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Screening for acute HIV infection in community-based settings: Cost-effectiveness and impact on transmissions

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Summary *Objectives:* To determine cost-effectiveness of three community-based acute HIV infection (AHI) testing algorithms compared to HIV antibody testing alone by focusing on the potential of averting new infections occurring within a one-year time horizon among men who have sex with men (MSM).
Methods: Data sources for model parameters included actual cost and prevalence data derived from a community-based AHI screening program in San Diego, and published studies. Main outcome measure was costs per infection averted (IA). The lower end of the cost range of discounted lifetime costs of an HIV infection (i.e. $236,948) was used for defining cost-effectiveness.
Results: The most sensitive algorithm for AHI detection, which was based on HIV nucleic acid amplification testing, was estimated to prevent between 5 and 45 transmissions, with simulated costs per infection averted between $965 and $141,256 when compared to HIV antibody testing alone.

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Conclusion: AHI testing was cost-effective in preventing new HIV infections among at risk MSM in San Diego, and also among other MSM populations with similar HIV prevalence but lower proportions of AHI diagnoses. These results indicate that community-based AHI testing among MSM in the United States can pay for itself over the long run.

Introduction

HIV antibody testing remains the most widely used approach to diagnose HIV infection in community-based settings in the United States.[1] HIV antibody tests, however, fail to detect acute HIV infection (AHI), which is the earliest stage of HIV disease and lasts until the body develops antibodies against HIV.[2] AHI is associated with transient levels of extremely high titer viremia[3] resulting in a high level of infectiousness that serves as a major driver of HIV transmission in the United States and other resource rich countries.[4–6] As many as half of HIV transmissions occur from persons with AHI,[7] which makes detection of AHI critical to HIV prevention strategies.[4–6,8] While guidelines support early initiation of antiretroviral therapy (ART) for the prevention of HIV transmission (i.e. treatment as prevention),[9,10] AHI diagnosis may reduce transmission risk even in the absence of other interventions, as evidence suggests that individuals generally reduce their risk behavior after being diagnosed with HIV.[5,11]

Although detection of AHI offers opportunities to reduce infectivity (primarily ART and risk reduction) and transmission risk, screening for AHI is not widely performed in community-based settings. Commercially available point-of-care (POC) assays for AHI have limited sensitivity, while non-POC assays require follow up for results and are generally more costly to perform. By comparing four community-based testing strategies, we have recently shown that costs for detection of one case of AHI may be below US $20,000 in at risk men who have sex with men (MSM).[12,13] Calculation of cost-effectiveness per transmission prevented (i.e. infection averted [IA]) is more complicated, but has two major advantages: i) cost thresholds are easier to define, as there are comprehensive estimates of lifetime treatment- and healthcare costs per HIV infection,[14,15] and ii) the measure is more complete in terms of costs to the healthcare system. Consistent with federal efforts to reduce the costs of healthcare through the deployment of effective prevention measures, calculation of costs per IA will allow us to determine if testing can pay for itself over the long run.

The objective of this study was to determine cost-effectiveness of three community-based AHI testing algorithms compared to HIV antibody testing alone by focusing on the potential of averting new infections.

Material and methods

This one-year cost analysis compared community-based HIV testing strategies based upon the cost per IA in 2014 US dollars. Cost analyses were conducted using an established HIV testing program perspective. The study evaluated four community based HIV testing strategies,[12] including three that detect AHI (Early Test [i.e. routine HIV nucleic-acid-amplification testing in all antibody negative persons], Architect, and Determine [both based on HIV p24 antigen detection]), and one that relies on HIV antibody testing alone. The model was built on our recent cost-model that compared these four algorithms with regard to costs per AHI diagnosis in 2014 US dollars,[12] which was based on published risk data and HIV observed in MSM undergoing community-based AHI screening in San Diego between 2006 and 2014.[16–20] Detailed description of the algorithms and methods can be found elsewhere,[12] and is summarized in the supplementary appendix (SI Appendix, SI Appendix Table S1, SI Appendix Fig. S1).

Cost per infection (i.e. transmission) averted

Estimations of the potential impact of missed AHI diagnoses on subsequent spread of HIV were conducted by combining published transmission risk estimations with data on risk and testing behavior observed in MSM diagnosed with AHI between April 2008 and July 2014 with the "Early Test", a community-based, confidential AHI screening program in San Diego, California.[16] To assess the frequency of testing in those diagnosed with AHI, we calculated the time period between the last negative test and the day they tested positive by NAT and assumed that it would have taken those individuals exactly the same time period to test again. We also assumed that the risk behavior reported by those with AHI for the last 12 months before diagnosis [i.e. condomless insertive anal intercourse (CIAI) and number of male partners] would reflect the ongoing risk behavior in the absence of an HIV diagnosis. In addition, we focused only on direct transmission occurring from individuals with missed AHI diagnoses. Finally, we assumed that those diagnosed with AHI would not transmit HIV during the first year after diagnosis (immediate ART is routinely provided to "Early Test" participants diagnosed with AHI, in addition studies have shown that transmission risk behavior may decrease significantly in the months after HIV diagnosis[5]). Using these assumptions, we calculated estimated numbers of transmissions from undiagnosed (i.e. missed) acute HIV diagnoses. Incremental cost effectiveness ratios (ICERs) were calculated by comparing two different testing algorithms, with the numerator representing the difference in annual cost of the two algorithms and the denominator representing the difference in IA. Numbers of IA by each of the AHI were calculated by two different approaches: a) per-contact transmission risk and b) per-partner transmission risk.

Cost thresholds

Discounted lifetime costs of an HIV infection have recently been updated [i.e. between $229,800 and $338,400 depending on the time point of diagnosis and ART initiation[15]]. As those costs were calculated in 2012 US dollars, the thresholds were updated to 2014 US dollars by adding the cumulative rate of inflation (i.e. 3.1%), resulting in an