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Cost-Effectiveness Considerations for Disease Intervention

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Introduction

As part of the American Rescue Plan Act of 2021, the federal government announced more than one billion dollars in new funding to support the disease intervention specialist (DIS) workforce.[1] As this funding is dispersed, state and local public health officials will decide how to best use it to advance public health goals, given budget and workforce constraints. Decisions on how to develop and implement a program or intervention are made in consideration of these resource limitations, and cost-effectiveness analysis (CEA) provides a framework for guiding this decision-making process.

CEA is motivated by the need to maximize some health outcome given a limited set of resources, or conversely, to minimize the costs to achieve a particular health goal.[2] In essence, CEA quantifies trade-offs between the costs and benefits of a health intervention. A core concept in CEA is the idea of opportunity costs, or the value of potential alternative uses of a resource.[3] We typically want to avoid using limited resources on an activity if an alternative use of these resources could result in larger health gains. Costs of an intervention are measured in dollars, and benefits are measured in terms of a health outcome of interest. The costs and benefits of each intervention are then compared, and interventions that yield greater health gains per dollar spent and should thus be prioritized, all else being equal.

DIS may engage in a variety of different activities that go well beyond sexually transmitted infection (STI) partner notification. The overall benefits of having a strong DIS workforce are broad and difficult to quantify. Rather than estimating the full benefits of DIS, this commentary will focus on using CEA methods to help decision makers prioritize DIS activities.

Effectiveness of Disease Intervention

DIS perform a wide range of activities which may have broad public health benefits. Historically, a core component of the work of DIS has been partner services for patients diagnosed with HIV and STIs. Common DIS partner services include contact tracing, expedited partner treatment (EPT), and linkage to testing and treatment.[4] Current STI DIS activities go beyond these primary activities, often including linkage to routine

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health care, facilitating enrollment in health insurance, referring patients to related social services, provider education,[5] and conducting surveillance activities.[4] These activities can improve patient outcomes in areas well beyond the targeted infection. DIS also provide critical support during public health emergencies, such as foodborne illness outbreaks, Zika, and Ebola.[6] Further benefits of disease intervention activities include the downstream transmission links broken by diagnosing and treating an infection, averting some number of additional infections.

An important first step to measuring the effects of an intervention is choosing the health outcome of interest. In an ideal world, we would like to know how preventive measures impact epidemiological outcomes, like the number of infections and major sequelae treated and/or averted. More often, intermediate or process outcomes, such as number of patients tested, are more feasible to track. For example, Johnson et al. (2017) used several process and outcome metrics when assessing partner services for HIV and STIs in New York State.[7] Their process measures included the number of index cases assigned, the number of index patients interviewed, and the number of partners notified of exposure. Outcome measures included number of partners who were treated, after diagnosis or presumptively, and number of partners newly diagnosed with HIV. Other examples of outcomes used include the cost per partner with syphilis treated and the cost per partner diagnosed with HIV.[8, 9]

Incorporating dynamic effects into CEA more thoroughly accounts for the benefits of an intervention but comes at the cost of additional complexity and assumptions. Dynamics may be incorporated by using results from mathematical models to estimate the number of infections averted per some intermediate outcome, such as patients treated. More comprehensive and complex estimates of benefits may be less precise and less translatable to other contexts. An alternative strategy is to estimate the population-level effects of a program or policy without explicitly modelling the underlying transmission pathways, by estimating changes in cases at a more aggregate level such as county or state.[10, 11] Aggregate analyses could inform state health departments on funding allocations and opportunities for program coordination.

The lack of ability to fully account for all benefits of a program or intervention is not necessarily a limitation of CEA. Valid comparisons between interventions can be made on common process or intermediate outcomes alone. For example, we may want to compare two different methods for notifying partners after a diagnosis of syphilis. The epidemiological outcomes *per partner notified* may be the same across both methods, and we can use CEA to learn how to efficiently notify the most partners given our available resources.

Comparing multiple interventions is most straightforward when the interventions have the same singular outcome, since CEA outcomes must be in common units. However, there may be efficiency gains when DIS conduct complementary activities, such as partner services for both HIV and syphilis. When there are multiple outcomes of interest or outcomes vary across interventions, comparisons are still possible under a cost-utility framework in which health outcomes are converted into health utilities, such as quality-adjusted life years (QALYs) or disability-adjusted life years (DALYs). Conversion to health utilities can be

a valuable tool for comparing services with disparate outcomes. For example, converting outcomes of recommended preventive services into QALYs allowed for all U.S. Preventive Services Task Force (USPSTF) A- and B-rated services to be ranked in terms of clinically preventable burden and cost-effectiveness.[12] However, health utilities may not be well-defined for some outcomes, their calculation is difficult and may lead to mismeasurement, and their complexity and imprecision may limit their usefulness at the program level.

Costs of Implementing Disease Intervention

The analytic perspective of a CEA plays in important role in how costs are measured. Common perspectives include the payer, health care sector, and societal.[13] The payer perspective considers costs from a single payer; examples of this could be a local health department with a fixed budget for prevention activities or an insurance payer like Medicaid. The health care sector perspective includes all medical costs, including those paid by all third-party insurers and patients out-of-pocket. The societal perspective is the broadest and considers all costs related to an intervention, including non-medical factors like patient transportation costs.

The Second Panel on Cost-Effectiveness in Health and Medicine suggested evaluating cost-effectiveness from multiple perspectives, including societal.[13] However, in the case of a local health department using CEA to determine their best mix of prevention activities, evaluations from the simpler payer perspective may be sufficient (and more feasible). Ultimately, the decision of which costs and effects to include in an analysis is driven by the objectives of the decision-maker. Consider a public health department deciding how to spend a fixed budget for STI prevention. The relevant costs to include might be those directly impacting the department's expenditures, and costs paid by patients and their insurers might not be considered. When CEA is conducted by an academic institution or policymaker, then full societal costs may be relevant, without limiting the perspective to constraints specific to individual organizations.

Once the study's perspective has been determined, cost data collection is often required. Collecting costs on DIS interventions comes with its own complexities. DIS typically spend their time on a variety of activities and personnel is often the largest component of a program's cost,[14] so precisely mapping out the relevant components of the intervention of interest and correctly apportioning staff time and salaries is critical. This may require a time and motion study that measures the amount of time a DIS spends on each activity over a representative period of time.[15] For example, Williams et al. (2022) collected data on mileage and travel time for DIS because their services required frequent travel. Collecting this type of data may have the added benefit of identifying operational inefficiencies. Finally, when a societal perspective is considered, patient time costs may be particularly important. For example, if testing and/or treatment is done remotely, then the patient is implicitly receiving the valuable benefit of not having to travel to a clinic for those services.

Assessing Cost-Effectiveness and Prioritizing Activities

Outcomes and costs described in the previous two sections are combined to calculate cost-effectiveness ratios, which tell us the cost of producing one additional unit of health. When there is no comparison intervention, an average cost-effectiveness ratio (ACER) may be calculated by simply dividing costs by the health outcome. When an intervention is being compared to some reference case or standard of care, then incremental cost-effectiveness ratios (ICERs) may be calculated ($\frac{Cost_{intervention} - Cost_{reference}}{Outcome_{intervention} - Outcome_{reference}}$). The general interpretation is the same: how much additional health benefit we are achieving from the additional expenditure on some public health intervention. The ratios give a summary measure that can then be used to determine whether an intervention is worth its price. Lower ratios imply that each dollar spent results in greater health benefits, or equivalently, that greater health improvements can be achieved at a given budget.

In the short run, if a program is operating with a fixed budget, CEA can help inform the organization how to best use those dollars. If the upfront costs of a program or intervention exceed an organization's allocated budget, then a less cost-effective intervention may be the only feasible option. The same could be true if the organization faces other resource constraints, such as having too few trained DIS on staff. In the longer run, CEA can help justify changes in budget to specific priority areas. For example, the most cost-effective intervention may not be possible due to budget or other resource limitations. The cost-effectiveness finding in this case would provide a strong, quantitatively supported argument for increasing the prevention budget.

The basic steps for conducting a CEA and prioritizing interventions are as follows. First, determine the analytic perspective, i.e., from whose perspective should the costs and effects be considered? Second, determine which costs components need to be included and how to measure them. Similarly, determine which outcomes/effects are both of interest and feasible to measure. For example, a program may choose to focus on an intermediate outcome variable rather than QALYs averted, since the latter may be more cumbersome to measure. Next, collect the necessary data elements. Consider which data elements are already as part of standard accounting or surveillance activities, and which elements will require additional efforts. After data collection, calculate the cost-effectiveness ratios and rank the alternatives. Beyond evaluating one's own programs, a decision-maker may want to collect evidence of cost and cost-effectiveness from published sources as well. In any case, sensitivity analyses should be conducted to assess how sensitive the cost-effectiveness ratios may be to changes in the input assumptions. This is particularly important when comparing a local intervention to findings from the literature, which may have been studied under significantly different economic and epidemiologic contexts. If this process clearly identifies a more cost-effective intervention, then the CEA results, alongside other considerations such as budget, timelines, and strategic objectives, can be used to prioritize limited resources.

Discussion

As the DIS workforce is strengthened and expanded, knowledge of how to efficiently use DIS becomes increasingly important. Currently, there is limited evidence on the cost-

effectiveness of DIS activities.[7–9, 14] When evaluating the cost-effectiveness of one's own program, often new data collection efforts will be required. This requires foresight and planning to conduct high quality cost-effectiveness studies. Considering this, CEAs may be integrated into an organization's standard evaluation efforts, allowing for a continuous reevaluation and prioritization of program activities. While CEA has the potential to add substantial value to prevention efforts, there are limitations that must be considered. Cost-effectiveness is only one aspect of a decision-making process; organizations may have objectives beyond simply reducing overall health burden, such as disparity reduction, that could result in the adoption of a less cost-effective intervention. Further, the cost-effectiveness of an intervention conducted in one context may differ significantly when more widely adopted or as economic and/or epidemiological conditions change. When comparing interventions from the literature, careful attention should be paid to the perspective and assumptions used.

This paper lays out some practical considerations for conducting CEAs related to disease intervention. More general and detailed guides to CEA can be found elsewhere.[13] Innovative approaches to utilizing DIS have the potential to greatly improve public health, and CEA may help justify the adoption of some of these new approaches.

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