A RAND NOTE

DISCOUNTING OF NONMONETARY EFFECTS

Emmett B. Keeler, Shan Cretin

June 1982

N-1875-HHS

Prepared for

The U.S. Department of Health and Human Services

Rand
SANTA MONICA, CA. 90406

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PREFACE/ABSTRACT

Cost-effectiveness analysts generally assume that preferences over time are such that streams of monetary and nonmonetary program effects can be reduced to one discounted sum of monetary costs and another of effects. It is known that if the nonmonetary effects can be cashed out in a way that does not vary with time, then the rates of discount for monetary and nonmonetary effects have to be equal. This Note presents a more compelling argument for the equality of those rates when hard to monetize benefits such as life-saving are involved. The Note shows that if the ability to produce the nonmonetary effect does not diminish too quickly over time, failure to discount benefits implies that programs are always improved by delay. In general, discounting benefits and costs at different rates can lead to peculiar results.

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DISCOUNTING OF NONMONETARY EFFECTS

INTRODUCTION

Cost-effectiveness analysis has become an accepted component of policy analysis in the Federal government. The Office of Management and Budget (OMB) has instructed a number of agencies to prepare cost-benefit or cost-effectiveness analyses for their regulations. Although OMB originally favored cost-benefit analysis (in which all costs and all benefits are assigned a dollar value), many agencies find it more appropriate to conduct cost-effectiveness studies (in which the benefits may be measured in nonmonetary terms, such as years of life saved or parts per million of pollutant). As a result of a recent Supreme Court decision, the Occupational Safety and Health Administration (OSHA) now relies solely on cost-effectiveness analyses (3).

Congress is also committed to cost-effectiveness analysis as one component of policymaking. The Office of Technology Assessment (a Congressional agency) has used cost-effectiveness analysis in their own work and has commissioned several research studies employing these techniques to evaluate life-saving programs (11). Although most life-saving programs have involved new medical techniques or disease prevention programs, the health field is not the only arena in which the evaluation of nonmonetary benefits against costs must be made. Flood control projects, environmental protection projects, occupational safety measures, and even military programs may have life-saving or other nonmonetary effects as a primary benefit.

In applying traditional cost-effectiveness methods to programs whose main benefits involve extension of life, a controversial and important issue has emerged: How should one handle monetary costs and life-saving benefits that accrue at different times (2, 11, 14)? The value one places on a cost or a benefit may vary depending on when it occurs, reflecting an individual's time preference. In investment analyses, where both the costs and benefits are monetary, the time preference problem has been handled by discounting both the costs and the benefits at a specified discount rate. Whereas most people readily accept the need to discount money, the discounting of life-saving benefits has met with considerable resistance (13). Several cost-effectiveness studies in health areas have attempted to skirt the issue by discounting costs but not benefits (5, 7) or by choosing very low rates of discount (11).

Although the question of how to handle discounting in cost-effectiveness studies has arisen primarily in life-saving programs, the issues are similar for any nonmonetary benefits. Is the choice among discounting strategies an arbitrary one or are there technical reasons to prefer one approach over another? This is the question addressed in this Note.

The controversy over the "proper" discounting of costs and benefits in life-saving programs is far from moot. The choice of discounting strategy can profoundly affect the results of a cost-effectiveness analysis of a life-saving program.

To illustrate this point, Table 1 compares two programs for reducing mortality from heart disease: mobile coronary care units

Table 1

COST PER ADDED YEAR OF LIFE UNDER DIFFERENT DISCOUNTING ASSUMPTIONS

Discount rate for Costs	Benefits	Program: MCCU	Screening
0	0	$3,100	$ 2,400
5	5	4,300	3,900
10	10	6,100	67,000
5	0	$330	$1,000

(MCCU) that would increase the probability of survival of adults who have had a heart attack and a preventive program to screen children for elevated cholesterol and recommend dietary changes to those identified (4). The entries represent the cost in dollars of each added year of life for a cohort of ten-year old boys. As can be seen, lower discount rates make the preventive program look more desirable.

In the MCCU program both costs and benefits are delayed by about 40 years for the ten-year old cohort. Both are similarly attenuated by discounting, leaving the cost-effectiveness ratio relatively unaffected by changes in the discount rate. In the screening program, costs are largely immediate while benefits are delayed about 40 years, making the cost-effectiveness ratio very sensitive to the discount rate. At low discount rates, the screening program appears more cost effective than the MCCU program. As shown in the last row, discounting costs but not benefits boosts the apparent cost-effectiveness of both programs, but especially that of the MCCU with its delayed costs.

Discounting only costs leads to a further complication in evaluating programs such as the MCCU program in which both costs and benefits are delayed. The cost-effectiveness ratio becomes very sensitive to the choice of age for the evaluation cohort. Evaluating the program from the perspective of a twenty- or thirty-year-old cohort (instead of a ten-year-old cohort) shortens the time period from the evaluation base year until the program actually begins. The cost per year of life saved increases by a factor of $(1+r)^{(n-10)}$, where r is the discount rate and n is the age of the cohort, from $330 for the ten-year-old cohort to $1,500 for a forty-year-old cohort.

Most analysts use equal discount rates for costs and benefits (2, 4, 11). In this Note, we will explore the consequences of using different discount rates when our ability to produce benefits for a given cost is assumed to be stable over time. Although we analyze life-saving programs, the conclusions will apply equally to any nonmonetary benefit with a stable production function.

WHEN MUST DISCOUNT RATES BE EQUAL?

When evaluating purely monetary costs and benefits, the choice of the discount rate is usually dictated by the prevailing interest rate (after adjusting for inflation).[1] This is true whenever the funds used to underwrite the costs or the returns on the investment can be reinvested freely over the life of the project (10). In this case, all money, whether it is an expense or income, must be treated in the same

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[1] The discount rate is conventionally applied to constant-value (i.e., inflation-adjusted) dollars. With moderate inflation, the discount rate is approximately the interest rate less the expected rate of inflation.

manner. If an investor insisted on discounting costs at 10 percent, for example, and not discounting income, he or she should be willing to spend \$110 one year hence (a discounted present value of \$100) in return for income of \$105 per year hence (not discounted, so the present value is \$105). This is equivalent to giving away \$5 a year from now. The implication is clear: If cost-benefit analysis is used to evaluate financial decisions, the same discount rate must be used for costs and benefits to ensure rational results.[2]

Under what situations can a similar technical argument be made for using equal discount rates when costs and benefits are measured in dissimilar units? To answer this question, we will first develop a model of the programs under evaluation and the preference structure implied by the cost-effectiveness evaluation.

We will show that failure to discount benefits at all implies that no life-saving program should ever be started. Discounting benefits at a lower rate than costs implies that a program can only be funded if the set of programs under consideration has sharply decreasing returns. Finally, the lower the discount rate on benefits, the less money is spent on current cohorts of people.

MODEL OF PROGRAMS AND PREFERENCES

Cost-effectiveness is most useful when a policymaker is seeking to maximize a given benefit on a limited budget. When the expenses and the benefits are both immediate, the cost-effectiveness ratio ranks the

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[2] This is not to say that all analysts will want to use cost-benefit analysis even in investment problems. Individuals with nonlinear utilities for money, for example, might not agree with the rank ordering of projects implied by a simple cost-benefit analysis. In other situations, tax laws may make apparently unattractive investments worthwhile.

alternatives under consideration by their effect per dollar spent. The problem of ranking programs is more complex if costs or benefits (or both) occur over longer periods of time. Now preferences on the timing of costs and benefits must be incorporated into the cost-effectiveness ratio.

Cost-effectiveness analysis assumes that the program can be fully described knowing only the costs incurred over time and the time stream of resulting benefits. A program P is described by a vector (C; B) = $(c_0, c_1, c_2, \ldots, ; b_0, b_1, b_2 \ldots)$, where c_i and b_i are the cost and benefit in time period i and are greater than or equal to zero for every i.

The next step in most cost-effectiveness studies is to reduce the vector (C; B) by replacing the vector C with the aggregated discounted costs and the vector B with the aggregated discounted benefits. If R_c is the rate of discount for costs and R_b is the rate of discount for benefits, then we define the discount factors

$$\alpha = 1/(1 + R_c) \text{ for costs and}$$

$$\beta = 1/(1 + R_b) \text{ for benefits.}$$

We then define two scalars: $C(\alpha)$ (the discounted costs) and $B(\beta)$ (the discounted benefits). Using standard discounting techniques:

$$C(\alpha) = \sum_{i=0}^{\infty} c_i(\alpha)^i$$

$$B(\beta) = \sum_{i=0}^{\infty} b_i(\beta)^i.$$

The pairs of scalars $C(\alpha)$ and $B(\beta)$ will only be meaningful if they reflect the same preference for programs as the original vectors. In this paper, as in most applications of cost-effectiveness analysis, this is assumed to be the case. Formally, let $\mathcal{P}$ denote the set of all programs under consideration and R(C; B) denote the complete preference ordering of programs based on the full vector of costs and benefits.

Assumption 1. There exists an α, $0 < \alpha < 1$, and β, $0 < \beta \leq 1$, and a preference function R' based on the scalars $C(\alpha)$, $B(\beta)$ such that $R'[C(\alpha), B(\beta)]$ agrees with R(C; B) for all pairs of programs from the set $\mathcal{P}$ for which $C(\alpha)$ and $B(\beta)$ converge absolutely.[3]

EVALUATION PERSPECTIVE: INDIVIDUAL OR SOCIETAL?

In most business applications of cost-effectiveness analysis, the costs and benefits over time apply to the same individual or group. In public policy decisions, we often face situations in which costs and benefits fall on different individuals. Competing programs will often benefit entirely different groups (sickle-cell screening versus Tay-Sachs screening, for example). In particular, delaying a program may alter which individuals incur costs or reap benefits.

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[3] Assumption 1 can be derived from an equivalent set of assumptions about the vector stream itself. If preferences over the time stream of costs and benefits follow certain rules, then for some discount factor program rankings based only on the scalars $C(\alpha)$ and $B(\beta)$ will agree with rankings based on the full vector stream. In particular, Assumption 1 will hold when:

1. The cost vector C is preferentially independent of the benefit vector B. (See Keeney and Raiffa (10) for a full discussion of preferential independence.)
2. Preferences between costs (benefits) in the first two periods are independent of costs (benefits) in the remaining periods.
3. If two streams have identical first-period costs (benefits), then preferences between these two streams will be maintained when the first period costs (benefits) are deleted and the remaining elements are moved up one period.

The last two assumptions are equivalent to Koopman's assumptions (8), except for another technical assumption made there. That assumption can be interpreted by comparing temporary programs that benefit just one cohort of people with long-range programs that benefit all future cohorts equally. It is violated if every long-run program (with positive benefits) is preferred to every temporary program (no matter how large the benefit). When benefits are not discounted, the assumption must be violated, because every long-run program must be preferred to every temporary program. Since we are specifically interested in the case where benefits are not discounted, we will not make this assumption.

Two possible perspectives may apply in evaluating health programs: individual or societal. What is appropriate in the analysis from one perspective may be totally inappropriate from the other. Consider, for example, a diet program aimed at preventing future health problems. An individual may consider the program P, beginning the diet immediately, with its attendant stream of costs and benefits (C; B). As an alternative, the individual may wish to consider the program $P^{\dagger}$, waiting one year and then beginning the diet. The costs and benefits associated with $P^{\dagger}$ will not necessarily represent a simple shift of the costs and benefits associated with P. Delaying one year may reduce the benefits possible from the diet. Because life is finite, delaying sufficiently (say, 70 years) will reduce both the costs and the possible benefits to zero.

Now let us consider a similar program from the point of view of society. Suppose the program is the implementation of a healthful diet among school age children. When this program is delayed by one year, the costs and benefits will apply to a somewhat different population. If the population is stable, the size of the program will not vary with the year in which it is implemented, and the cost-benefit vector for the delayed program will be identical to the original vector shifted in time. When viewed from the perspective of the cohort served by each program, the cost-effectiveness ratio is constant provided the production function is stable over time.

In this analysis, we take the societal perspective rather than the individual perspective. We further assume that the population is stable and that the possibilities for producing benefits do not decrease over time.[4] This means that any feasible program P can be delayed one period. More formally,

<u>Assumption 2</u>. If P is a feasible program characterized by (C; B), then $P^\dagger$, achieved by delaying P one period, is also feasible and is characterized by $(C^\dagger, B^\dagger)$, where

(a) $c^\dagger_0 = b^\dagger_0 = 0$ and

(b) $b^\dagger_{i+1} = b_i$ and

(c) $c^\dagger_{i+1} = c_i$, for all $i \geq 0$.

Finally, we need to make some assumptions about the relationship between costs and benefits. To do this, we will first categorize programs by the number of periods during which costs are incurred. Let $\mathcal{P}_i$ be the set of all programs with no costs after period i. For each set of programs $\mathcal{P}_i$, we will define the benefit production function, that is, the maximum amount of discounted benefit achievable for an expenditure of x discounted dollars, for all possible values of x. We define a distinct production function $f_i(x)$, associated with each set of programs $\mathcal{P}_i$:

$$f_i(x) = [\text{Max } B(\beta) | C(\alpha) \leq x \text{ and } (C; B) \text{ in } \mathcal{P}_i].$$

Using this notation, we make some simple assumptions about these production functions.

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[4] In fact, the results which follow will hold using a somewhat weaker assumption, under which the costs of producing benefits rise at a constant rate for each period of delay. For the later propositions to hold, the rate must be less than the difference between the rates of discount for costs and benefits times the benefit discount factor. The alternative form of Assumption 2 is the same, except $(c^\dagger)$ replaces (c): $(c^\dagger)$ $c^\dagger_{i+1} = (1 + \gamma)\, c^\dagger_i$, where $0 \leq \gamma < (\beta/\alpha)-1 = (R_c - R_b)(\beta)$. The proofs follow the same lines as in the case $\gamma = 0$.

Assumption 3. For all i and for all $x \geq 0$:

(a) $f_i\ (0) = 0$,

(b) $f'_i(x) > 0$.

Part (a) is trivially true whenever benefits are measured relative to the benefit level with zero expenditures. Assuming that the first derivative of the production function is positive ensures that benefits will increase with increasing budget x.

RESULTS

We now explore the consequences of discounting costs but not benefits. In the notation adopted earlier, this corresponds to $\beta = 1$, while α is < 1.

Proposition 1. If $\alpha < \beta = 1$, and Assumptions 1 through 3 hold, then every program in $\mathcal{P}_i$ is dominated by a program in $\mathcal{P}_{i+1}$ with lower aggregated costs and greater aggregated benefits.

Proof. Let (C; B) be any nonzero program in $\mathcal{P}_i$ with aggregated costs $C(\alpha) = x$ and aggregated benefits B(1). Since $f'_i(x) > 0$, one can choose a program in $\mathcal{P}_i$ with aggregated (discounted) costs $x + \varepsilon$ and aggregated benefits greater than B(1). By Assumption 2, this program can be delayed one period to produce a program in $\mathcal{P}_{i+1}$ with aggregated costs $\alpha(x + \varepsilon)$ and benefits greater than B(1). We have only to choose $\varepsilon < x(1 - \alpha)/\alpha$ to guarantee that the delayed program has lower aggregated costs and higher aggregated benefits than the original program (C; B).

Proposition 1 implies that the discounting of costs but not benefits in a cost-effectiveness analysis has a paralyzing effect on a decisionmaker. If the programs under consideration satisfy

Assumptions 1 through 3, analysts using cost-effectiveness as the basis for choosing among programs can never start a program. For any attractive program, there is always a superior delayed program which should be funded first. The result is that no program with a finite starting date can be selected.

This result does NOT imply that undiscounted benefits are meaningless. On the contrary, they can be very useful in describing a program, since most people have a better intuitive grasp of the meaning of additional years of life expectancy, for example, than they do of additional discounted years of life expectancy. The undiscounted benefits are only absurd as the numerator of a benefit-cost ratio in a context where that ratio will be used to rank programs.

We now turn to the case in which both costs and benefits are discounted, but benefits are discounted at a lower rate than costs. In this case, a weaker version of Proposition 1 holds.

<u>Proposition 2</u>. If $\alpha < \beta < 1$ and Assumptions 1 through 3 hold, then

(a) For every program in $\mathcal{P}_i$, there exists a program in $\mathcal{P}_{i+1}$ with a greater benefit to cost ratio and

(b) For any program P* in $\mathcal{P}_i$, any other program P in $\mathcal{P}_i$ with positive benefits can be delayed until P has a larger benefit cost ratio than P*.

<u>Proof of 2a</u>. Delaying any program in $\mathcal{P}_i$ one period increases its benefit to cost ratio.

<u>Proof of 2b</u>. Let $k = \beta/\alpha$. Let R* be the benefit to cost ratio of P* and let R be the benefit to cost ratio of P. Since $R > 0$, we can

find an integer $t > \log(R^*/R)/\log k$. Delaying P by t periods increases its benefit to cost ratio to Rk^t, which is greater than R^*.[5]

This proposition is weaker than Proposition 1 because the scope of the delayed program is smaller than the scope of the original program. With enough delay, even the worst program with positive benefits becomes better than the best immediate program. However, we may still be able to implement the best current program PROVIDED we have sufficient total budget to cover the current program while setting aside enough to cover all the delayed programs with better or equal cost-effectiveness. Now the paralyzing paradox that followed from Proposition 1 (namely, that we can never begin a program) will only occur for certain classes of production functions. We will next derive conditions specifying these classes of production functions for the special case of programs which benefit a cohort of individuals.

Application of Proposition 2 to Cohort Programs

Many programs in health and education lend themselves to cohort analysis, which can be applied to programs that benefit a well-defined group of people. It is then possible to accumulate all the benefits of the program by following this group of people over time. When the last member of the cohort dies, all benefits of the program will have materialized. A program to screen school age children for hearing loss, for example, could be analyzed as a cohort program. The relevant cohort may be quite disparate in terms of age or location (as in a program to provide wheelchairs for all paraplegics or a program of cardiac ambulances for victims of heart disease) so that cohort analysis can be applied to a broad range of programs.

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[5] In the more general case where costs increase at rate γ, let $k = (1/(1+\gamma))(\beta/\alpha)$.

One feature of cohort programs is that such programs can be delayed; they will then apply to a different, later cohort. The cohorts to whom these delayed programs apply can be unambiguously ordered by a criterion such as the birth year of the youngest cohort member. If we assume that the production possibilities are stable and that all the programs under consideration are of the cohort type (that is, can be shifted in time yielding the same cost-benefit stream from the time of implementation), then it follows that

$$f_i(x) = f(x) \text{ for all } i.$$

As before, we assume that $f'(x) > 0$. For mathematical simplicity, we will also assume $f''(x) \leq 0$. Most individual programs would satisfy this condition of nonincreasing marginal returns, but programs with large fixed costs would not. Even with such programs, $f(x)$, which depends on sets of programs rather than individual programs, might have a nonpositive second derivative provided there are other programs in the set with linear or decreasing benefits over a range of costs. The composite benefit-cost curve ($f(x)$) results from ranking all available programs in order of decreasing cost-effectiveness; the curve becomes less steep as less attractive programs are considered. Grosse, for example, showed that proposed government health programs in 1966 generated a production function with nonincreasing marginal returns (6).

We will now establish conditions on $f(x)$ under which it will be possible to fund programs.

For a budget ceiling M, the optimal budget allocation using cost-effectiveness criteria is the solution to the following constrained optimization problem:

$$\text{Max } \Sigma\ (\beta)^i f(x_i)$$
$$\text{s.t. } \Sigma\ (\alpha)^i x_i \leq M$$
$$x_i \geq 0,$$

where

$$X = (x_0, x_1, x_2, \ldots)$$

is the vector describing the operating budget for the ith cohort. Since $f''(x) \leq 0$, the first derivative must have its maximum at zero. Let

$$f'(0) = A^*.$$

Then

$$f'(x) \leq A^* \text{ for all } x \geq 0.$$

In order to be able to invest in any current programs, then, the total budget must be large enough to cover all programs (delayed and nondelayed) with a cost-effectiveness of A* or better.

The marginal cost-effectiveness of the last dollar spent in the current year's budget is just $f'(x_0)$. However, the cost-effectiveness of investments in the ith year will be enhanced by the differential discounting of costs and benefits. The marginal cost-effectiveness of the last dollar invested in year i will be

$$f'(x_i)*(\beta/\alpha)^i$$

A budget allocated on cost-effectiveness grounds must satisfy:

$$x_i = 0 \qquad \text{for all i such that } f'(0)(\beta/\alpha)^i < A$$

and

$$f'(x_i)(\beta/\alpha)^i = A \qquad \text{for all i such that } x_i > 0,$$

where A is the break-even cost-effectiveness level, separating funded from unfunded projects. Since $f'(x)$ is a nonincreasing function of x, this implies that $x_{i+1} > x_i$ for all i. The total dollars allocated, S(A), is just the discounted present value of the expenditures in all years:

$$S(A) = \Sigma\ (\alpha)^i (x_i).$$

In order to be able to spend any monies in the current year, the break-even cost-effectiveness level A must be greater than or equal to A*, i.e., the budget ceiling M must be greater than S(A*). If the budget M is less than S(A*), programs will not begin until year t, where t is the smallest integer such that

$$S(A^*)(\alpha)^t \leq M.$$

Therefore, if S(A*) diverges, then no finite budget can ever fund programs with a finite start date.

For certain functional forms for f(x), it is easy to specify conditions under which S(A*) converges. For example, if $f(x) = x^{(1/c)}$, $c \geq 1$, then S(A*) converges if $\beta^c < \alpha$. If f(x) = log(x + 1), S(A*) converges for $\beta < 1$. For f(x) = 1 - exp(-x), S(A*) converges for all values of β.

Using a lower discount rate for benefits than costs does not necessarily paralyze the decisionmaker who relies on cost-effectiveness analysis, but it has peculiar consequences for the budget allocation over time. For one thing, as time goes on, progressively fewer and fewer cost-effective programs are implemented. Some programs are not being funded in the current year because they are not sufficiently cost-effective so that money can be spent in the future on even less efficient programs. Current programs are being held to a more stringent standard than future programs, and the result is a small initial year allocation that increases in every succeeding year.[6]

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[6] It is possible that programs with bounded costs can have

Although we found no published articles supporting the use of a higher discount rate for benefits than for costs, it is interesting to see what the consequences of this practice would be. Under the same assumptions about the production function, the optimal budget would decrease over time rather than increase, with the largest expenditure in the current year. Programs in the future would have to meet more stringent cost-effectiveness criteria than current programs. The longer the delay, the more efficient the program would have to be in order to be funded.

DISCUSSION

In cost-effectiveness analysis, dollar costs and nonmonetary benefits are purposely kept in different units of measurement, usually because an analyst is loathe to place an explicit dollar value on the benefit. Once we have separated years of life, for example, from dollars, there is no automatic link between the costs and benefits that would require us to use the same discount rate for both. There is no established market for years of life and much disagreement about the appropriate way to establish an explicit shadow price for a current year of life. There is even less consensus about how to trade off current years and future years of life. We cannot make a direct argument, then, that the discount rate for nonmonetary benefits and costs must be the

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infinite benefits. In this case by delaying the start, we can have programs with arbitrarily small costs and infinite benefits. These programs are still optimal in the sense of the Von Weizacker overtaking criterion, and the bigger budget leads to better programs in that sense. A stream of benefits, b', overtakes another, b, if there exists a T such that for all $T' > T$:

$$\Sigma^{T'} \beta^{i} b'_{i} \geq \Sigma^{T'} \beta^{i} b_{i}.$$

This means that eventually one program gets ahead of another to stay.

same. We have been able to show, however, that the use of a lower discount rate for benefits than for costs leads to some peculiar, even absurd, consequences in the allocation of monies over time on a cost-effectiveness basis.

In this analysis, we have used added years of life as an example of a nonmonetary benefit. In the health field, ethical arguments have been raised against the discounting of life years. In light of our results, these ethical arguments seem less than compelling, since failure to discount benefits implies that we should always be willing to transfer resources away from present health needs to buy additional years of life for future generations. There are several philosophical objections to this ethical argument and its consequences.

First, it is hard to guess how future generations would want to spend the resources. We know neither the values they will put on health versus other uses of the money, the context of their health problems, or indeed who they will be. Second, simple maximization of undiscounted benefits would stop many intuitively desirable programs. Population planning reduces future years of life, and a medical X ray on a child causes infinite undiscounted expected genetic changes. Finally, justice is not served by transferring money from poor people to rich people, or by transferring health care from the sick to the well (12). Yet future generations will probably be richer and live longer than we will.

Decisions about programs that generate a public good, such as information on treatment for cancer, cannot be tailored to individual preferences. The results in this Note apply in evaluating cancer research programs, where we must rely on a consensus about benefits. In contrast, our results do not apply in choosing a treatment for individuals already afflicted with cancer. In the latter case, we should rely on their personal values. When patients with lung cancer were asked to value the survival profiles associated with surgery and with radiotherapy, their responses showed great individual variation in implicit discount rates on future years (9).

In considering programs that add years of life, we have not looked at any detail about those years. Certainly, we value different decades of our own lives differently. Most people display a U-shaped preference for saving others' lives as a function of age, preferring that the lives of young adults be saved over those of infants or the very old (1). In addition, most health-related programs affect the quality as well as the quantity of life. In theory, at least, one can look at a nonmonetary benefit that adjusts for the age and quality of life-years saved. Once these adjustment are made, the question of how to discount these benefits in comparison to costs still remains, and our results still hold.

We conclude that any cost-effectiveness analysis using different discount rates for costs and benefits is difficult to justify. This practice leads to patterns of spending over time that most policymakers would not accept. Even those analysts who are willing to accept the consequences of using a lower discount rate for benefits should also present their results with equal rates of discount. In the health field, standard practice is to use both five and ten percent rates of discount. As with any accounting convention, uniform practices permit an easy comparison with the body of work in the field.[7]

[7] We would like to thank Dutch Leonard, Duncan MacRae, John Mendeloff, Milton Weinstein, and Richard Zeckhauser for their helpful discussion of this issue at the 1980 APPAM Research Conference.

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