The discount rate in the economic evaluation of prevention: a thought experiment

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Abstract

***Objectives*—In the standard economic model of evaluation, constant discount rates devalue the long term health benefits of prevention strongly. This study shows that it is unlikely that this reflects societal preference.**

***Design*—A thought experiment in a cause elimination life table calculates savings of eliminating cardiovascular disease from the Dutch population. A cost effectiveness analysis calculates the acceptable costs of such an intervention at a threshold of 18 000 Euro per saved life year.**

***Methods*—Cause specific mortality (all cardiovascular causes of death and all other causes) and health care costs (all costs of cardiovascular disease and all other causes of costs) by age and male sex of 1994.**

***Results*—At a 0% discount rate, an intervention eliminating cardiovascular disease may cost 71 100 Euro. At the same threshold but at discount rates of 3% or 6%, the same intervention may cost 8100 Euro (8.8 times less) or 1100 Euro (65 times less).**

***Conclusions*—The standard economic model needs more realistic duration dependent models of time preference, which reflect societal preference.**

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Discounting in economic evaluation implies that costs and benefits occurring at different points in time are valued differently. Weinstein and Stason proposed the problem as follows: take a programme with identical costs now, but programme A yields one year of life now, and programme B will yield one year of life within 40 year.[1] Few will doubt what programme policy makers will choose. In general we prefer to pay as late as possible, and to enjoy the benefits as soon as possible. In the standard model of economic evaluation of health interventions, a simple exponential model is recommended to represent this time preference: the discount rate.[2] Values in the future are devalued by a constant annual percentage, equal for costs and effects. That means that at a discount rate of 5% health effects are devalued in year 1 by 5%, in year 10 by 40%, in year 20 by 65% in year 30 by 80%, and so on. The further away costs and effects in the future, the more they will be discounted and the less they are valued now.

In the standard model of economic evaluation, discount rates for costs and health effects have to be equal for various reasons.[1 3–6] Applying discount rates for the rise in consumption in real terms, something of 5% to costs and effects, makes nearly all prevention programmes aiming at long term benefits very cost ineffective.[7] We demonstrate by a thought experiment that it is highly unlikely that the constant discount rate reflects societal preference.

Methods and Results

A thought experiment is a device of the imagination, an experiment that can achieve its aims without being executed. Its aim is to create an anomaly in the reigning theory.[8] In this thought experiment, we radically eliminate cardiovascular disease as cause of death and as cause of health care costs, in a hypothetical cohort of new borns. We then recalculate life expectancies and health care costs at various discount rates as if cardiovascular disease never existed. Because cardiovascular disease is prevalent in old age, any change in discount rate has tremendous consequences.

We use a cause elimination life table with two causes of death and two sources of costs (cardiovascular diseases and all other causes of health care costs and deaths). The methods have been presented previously in more detail.[9] The life table is interpreted as a cohort, and is based on the mortality of all causes and of all cardiovascular causes (ICD-9 codes 390–440) of Dutch men (1990–94). Medical costs of cardiovascular diseases and of all other causes than cardiovascular disease are taken from the Cost of Illness Study of 1994.[10] We assume that an intervention eliminates all cardiovascular diseases, both as a source of costs and as a cause of death. Discounting is appropriate

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Table 1 Life expectancy at birth (E_0), life time cost expectancy (CE_0), and both expectancies after elimination of cardiovascular diseases ($E\text{-}_0$; $CE\text{-}_0$). ΔE_0 and ΔCE_0 show the life time savings in life years and Euro (if negative, these are costs) after elimination of cardiovascular disease. At 18 000 Euro per saved and discounted life year, the acceptable cost of an intervention at birth is $18000 \times \Delta E_0 + \Delta CE_0$ Euro

Discount rate	*E_0*	*CE_0*	*$E\text{-}_0$*	*$CE\text{-}_0$*	*ΔE_0*	*ΔCE_0*	*Acceptable costs*
0%	74.15	124000	78.89	138000	4.74	−14000	71100
3%	29.31	32600	29.76	32700	0.45	−100	8100
6%	16.25	15300	16.30	15100	0.05	200	1100
10%	9.879	9230	9.883	9170	0.004	60	130

Values are rounded.

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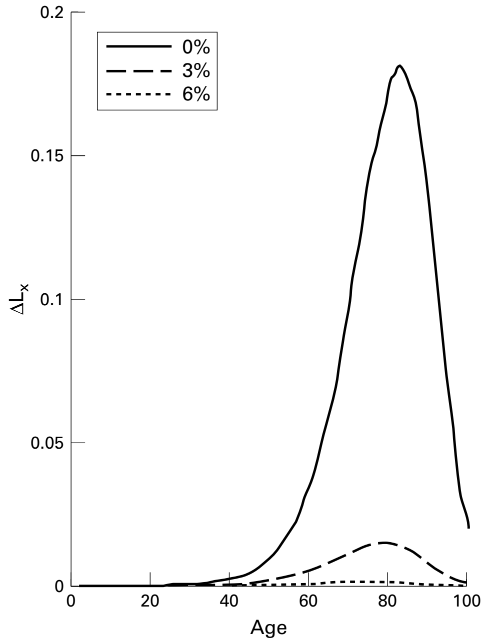

Figure 1 Life years saved by age (ΔL_x) after elimination of cardiovascular mortality at birth, at discount rates of 0%, 3% and 6%. The surface is the saved life expectancy.

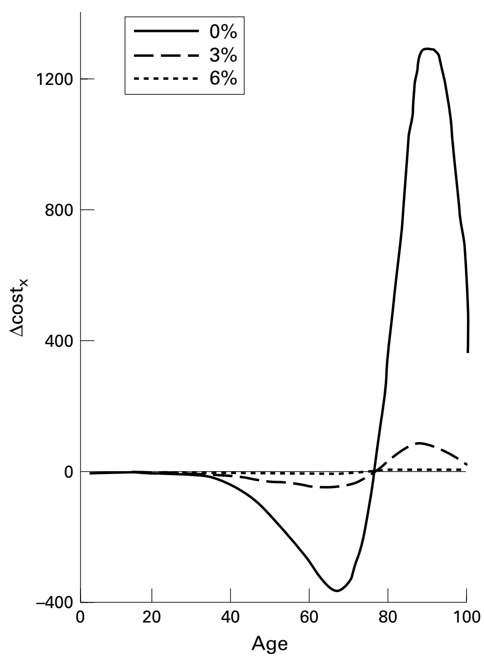

Figure 2 Changes in health care costs ($\Delta Cost_x$) by age after elimination of cardiovascular disexase at birth, both as cause of death and as cause of costs at discount rates of 0%, 3% and 6%.

because in a cohort age and time are equivalent. In the Netherlands, 18 000 Euro per saved discounted life year is considered an acceptable price for prevention programmes.[11] The acceptable costs of an elimination programme at time 0 are then equal or less than (18 000 Euro × saved life years + saved costs). The saved costs are the result of the savings, caused by the eradication of cardiovascular disease and the costs, caused by life extension.

Table 1 lists the main results. Male life expectancy (E_0) in 1990–94 was 74.2 years. The undiscounted costs of the life table cohort subjected to the mortality risks of 1990–94 and the health care costs of 1994 (the lifetime expected costs at birth, CE_0) are 124 000 Euro. After elimination of cardiovascular mortality, life expectancy increased by nearly five years and costs increased by 14 000 Euro. The costs generated by life extension are higher than the costs saved by elimination of cardiovascular disease.[9 10] However, because nearly five life years are saved, these costs of life extension are rather trivial: elimination of cardiovascular disease may cost more than 71 000 Euro, and still be considered cost effective.

Discounting at even small rates changes these estimates tremendously. At 3%, the discounted life expectancy decreases by 60% or 45 years, and the discounted cost expectancy decreases even by 74% or 90 000 Euro. The discounted costs of life extension disappear, but the discounted benefits decrease by 90%. The acceptable price of elimination decreases ninefold from 71 000 Euro to 8100 Euro. At 6%, the acceptable prices decrease 70-fold (1100 Euro). Figures 1 and 2 show graphically the results from table 1. Health gains and the costs of life extension are many years away in the future of the birth cohort, and will disappear almost completely after discounting.

KEY POINTS

- If resources are scarce, trade offs have to be made between investing in the care of existing disease and in the prevention of future disease.
- In the standard model of economic evaluation, costs and health effects are devalued by a constant discount rate.
- The utility of eliminating all cardiovascular diseases in a cohort of new borns is excessively dependent of the constant discount rate used.
- Economic evaluation of prevention needs a more realistic model of time preference that reflects societal preferences.

Discussion

The use of discount rates implies that we strongly devalue the benefits of any preventive activity implemented at youth or adult age and aimed at degenerative diseases. Indeed, at a discount rate of 6% a vaccination that would save us eternally from all cardiovascular diseases would not be considered worthwhile at expenses over 1100 Euro, the price of a better colour television set or hi-fi set. We think that few people would agree.

It is not the rationale of discounting that is to be doubted. In medicine, there are many practical examples of the hypothetical case as presented by Weinstein and Stason.[1] Compare for example vaccination against hepatitis B and treatment of hepatitis B patients. Assume that by vaccinating against hepatitis B we must forego treatment of patients with chronic hepatitis B, or vice versa. Then, the adequate weighing of future disability is of crucial importance. Using zero % discount rates

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implies that we value the disease within 20 or more years equal to existing disease now. This is contrary to "the law of cure". Only if the future health benefits of vaccination outweigh by far the actual health benefits of treatment can we accept to forego treating hepatitis B. The aging of the population will coincide with the boom in preventive health care technology, driven by the increasing knowledge about the genetic basis of many diseases. Choices between care, cure and prevention will be inevitable.

The problem is the constant monotonous discount rate in the standard model of economic evaluation. This constant rate is responsible for the strong dependence of future values of the future time horizon. Empirical studies about time preference are relatively rare, small, limited to selected populations and beset by low response rates (probably a consequence of the high level of abstraction of the questions asked). None of these show any empirical support for the monotonous constant discount rates.[12] On the contrary, observed discount rates depend on the length of the time horizon proposed.[12–14]

Value judgements over time are neither objective measures, nor are they obvious results of an irrefutable theory. But neither are they arbitrary. People are clearly willing to invest in their health during their life course. Parents are even more eager to invest in the future health of their children. This makes little sense if they would devalue health over time at an eternally negative compound interest. But resources are constrained and opportunity costs are attached to these investments. To guide people and policy makers in their choices about the values of prevention we need better empirical estimates of time preferences, and more realistic time dependent models of discounting that reflects these.

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Conflicts of interest: none.

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