



Risk in Perspective

Gains in Life Expectancy from Medical Interventions



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"...a gain in life expectancy from a medical intervention can be judged as large or small by comparing it with others of its type, that is, with other interventions aimed at the same target population."

Quantitative measures of the outcomes of medical interventions have moved to center stage in an environment of concern over ensuring the quality of health services while containing medical expenditures. However, decision makers lack perspective for assessing the clinical or policy significance of measured outcomes. Clinicians and others who use the results of clinical trials focus on the quality of evidence for the effectiveness of a medical intervention, using well-established test statistics such as p-values to assess the degree of confidence that can be placed in the results. These decision makers are less familiar with the available benchmarks for judging the magnitude of the effectiveness of a medical intervention. Without such benchmarks it is impossible to answer the question: "How large is large?"

One important quantitative measure is the gain in life expectancy (LE). It is especially difficult to establish perspective on the LE gains from preventive interventions, because frequently only a small fraction of the recipients of the intervention

actually realize any benefit, driving down the average gain. Thus, strategies aimed at preventing life-threatening diseases may appear ineffective alongside treatments of the already ill.

In this issue of RISK IN PERSPECTIVE, we report the results of a Program on the Economic Evaluation of Medical Technology study in which benchmarks for magnitudes of life expectancy gains were developed. The basis for our benchmarks is that a gain in life expectancy from a medical intervention can be judged as large or small by comparing it with others of its type, that is, with other interventions aimed at the same target population.

Gain in Life Expectancy as a Measure of Outcome

In the field of public health, the effectiveness of life-saving preventive services is usually measured in terms of numbers of deaths avoided.

The Program on
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However, some deaths are more premature than others. Avoiding a teenage fatality from an automobile accident is different from avoiding a death from hospital-acquired pneumonia in a patient with end-stage cardiac disease.

The effectiveness of life-saving medical treatments is most often measured in terms of the increase in the proportion of people alive at a fixed point in time - for example, as a change in the five-year survival rate. Again, the information in this measure is incomplete. Two populations with the same chances of 5-year survival may have very different probabilities of surviving the sixth year or the following 20 years.

In contrast, life expectancy gain is a much richer measure of life-saving effectiveness than deaths avoided or a snapshot change in survival rate. LE gain is a composite measure of the gain in survival caused by the intervention. Mathematically, the LE gain is the area between the survival curves of the treatment and control groups (Figure 1). The two traditional metrics for measuring the effectiveness of treatments -- percent survival at a point in time and median survival time -- each capture only one dimension of the shift in the survival curve.

There are two challenges associated with using life expectancy gain as a measure -- one for the analyst, and one for the user of the analysis. First, survival data are almost always "censored", some members of the cohort are still alive at the end of the clinical trial or observational study. A model must be constructed to extrapolate the survival curves beyond the end of the study.

The second challenge is cognitive; a life expectancy gain is usually thought of as a certain gain at the end of life, rather than as a probabilistic gain throughout the remainder of life. This cognitive distortion is

greater for preventive interventions than for treatments.

What Causes Life Expectancy Gains to Vary?

Age, gender, and race are the primary determinants of life expectancy in the general population. In populations with risk factors for particular diseases and in populations already ill, these factors become less important as relative risk rises or clinical status worsens.

The prevalence and incidence rates of the disease in the target population set upper bounds on the gain from a preventive intervention. Thus, a screening intervention can never lead to a large gain in life expectancy if the disease has low prevalence, and a vaccination program can offer only limited life expectancy gain if the disease has low incidence. On the other hand, curative or palliative interventions are targeted at populations in which everyone already has the disease, so the potential exists for large gains. However, the same factor that makes the potential gain large -- a poor prognosis -- will often drive down the actual gain if survivors face competing risks that reduce the potential gain in longevity.

Building a Database of Life Expectancy Gains

LE gains from a variety of medical interventions were taken directly from, or calculated from, data in 83 published articles. Our aim was to gather LE gains for as wide a variety of interventions as possible. Most of the articles that yielded the information we sought were either decision analyses, or cost-effectiveness analyses. Some very important interventions do not appear in our database. Investigators generally examine interventions that are salient, because they are new or controversial. For example, breast cancer is prominent in our database because of the controversies over the opti-

mal age to begin mammography and the role of genetic testing.

In our article in *The New England Journal of Medicine* the LE gains are presented in five tables organized primarily by target population. The first two tables are concerned with preventive strategies, and the other three with treatments. A sample of the results from each table are presented in Figure 2. The complete versions of all five tables have been posted on HCRA's website: <http://www.hsph.harvard.edu/organizations/hcra/NEJM.htm>

Life expectancy gains for prevention in the general population tend to be measured in months. The largest gains are associated with reductions in risk of cardiovascular disease, such as regular exercise, and the smallest with childhood vaccinations. Screening for common, treatable, cancers (breast, cervix, colon) tends to be intermediate, while screening for less common or less treatable cancers produces much lower gains. It is evident that for preventive interventions targeted at people of average-risk, a gain on the order of a month of life expectancy can be considered "large". To place these gains in perspective, demographers have estimated that eliminating all deaths from heart disease or cancer would add only approximately 3 or 2 years to life expectancy in the United States, respectively.

Prevention in elevated-risk populations produces gains that are highly variable. In some cases, "elevated" risk is only slightly above average risk for the disease; in other cases, it is much greater. Some interventions in this category, including smoking cessation, yield LE gains on the order of several years, but others, such as coronary risk-factor reductions for persons with a previous heart attack, are in the range of months. In general, for preventive interventions targeted at people with elevated

risk, a gain on the order of a year of life expectancy can be considered "large".

We also reviewed LE gains for treatments of target populations diagnosed with cardiovascular disease, cancer, and a variety of other diseases - HIV, gallstones, hepatitis, end stage renal disease, and suspected appendicitis. The LE gains from treatments vary widely, but very few are less than a month.

Standardizing Outcomes Data

We have developed the first comprehensive database of published gains in life expectancy from medical interventions, stratified by target population. This work is a contribution to the developing technology of calibrating and standardizing the effectiveness of medical interventions, and can help inform a clinician's intuition, a policy maker's judgment, or a reporter's "spin" about the importance of a life-extending preventive service or treatment.

The organization of LE gains by target population, by disease, and by type of intervention, has established a framework that can be used for the presentation of other standardized outcomes data. Quality-adjusted life expectancy (QALE) gains could be systematically presented alongside LE gains. Since LE gains and/or QALE gains are usually available in cost-effectiveness analyses, cost-effectiveness ratios -- measured in both dollars per year and dollars per quality-adjusted year -- could be added to the tables.

FURTHER READING

Naimark D, Naglie G, Detsky AS. The Meaning of Life Expectancy: What is a Clinically Significant Gain? *J Gen Intern Med* 1994; 9:702-707.

Wright JC, Weinstein MC. Gains in Life Expectancy from Medical Interventions - Standardizing Outcomes Data. *N Engl J Med* 1998; 339(6): 380-386.

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Figure 2: Life Expectancy Gains

