Patient-Assessment-Instruments/Quality Measures/Downloads/NationalImpact AssessmentofQualityMeasuresFINAL.pdf).
2. Martin AB, Lassman D, Washington B, Catlin A. Growth In US health spending remained slow in 2010; health share of gross domestic product was unchanged from 2009. Health Aff (Millwood) 2012;31:208-19.
3. Jha AK, Joynt KE, Orav EJ, Epstein AM. The long-term effect of Premier pay for performance on patient outcomes. N Engl J Med 2012;366:1606-15.
4. Lindenauer PK, Remus D, Roman S, et al. Public reporting and pay for performance in hospital quality improvement. N Engl J Med 2007;356:486-96.
5. Ryan AM, Doran T. The effect of improving processes of care on patient outcomes: evidence from the United Kingdom's Quality and Outcomes Framework. Med Care 2012;50:191-9.

DOI: 10.1056/NEJMp1204939

The Cost-Effectiveness of Environmental Approaches to Disease Prevention

Dave A. Chokshi, M.D., and Thomas A. Farley, M.D., M.P.H.

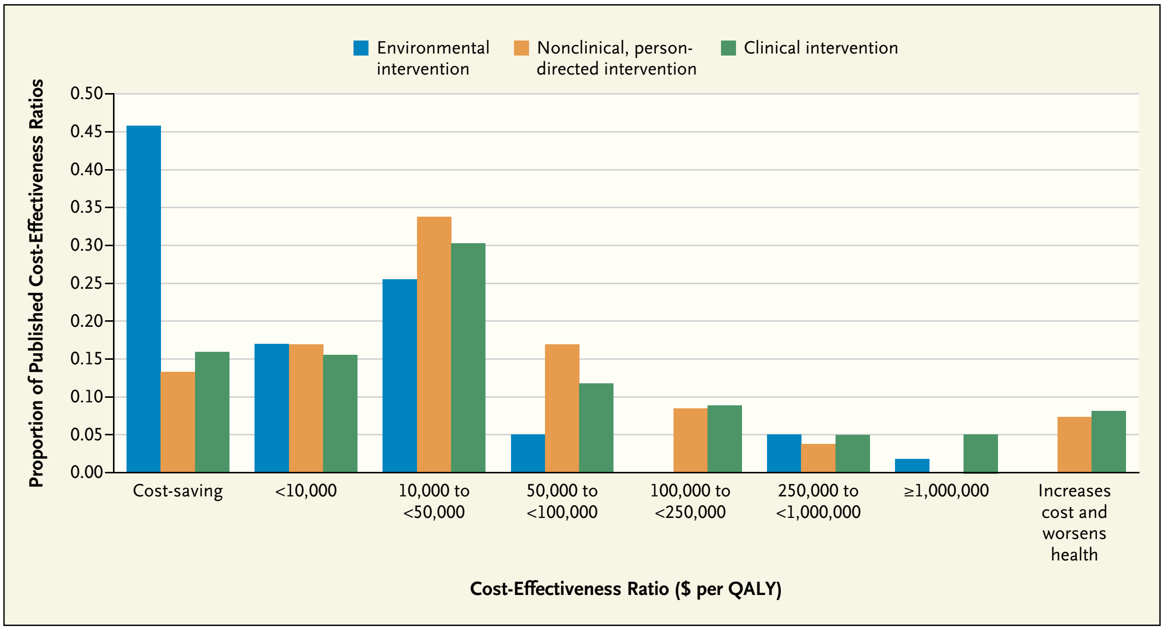
How can society prevent the most disease and deaths per dollar spent? This question arose throughout the debate on U.S. health care reform and will continue to drive decision making as health care funding becomes increasingly constrained. In an atmosphere of austerity, demonstrating the cost-effectiveness of preventive health interventions becomes particularly important.

Although preventive approaches to disease are intuitively appealing — and frequently presented as a way to reduce costs — analyses have suggested that, as a whole, they're no more cost-effective than therapeutic interventions.[1] But are some preventive approaches more cost-effective than others? The National Commission on Prevention Priorities attempted to address this question, ranking clinical preventive services in terms of cost-effectiveness and "clinically preventable burden" of disease.[2] Yet some preventive services, such as tobacco taxes or water fluoridation, are not delivered in health care settings. Understanding whether certain approaches are more cost-effective than others requires a framework for categorizing preventive interventions.

Medicine traditionally classifies preventive interventions on the basis of disease course: primary prevention aims to prevent new cases of disease; secondary prevention and tertiary prevention mitigate the effects of existing disease. We propose two overlapping dimensions to further characterize primary preventive interventions: environmental versus person-directed, indicating whether the proximate target is an element of the environment or an individual, and clinical versus nonclinical, indicating where an intervention takes place. Separating person-directed from environmental interventions permits the comparison of prevention conducted individual by individual (e.g., cancer screening) with prevention that acts on persons indirectly by altering the physical or social environment (e.g., a ban on trans fats). Whether an intervention takes place within a health care setting or elsewhere has implications for resource allocation, since funding streams for clinical and nonclinical interventions tend to be distinct. Some nonclinical interventions, such as syringe-exchange programs, are person-directed, but all environmental interventions are nonclinical.

Because reaching individuals directly is generally more expensive than changing an environmental element, we hypothesized that unless a person-directed intervention was very effective (like childhood immunization, for example), environmental interventions would generally be more cost-effective. We further hypothesized that it mattered where an intervention was delivered and that nonclinical, person-directed interventions would be more cost-effective than clinical interventions. To test these hypotheses, we conducted a comparative analysis of the cost-effectiveness of environmental, nonclinical but person-directed, and clinical preventive interventions.

We analyzed the contents of the Tufts Medical Center Cost-Effectiveness Analysis (CEA) Registry, which contains information on 2815 cost-effectiveness analyses published through December 2011. Costs per quality-adjusted life-year (QALY, a unit of measure for survival that accounts for the effects of suboptimal health status) are reported after conversion to 2011° U.S. dollars. Only cost-utility analyses — which permit comparison of programs addressing different health problems by converting health outcomes into a common metric — are included in the registry. We excluded studies that didn't report on an intervention meet-



Cost-Effectiveness of Categories of Preventive Interventions.

ing the definition of primary prevention and categorized the remaining studies as environmental, clinical, or nonclinical but person-directed (for complete methods, see the Supplementary Appendix, available with the full text of this article at NEJM.org).

According to our definitions, the CEA Registry contained 401 studies of clinical prevention, with 1259 associated cost-effectiveness ratios; 37 studies of nonclinical, person-directed prevention, with 83 associated cost-effectiveness ratios; and 31 studies of environmental prevention, with 59 associated cost-effectiveness ratios. Environmental interventions were generally more cost-effective than clinical interventions or nonclinical, person-directed interventions (see graph); the proportion that were cost-saving was higher among environmental interventions (46%) than among clinical interventions (16%, P<0.001) or nonclinical, person-directed interventions (13%, P<0.001). The distribution of cost-effectiveness ratios was similar for clinical interventions and nonclinical, person-directed interventions. Twenty-seven of the 59 cost-effectiveness ratios for environmental interventions (46%) indicated that the interventions were cost-saving; an additional 10 environmental interventions (17%) cost less than $10,000 per QALY, and 15 (25%) cost $10,000 to $50,000 per QALY. As a point of reference, $50,000 to $100,000 per QALY is often used as the upper limit for favorable cost-effectiveness ratios.

In an environmental model of prevention, people's behavior is influenced by their physical and social environment.[3] It can be far less expensive to alter an environmental element to which many people are exposed than to interact with each person directly. Even if the effect of an altered environment on each person is small, the cumulative population effect can be large; cost-effectiveness can be favorable because the cost per person reached is small. For instance, Smith-Spangler et al. estimated that, as compared with the status quo, a tax on sodium that reduces population sodium intake by 6% would reduce heart disease and stroke incidence, increase QALYs by 1.3 million, and save $22.4 billion over the lifetime of adults who are currently 40 to 85 years of age.[4]

We were surprised to find that nonclinical, person-directed preventive interventions were not more cost-effective than clinical interventions. Although the absence of a discerned effect may not indicate a true absence of effect, this finding suggests that the "environmental" character of an intervention may be more important than the "nonclinical" character in determining cost-effectiveness. Environmental change may have initial costs followed by lasting effect (e.g., building recreational facilities to promote physical activity), whereas person-directed interventions have continued costs (e.g., exercise programs). Furthermore, many environmental interventions are low-cost because they're implemented by regulation (e.g., smoke-free-air laws) or are executed centrally (e.g., food fortification with folic acid). Some environmental interventions, such as excise taxes, may generate government revenue that can offset costs or be used for health programs.

Our finding that the environmental interventions studied were the most likely to be cost-saving doesn't necessarily mean that all environmental interventions are cost-effective. Some may be expensive to implement and benefit few people — for example, building-safety regulations that prevent extremely rare injuries. The finding suggests, however, that there may be more cost-effective environmental interventions than are currently recognized and that such interventions deserve more attention.

Our analysis could be biased by underreporting of studies of ineffective environmental interventions, leading to an overestimate of favorable cost-effectiveness. On the other hand, published studies are more likely to investigate contentious topics, rather than interventions widely known to be cost-effective. Also, we found significantly fewer studies on environmental and nonclinical, person-directed interventions than on clinical interventions. More generally, cost-effectiveness is predicated on an initial demonstration of effectiveness, which is often difficult and analytically fraught for preventive interventions, particularly environmental ones. Assessing the value of prevention is more difficult than evaluating treatments for established disease, because the long time horizon for clinical end points introduces considerable uncertainty about benefits.

Our findings have important implications for resource allocation. Environmental prevention is key to addressing the growing disease burden and cost of chronic illnesses. For example, in New York City, an environmental approach to chronic-disease prevention included increased tobacco taxes, a comprehensive smoke-free-air law, mass-media campaigns against smoking and sugar-sweetened beverages, the banning of trans fats from restaurants, and a restaurant calorie-labeling initiative. It has been estimated that the antismoking initiatives alone reduced the number of smokers in the city by 450,000 over a decade and the number of smoking-related deaths by 1500 per year. But increased investment in environmental interventions should not be pitted against person-directed interventions: in most cases, the two work synergistically, as they did in effecting large decreases in mortality from cardiovascular disease in the second half of the 20th century.[5]

The paucity of studies on the cost-effectiveness of environmental preventive interventions impedes their broader adoption. Unlike other forms of economic evaluation, cost-effectiveness studies can demonstrate value through direct comparison of alternative interventions. The scientific literature now points to the value of implementing preventive environmental interventions that are cost-saving and conducting additional cost-effectiveness studies of such interventions.

The views expressed in this article are those of the authors and do not necessarily represent those of the New York City Department of Health and Mental Hygiene.

Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.

From Brigham and Women's Hospital and Harvard Medical School — both in Boston (D.A.C.), and the New York City Department of Health and Mental Hygiene, New York (T.A.F.).

1. Cohen JT, Neumann PJ, Weinstein MC. Does preventive care save money? Health economics and the presidential candidates. N Engl J Med 2008;358:661-3.
2. Maciosek MV, Coffield AB, Edwards NM, Flottemesch TJ, Goodman MJ, Solberg LI. Priorities among effective clinical preventive services: results of a systematic review and analysis. Am J Prev Med 2006;31:52-61.
3. Brownson RC, Haire-Joshu D, Luke DA. Shaping the context of health: a review of environmental and policy approaches in the prevention of chronic diseases. Annu Rev Public Health 2006;27:341-70.
4. Smith-Spangler CM, Juusola JL, Enns EA, Owens DK, Garber AM. Population strategies to decrease sodium intake and the burden of cardiovascular disease: a cost-effectiveness analysis. Ann Intern Med 2010;52:481-7.
5. Ford ES, Capewell S. Proportion of the decline in cardiovascular mortality disease due to prevention versus treatment: public health versus clinical care. Annu Rev Public Health 2011;32:5-22.

DOI: 10.1056/NEJMp1206268