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Cost-Effectiveness Analysis and HIV Screening: The Emergency Medicine Perspective

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Abstract

Cost-effectiveness analysis is a useful tool for decision makers charged with prioritizing the myriad medical interventions in the emergency department (ED). This analytic approach may be especially helpful for ranking programs that are competing for scarce resources while attempting to maximize net health benefits. In this article, we review the health economics literature on HIV screening in EDs and introduce the methods of cost-effectiveness analysis for medical interventions. We specifically describe the incremental cost-effectiveness ratio—its calculation, the derivation of ratio components, and the interpretation of these ratios.

INTRODUCTION

Background

As medical technology advances and the costs of health care multiply, the use of analytic methods to maximize the value of health services has become increasingly common. The field of health economics aims to identify the interventions that produce the best health outcomes with available resources. Cost-effectiveness analysis is one helpful method for assisting policymakers as they gauge the economic value of expensive interventions. This analytic approach may be used to help rank programs competing for scarce resources while maximizing the net health benefits that can be derived from a fixed budget.

Importance

In 2007, the American College of Emergency Physicians released a policy statement affirming the importance of the Centers for Disease Control and Prevention (CDC) 2006 recommendations for routine HIV screening. Support of ED-based HIV screening in this statement, however, was contingent upon adequate and sustained funding to achieve this goal.[1] In this article, we begin by reviewing the current literature on the economic evaluation of HIV screening in emergency departments (EDs). We then introduce the 3 types of formal economic analysis: cost analysis, cost-benefit analysis, and cost-effectiveness analysis. Next, we present details about cost-effectiveness analysis for medical

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interventions, describing the calculation of cost-effectiveness ratios, the derivation of their components, and the interpretation of their results. Finally, we describe several published cost-effectiveness analyses from EDs and summarize the cost-effectiveness analyses specific to HIV screening.

Reports of Effectiveness and Costs of HIV Screening in EDs

In 2000, the Public Health and Education Task Force of the Society of Academic Emergency Medicine published recommendations for grading preventive interventions considered suitable measures for routine emergency care.[2,3] After reviewing 17 interventions, the task force assigned HIV screening and 4 other services an alpha rating, defined as sufficient evidence to support offering this service in EDs. In 2006, CDC revised its guidelines for HIV screening to recommend that all adults and adolescents be offered an HIV test in health care settings, including EDs.[4] At that time only 13% of academic EDs adopted policies recommending routine HIV screening.[5] More recent data suggest the increased adoption of guidelines: universal HIV screening was offered in 16% of academic EDs in 2007 and 65% in 2009 (see articles in this issue by Haukoos and Rothman).

A recent review by Kelen and Rothman revealed over 30 reports from individual ED-based programs or studies of HIV testing in the past 10 years.[6] Although many of these reports cited cost, the lack of sustained funding, or the lack of evidence of cost-effectiveness of HIV testing in the ED as a potential limitation of widespread program implementation,[2,6–9] many authors did not report the costs associated with the program and rarely, if ever, undertook formal economic analysis.

We conducted a literature review on economic analyses of HIV testing in the ED from 1996 to the present, searching MEDLINE for the following keywords: cost, economic, cost-effectiveness, cost-utility, cost-benefit, HIV testing, HIV screening, emergency department, emergency room, outpatient, and urgent care. We supplemented the MEDLINE search with a manual search of related references from the emergency medicine literature. Most of the studies summarized in the Table reported the total cost of the program[8, 10–15]; some included an analysis of the total cost,[10] the component costs,[14, 15] as well as the cost per patient screened, the cost per HIV-positive patient, or less frequently, the cost per HIV-infected patient linked to care.[14, 15]

Many of these analyses are performed from the perspective of the hospital providing the testing (or the funding source).[14] Thus, they may not incorporate some costs (eg, HIV treatment costs or the long-term benefits of screening, such as extension of life expectancy because of more timely HIV treatment or the potential for decreased transmission to sexual partners). Moreover, although the reported costs per HIV-infected patient identified may be informative for ED budget planning, these frequently reported economic outcomes are less helpful in estimating the value of HIV screening compared with the cost-effectiveness of other ED-based programs.[16, 17] What are the benchmarks, for example, of an attractive ratio of cost per patient screened or per patient identified? Other critical considerations are the cost of offering the test, of the time spent with people who refuse testing, and of the time required to test those who are uninfected. Finally, cost analyses should consider not only the wages of ED providers but the cost of taking advantage of a prevention opportunity. ED providers who participate in testing activities do so in lieu of providing other ED care, which may result in other delays in the ED. The diversity in reported cost outcomes suggests the need for economic analyses that can easily be compared, according to widely recognized standards, in various settings.

Overview of the Types of Economic Analysis

In general, 3 types of economic analyses are used in health care settings: cost (or cost-minimization) analysis, cost-benefit analysis, and cost-effectiveness (or cost-utility) analysis. Cost analysis provides an estimate of the resources used for a particular type of intervention or illness, and cost is reported as the outcome of interest.[18] Although cost analysis may be useful for planning and budgetary forecasting, it fails to provide information regarding the effectiveness or value of the intervention examined. In contrast, cost-benefit analysis incorporates not only the resources used for a clinical intervention but also a measure of the value (clinical benefit) of those resources.[18] Similar to cost analysis, cost-benefit analysis reports cost as the primary outcome, thus requiring researchers to value clinical benefits, such as lives saved or life years saved, in monetary terms.[18] Because of the ethical and methodological challenges inherent in converting clinical benefits to currency, formal cost-benefit analysis is not common in health care settings.

Unlike cost analysis and cost-benefit analysis, each of which has a single monetary outcome measure, cost-effectiveness analysis explicitly examines 2 outcome measures: (1) the monetary costs of alternative interventions and (2) the clinical effects (effectiveness) of the interventions being compared. In cost-effectiveness analysis, the value of an intervention is evaluated by using the incremental cost-effectiveness ratio, a measure of the added health benefits obtained for the added cost of a new program. To improve the quality and comparability of cost-effectiveness analyses, published guidelines advocate standard methods and assumptions.[18–22] Because of the frequent use (and misuse) of cost-effectiveness analysis and the term *cost-effective* in the medical literature,[20] we provide a brief overview of the methods of cost-effectiveness analysis.

Cost-Effectiveness Ratio

An incremental cost-effectiveness ratio compares the costs and health effectiveness (clinical benefits) of a new medical intervention (eg, program A) with the costs and effectiveness of a baseline intervention (eg, program B). The numerator is expressed in dollars; the denominator is expressed in years of life saved.

$$\text{Incremental cost-effectiveness ratio} = \frac{(\text{costA} - \text{costB})}{(\text{health effectA} - \text{health effectB})}$$

Because the units of a cost-effectiveness ratio are in dollars per years of life saved (or quality-adjusted years of life saved), higher incremental cost-effectiveness ratios indicate less economically efficient interventions.

Perspective of a Cost-effectiveness Analysis

The perspective depends on the intended use of the analysis and the decision maker seeking to use it; the assumed perspective may have a substantial impact on the conclusions drawn from the analysis.[23] An intervention may be cost-effective from the perspective of the entity that pays for the intervention, such as an employer or insurance agency, but not from society's perspective.

The US Panel on Cost-Effectiveness in Health and Medicine recommends that researchers conduct cost-effectiveness analyses from the societal perspective, thereby considering everyone affected by the intervention and counting all important outcomes and costs, regardless of who experiences them. Cost-effectiveness analyses performed from other perspectives may reasonably omit the outcomes and costs considered irrelevant to the decision maker. By considering all significant outcomes and costs, the societal perspective remains objective, allowing the gains of some members of society to be offset by the losses of other members.[20]

Measures of Cost

The costs incorporated into the numerator of the cost-effectiveness ratio include more than simply the cost of the intervention under consideration. They should include the lifetime costs of all the clinical events that are anticipated with each therapeutic alternative. In general, these costs may be divided into 2 groups: direct costs and indirect costs. Because costs will be compared, they should be expressed in a single unit of currency at a defined time to adjust for price inflation (eg, 2009 US dollars).

Direct medical costs are the costs of services involved in the delivery of medical care, such as acute hospitalization, outpatient visits, physician services, medical supplies, tests, and procedures. Direct nonmedical costs are the costs borne by agents outside the health care setting, such as patients' transportation costs, other out-of-pocket expenses, and resources from other agencies.

Indirect costs consider productivity losses and gains attributable to health status. These costs represent the time of patients or their family members that is consumed or freed by the medical interventions under consideration. Some of these costs may be excluded if they are trivial or similar to the costs of the alternative strategies being examined.[20]

Measures of Effectiveness

The US Public Health Service Task Force recommends the quality-adjusted life year (QALY) as the effectiveness outcome measure for cost-effectiveness analyses.[20] The QALY reflects both quantity and quality of life. The latter is based on responses from people who expressed their preferences for various health outcomes.[18]

Quality of life adjustments are based on patient or societal ratings of the quality of life associated with various health states, along with the time patients spend in each health state. The quality weights, also known as preferences or utilities, are reported on a scale of zero (representing death) to 1 (representing perfect health). Various theoretically sound methods (eg, *standard gamble, time tradeoff*) are used to derive these quality weights.[23] The time in each health state may be estimated in a number of ways. For example, researchers may use mathematical models to extrapolate long-term outcomes from short-term data reported by clinical studies.[24] Once quality weights and time in each health state are determined, quality-adjusted life expectancy, as measured in QALYs, may be calculated by multiplying the quality weight for each health state by the time spent in that health state; these products (for all possible health states) are then summed to obtain the total number of QALYs.

Discounting

Both the costs and benefits of medical interventions may be distributed by time. For example, HIV testing by an emergency physician encompasses cost (eg, the physician's time) and potential benefit to the patient. Future costs and benefits are derived from confirmatory testing and lifetime care for HIV-infected patients. In an economic evaluation of a medical intervention, costs and benefits are, by convention, *discounted* to their current value to ensure fair assessment across the time distribution.[20] Discounting, or the process of converting future costs or health benefits to their current values, adjusts for the timing of costs and health effects to reflect the general belief that people prefer to receive benefits sooner and pay costs later. The value of the discount rate in economic evaluations reflects the strength of the preference to expedite benefits and delay costs: the higher the discount rate, the lower the valuation of a future dollar or health outcome. The US Panel on Cost-

Effectiveness in Health and Medicine recommends that cost-effectiveness analyses discount both costs (ie, the numerator of the ratio) and health benefits (ie, the denominator) at 3% per year.[20]

Limitations of Cost-Effectiveness Analysis

Although cost-effectiveness analysis has many strengths as a decision tool, its inherent assumptions may not always be appropriate for patient-level decision making. The methods are population based and utilitarian and are intended to maximize overall health gains, disregarding which members of the population receive these benefits. The analysis does not explicitly take into account questions of justice and equity—or the problem that even strategies identified as cost-effective may remain unaffordable in some settings.[21] It may also be true that some programs are deemed worthy of funding in the absence of documented cost-effectiveness. Nucleic acid testing of donated blood for HIV, hepatitis B virus, and hepatitis C virus is essential to the safety of the blood supply. However, the cost-effectiveness ratios of such practices are very high ($1.5–$11.2 million/QALY).[25, 26] Cost-effectiveness, then, should be only one consideration in deciding how to ethically and efficiently allocate scarce resources. The adoption of a particular strategy may be based on numerous setting-specific considerations: for example, infrastructure, equity, disease severity, qualitative attributes of the strategies, societal priorities and values, ethical considerations, nonmonetary constraints, synergy with other high-priority initiatives. Nonetheless, the results of cost-effectiveness analyses may be used to inform the prioritization of various strategies or to direct resources toward strategies that hold promise for maximizing gains in health.

Interpreting the Results of Cost-Effectiveness Analyses

The strengths of cost-effectiveness analysis lie in its objective evaluation of interventions using accepted methods that incorporate standardized reporting criteria and explicit assumptions.[18–22] A cost-effective intervention does not necessarily cost less than an alternative intervention. Indeed, most interventions considered cost-effective extend life and thereby cost more, rather than less, money. An attractive cost-effectiveness ratio falls within the range of ratios for which society or a designated payer is willing (or able) to pay. Although there is no universal criterion for an attractive cost-effectiveness ratio, investigators have mentioned thresholds of $50,000–100,000 per QALY, or 3 times the per capita gross domestic product.[27–29] However, these thresholds lack substantial theoretical and empirical grounding and are not updated regularly.[29–34] Indeed, on the basis of a recent analysis by Braithwaite et al, society’s willingness to pay for medical care ranged, in 2009 US dollars, from $137,600 to $375,000 per QALY (reported as 2003 US $109,000 to $297,000 per QALY gained).[30]

Researchers may prefer to use alternative measures of effectiveness, such as cases of disease identified (Table). However, in the absence of measures of willingness to pay for such an outcome, it is challenging to conclude whether this kind of reported ratio represents a good value for the money. In addition, the value of programs analyzed by using differing measures of effectiveness cannot readily be compared within the framework of cost-effectiveness analysis. Therefore, the health outcomes in cost-effectiveness analyses should be measured in broadly applicable units, such as the QALY, as recommended by the US Public Health Service Task Force.[20] By using agreed-upon conventions for cost-effectiveness analysis,[18, 35] one can compare the cost-effectiveness of interventions in a given clinical setting, such as the ED.

Cost-Effectiveness of ED-based Interventions

As the entry point for many hospital admissions and the primary care venue for many at-risk or underserved patients, the ED often provides services related to routine medical care and public health interventions in addition to essential emergency care. Given the ED's many competing priorities, the availability of new technologies, and rising concerns regarding the high cost of medical care, cost-effectiveness analysis is a useful tool for decision makers in the ED who are charged with prioritizing the myriad medical interventions in an environment of economic constraints. Investigators in EDs have used cost-effectiveness analyses to offer guidance on the value of new technologies or on the adoption of competing medical care strategies. For example, Aledort et al, who performed a cost-effectiveness analysis of gonorrhea screening in urban EDs, found that testing vaginal swabs with a point-of-care rapid immunochromatographic strip test yielded a cost-effectiveness ratio of $8,520 per QALY gained (2009 US$, or $6,490/QALY as reported in 2002 US$) compared with the urine-based nucleic acid amplification test, which requires several days for processing.[16] In another example, Ladapo et al assessed the cost-effectiveness of the use of computed tomography to facilitate the triage of patients who have acute chest pain, but who are at low risk of acute coronary syndrome.[17] Compared with standard of care, computed tomography for women was cost-saving for women and for men, yielded a cost-effectiveness ratio of $7,430 per QALY gained (2009 US$; reported as 2005 US $6,400 per QALY).[17]

Cost-Effectiveness Analyses of HIV Screening

Two frequently cited analyses of HIV screening used computer simulation models to project estimates of the cost-effectiveness of routine outpatient HIV screening from the societal perspective.[36, 37] Although not ED-specific, these model-based studies can inform assessments of the economic efficiency of ED-based HIV screening. Paltiel et al reported cost-effectiveness ratios, in 2001 US dollars, for routine HIV testing among outpatients of $36,000 per QALY gained for a 3% prevalence of undiagnosed HIV infection and $38,000 per QALY for a 1% prevalence (2009 US $49,500 per QALY gained for 3% prevalence and $52,200 per QALY for 1% prevalence).[36] Similarly, Sanders et al reported that routine screening in a population with a 1% prevalence of undiagnosed HIV infection produced a cost-effectiveness ratio, in 2004 US dollars, of $41,000 per QALY gained (2009 US $49,600 per QALY gained).[37] In the absence of a formal cost-effectiveness analysis of data collected solely in the ED setting, these simulation model-based projections indicate that HIV screening in the ED may provide good value and may be a sound public health investment. Routine HIV screening programs continue to collect and analyze economic and efficacy data; the publication of the results of those analyses will lead to a more definitive assessment of HIV screening in EDs.

Conclusion

As increasing numbers of routine HIV screening programs are established and new HIV infections are identified, ED-based programs will be evaluated on their economic efficiency. Although numerous testing programs have reported cost outcomes, it can be challenging to compare results because of disparate units of efficacy, disparate perspectives, and lack of consistency in specifying the year for US currency values. We propose that performing (and reporting) cost-effectiveness analyses of ED-based HIV screening programs will facilitate cross-comparisons, promote fruitful discussion in the literature, and ultimately, enhance HIV screening efficiency.

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Table

ED-based HIV testing programs reporting economic outcomes, 1996–present.

Ref	Site; Study Period	Testing			Costs Reported, Type	Economic Outcomes, 2009 US$
		Strategy	Type	Tested, No. (% Positive)		
[12]	Urban teaching hospital, Midwest; July 1998–June 2002	Risk-targeted	Conventional	5,504 (0.71)	Budget	4,088/HIV-infected person
[8]	University hospital, Cincinnati; January 1999–December 2002	Risk-targeted	Conventional	5,232 (0.86)	Total program	3,507/positive test
[15]	Four urgent care centers, Massachusetts; January–September 2002	Routine	Conventional	2,444 (2.0)	Program components	6,370/positive test
						7,223/HIV-infected person linked to care
[14]	Mt. Sinai Hospital, Chicago; April 2003–August 2004	Routine	Fingerstick rapid	1,428 (0.6)	Program components and time-motion data	11,000/HIV-infected person
						29,400/HIV-infected person linked to care
[10]	George Washington University Medical Center, District of Columbia; September–December 2006	Routine	Oral rapid	2,486 (1.1) (preliminary positive tests)	Total program, based on cost of test and hourly wage for screeners	1,900/preliminary positive test
						5,500/person with confirmed HIV-infection
[11]	Various CDC-funded HIV counseling and testing sites; N/A	Routine	Fingerstick or oral rapid	NA (1)	Model-based cost analysis; data derived from the literature and various CDC-funded HIV counseling and testing projects	2,000/HIV-infected person receiving results
			Conventional	NA (1)	Same as above	2,200/HIV-infected person receiving results
[13]	Medical center ED, Boston; September 2003–May 2004	Routine	Oral rapid	1,427 (0.6)	Personnel only	$11,800/HIV-infected person

*Adjusted by using the consumer price index for medical services. For studies in which the dollar year was not reported, the currency was adjusted using the dollar year from the end date of the study.