY saved) resembles the highest figure that has been proposed as a decision rule candidate ($265,000 per QALY).[3] Although it may be argued that the substantial width of this range may limit its clinical value, the majority of incremental cost-effectiveness analyses results lies either above or below the band,[39] and therefore would be classified informatively. It is also important to observe that using a nominally higher (ie, more inclusive) cost-effectiveness rule would not necessarily increase overall health care costs if it were systematically adopted, as the cost-effectiveness of many common health services may be less favorable than this range.

Our results are validated by an analysis that was conducted independently.[40] Cutler et al estimated a benefit from modern health care (3.5 years) that was broadly consistent with our result (4.7 years) considering their shorter timeframe (their analysis covered 76% of the time interval of the present study, and their estimated benefit was 75% as large). Additionally, their estimated cost-effectiveness also was broadly consistent with our result when the same discounting assumptions were made (approximately $20,000 per LY saved, Cutler et al; approximately $28,000 per LY saved, current study, discounting costs and but not discounting benefits).[41] However, because cost-effectiveness analyses either discount both costs and benefits or discount neither costs nor benefits, these lower estimates are inapplicable to decision rules. Our results contrast with a recent study that has used contingent valuation to query individuals' hypothetical WTP to obtain perfect health, which estimated WTP per QALY well below $50,000.[42] However, this study placed a cap on the ratio of expenditures to annual income, and assumed that expenditures must occur at one particular point in time. This design may have resulted in an underestimate.

Limitations

The validity of our first approach rests on the inference that society is willing to pay for the advances that comprise modern health care. Although this inference is consistent with current spending and is supported by surveys comparing spending preferences across a wide range of alternative choices,[12,13] the tradeoffs in these surveys were implicit rather than explicit, and the validity of this inference may be questioned. We choose the year 1950 as an earlier anchor for our analysis because this year has been used as a reference point by numerous studies seeking to compare premodern with modern health care.[15–18] Although it may be argued that other anchors (eg, 1970) may also have been suitable, it is important to note that choosing a more recent anchor would likely have yielded less favorable (numerically higher) cost-effectiveness estimates,[40] and therefore our result would still be valid as a lower-bound estimate.

The validity of our second approach assumes that the preferences of individuals without subsidized health insurance resemble those of the general population. This may be a reasonable assumption because the absence of subsidized health insurance often reflects a preference of prospective employers rather than a preference of individuals (ie, subsidized health insurance may not be offered by potential employers of low-wage earners, particularly if employment choices are limited to smaller businesses).[14] Moreover, although individuals without subsidized insurance differ from the general population in important ways, (ie, lower income, different ethnic/racial composition, and poorer health status),[14] none is likely to undermine the validity of our analysis. Even those uninsured individuals who earn ≥4 times the poverty line are unlikely to purchase insurance,[14] making it less likely that the lower income of uninsured individuals explains a distinct preference against insurance. Ethnic/racial group is unlikely to independently predict a preference for eschewing health insurance. Finally, poorer health status is likely to increase rather than decrease the perceived value of health insurance, numerically lowering the cost-effectiveness estimate and therefore preserving the validity of our upper bound analysis.

We incorporated a published estimate of elasticity (ie, how demand for medical services varies with cost) that was not specific to medical services that lower mortality. Consequently, it may be argued that demand for mortality-lowering services may vary less with cost, and therefore that our estimate for uninsurance-related mortality (17% increase) may be high, particularly because the study from which the data originated (RAND) did not find that higher out-of-pocket costs consistently led to poorer clinical outcomes. However, this concern is unlikely to invalidate our results. Paying for care lowered demand for "highly effective" care as much as demand for "rarely effective" care in the RAND study (33% vs. 30% reduction in utilization, respectively),[30] and therefore the published elasticity estimate may be generalizable to services impacting mortality. Because the RAND study was underpowered to detect changes in clinical outcomes, it is not surprising that reductions in highly effective care (eg, hypertension treatment) did not worsen clinical outcomes during the study's follow-up period. Moreover, the most oft-cited estimate for uninsurance-related mortality (25%, IOM)[35] exceeds ours (17%), further reducing the likelihood that ours is an overestimate.

Finally, the validity of our study is affected by the accuracy of individuals' expectations regarding the costs and benefits of health care and of health insurance, and this has not been widely investigated. Nonetheless, this limitation should be interpreted in the context of the limitations of prior studies (eg, inferring WTP for health care from driving behavior by comparing speeding-related time savings with speeding-related health risks).[6] These studies not only had similar limitations regarding the accuracy of expectations, but often had the potentially greater limitation of assuming that decisions not explicitly involving health (eg, speeding) were made solely on the basis of health-related valuations.

CONCLUSIONS

We argue that the current, $50,000 per QALY decision rule is not consistent with observed spending behavior in the United States at a societal level. If it is necessary for a cost-effectiveness decision rule to be used, one linked to a far higher range (ie, $100,000 per QALY to $300,000 per QALY) is likely to be more consistent with aggregate spending behavior. Additionally, any simple decision rule should not be regarded as fixed, but rather should be expected to vary with changes in societal wealth, preferences, and the amount of money that is spent on health care. Although it has been argued anecdotally that the strength of a decision rule lies more in its ability to enforce order than in its ability to discriminate between correct and incorrect decisions, this argument should not be used to condone perpetuating the $50,000 per QALY rule. If a decision rule has little face validity, it will not be used for decision making anyway, so no order is attained.

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