Educational and Economic Outcomes of an Intervention to Improve Early Testing and Treatment of HIV

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ABSTRACT

Background: Education is needed to address professional practice gaps in testing, linkage to care, and treatment of human immunodeficiency virus (HIV) in the primary care setting. Further, little is known about the economic impact of continuing medical education in this area.

Methods: We executed one online and two live continuing education activities designed to enhance competence in testing and treating HIV. Competence was measured using pre- and post-activity case vignettes. Costs averted when participants implemented learning into their clinical practices were estimated using the outcomes impact analysis (OIA) model. We modeled: 1) decreased transmission of HIV resulting from awareness of infection and 2) earlier initiation of antiretroviral therapy (ART). The perspective was that of the healthcare payer and the time span was one year.

Results: Participants from the live (n = 64) and online (n = 230) activities demonstrated educationally and statistically significant improvement in all 3 competencies ($P \leq .01$ for all). Evaluations demonstrated a strong commitment to change and the intention to incorporate learning into practice. For the first OIA model, the estimated costs averted were be $10,731,517 when testing related awareness led to decreased transmission. For the second OIA model, earlier treatment comparing ART initiation at 351-500 CD4 cells/μL versus 201-350 CD4 cells/μL, the estimated costs averted were $11,685,686. When we compared initiating ART at 351-500 CD4 cells/μL versus < 200 CD4 cells/μL, the costs averted were estimated to be $39,521,676.

Conclusions: An educational intervention improved competence in testing, linkage to care, and treatment of HIV. Estimates of the economic impact suggest that implementation of learning from the activity is associated with substantial cost savings.

INTRODUCTION

The US Centers for Disease Control and Prevention (CDC) estimates that 15.8% of persons living with HIV (PLWH) in the United States are unaware they are infected [1].

Testing, linkage to care, and initiation of evidence-based antiretroviral therapy (ART) are important outcomes in primary care, where a substantial number of persons are unaware they are infected. Significant gaps remain in the delivery of care for PLWH. In 2009 the HIV Surveillance System of the CDC showed that, once diagnosed, 65.8% of PLWH were linked to care, 36.7% were retained in care, 32.7% received ART, and 25.3% achieved virologic suppression [2]. Further, diagnosis often occurs too late to fully benefit from ART. Among those diagnosed with HIV in 2012, 24% had advanced to AIDS [3]. Education of healthcare professionals leads to increased screening and testing for HIV [1,4-7]. We designed an educational intervention to enhance competence in testing, linkage to care, and treatment of PLWH. The activity audience was primary care physicians, physician assistants, nurse practitioners, and nurses involved in the management of PLWH. We report here the educational outcomes of the activity.

There is increasing interest in the economic impact of continuing medical education (CME) [8] yet few studies have evaluated the cost savings or cost effectiveness associated with CME [9,10]. This educational program was designed to promote earlier testing and treatment, which could in turn lead to reduced transmission and therefore fewer new cases and lower costs [11]. Earlier treatment can also decrease costs because delaying care is associated with rapidly escalating healthcare utilization [12,13]. We report the results of an estimate of costs averted as a result of the incorporation of learning into clinical practice, as estimated by a predictive model.

METHODS

To estimate the economic outcomes of these activities, we used the outcomes impact analysis model (OIA), which can approximate costs averted as a result of the

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incorporation of newly learned behaviors into clinical practice [14]. The OIA calculates the economic impact of CME activities on the practices of participants by estimating the costs saved from projected practice change. The rationale for the model is that the scope of changes in CME participant behavior would affect such a large number of practices and patients across multiple healthcare systems that it would be impractical to measure outcomes directly. We used the OIA to predict costs averted when participants implemented learning into their practices in such a way as to increase HIV screening, testing, or treatment.

EDUCATIONAL INTERVENTIONS

A CME activity titled *HIV in the Primary Care Setting: Screening, Access to Expert Care, and Treatment Initiation* was conducted with the following learning objectives: 1) apply recommendations and procedures for primary care practice treatment teams in screening, diagnosing, counseling, and treating patients with HIV disease; 2) develop integrated systems for linking patients newly diagnosed with HIV/AIDS to an appropriate care setting; 3) describe recommendations in current HIV treatment guidelines for initiating therapy and monitoring patients who are on an initial regimen; and 4) evaluate key factors in the decision to become an expert HIV caregiver. The program was a collaboration among HealthHIV, Discovery Institute of Medical Education, and Medscape and was supported by an educational grant from Bristol-Myers Squibb. Two 1-hour interactive live activities using an audience response system were held at annual primary care association meetings, one (n=30) in San Antonio, Texas in October 2010 and one (n=34) in Lake Lanier, Georgia in April 2011. Material from the meetings was used to create a 1-hour online Medscape activity (n=3368), which was offered from November 2010 to November 2011. Participants were mostly primary care providers.

DATA COLLECTION AND ANALYSIS

All participants completed a survey on demographics, satisfaction, commitment to change, and other items. To evaluate changes in participants' competence related to the learning objectives, we administered a case vignette. Case vignettes are a validated method of measuring competence [15,16]. Participants in the live activity used an audience response system to answer case questions before and after the activity. A self-selected convenience sample of online participants completed the case questions before starting the activity and then answered the same questions immediately at the end of the activity. Differences in pre-activity and post-activity case vignette scores were evaluated using Pearson chi-square with a p-value of 0.05 considered statistically significant.

MODELS AND VARIABLES

The perspective was that of the healthcare payer. Two models were constructed. For both models the base case was 2 in 10 activity participants implementing learning into their practice (Table 1). This was a conservative estimate based on both the level of commitment to change expressed by activity participants and the literature on behavioral outcomes after similar HIV education interventions [1,6,7]. The cost of expenditures for care was obtained from a cross-sectional review of medical records conducted by the HIV Research Network and represents the mean annual total expenditures across CD4 strata for PLWH in 2006 [13]. The costs were derived from inpatient days, outpatient visits, ART, and other prescribed medications.

One limitation to the OIA is the inability to know how many participants will actually change their behavior. The base case was that 20% would implement learning following the activity. Among the online activity participants, 38% stated that they would modify their treatment plans. Commitment to change was reported by 89% and 94% of the Georgia and Texas workshop participants, respectively, and 81% of online participants. Self-reported commitment to change is a strong predictor of behavior as shown in randomized trials [17]. Additionally, 84% of online participants said the content they learned from the activity would change their practices. Educational interventions similar to this one lead to significant change in provider practices. A didactic CME program that sought to increase HIV testing in pregnant women resulted in testing rates increasing from 5.7% to 64.2% [7]. Other studies have shown that education with a didactic component can change clinical practice

Table 1. Parameters Used in the Model

Parameter	Base Case	Range
% of participants who change behavior[1,6,7,17]	20%	10%–50%
Prevalence of HIV[31]	0.01	0.005–0.08
Panel size[30]	2300	1840–2760
Transmission rate unaware[22]	0.0877	0.044–0.175
Transmission rate aware[22]	0.0253	0.012–0.051
Proportion of patients accepting tests[23]	0.4	0.2–0.6
Percent receiving treatment[2]	0.2	0.1–0.3
Mean annual total expenditures[13]	$27,234	$15,106–$30,949
Mean annual expenditures for care initiated at CD4 count of 351-500 vs 201-350 cells/μL[13]	$3701	$3657–$3744
Mean annual expenditures for care initiated at CD4 count of 351-500 vs <200 cells/μL[13]	$12,517	$10,848–$14,186

behaviors in HIV-related providers [4,18-20]. Given these data, together with the high degree of self-reported commitment to change, it is reasonable to expect that 20% of participants incorporated learning into their practices.

The first model predicted cost savings resulting from cases averted when PLWH become aware of their infection (Table 2). The transmission rate among persons unaware they are infected with HIV is about 3 times higher than transmission among those aware they are infected [11]. Testing and awareness of HIV will decrease the transmission rate, preventing a substantial number of new cases [21,22]. Accordingly, cost savings associated with the direct medical costs of prevented cases can be estimated. The variables used in the model are shown in Table 1. The base case is 2 in 10 activity participants implementing learning to offer HIV testing to all eligible patients in their practice. The model accounts for 40% accepting a test, a rate comparable to that reported for an urgent-care center offering routine screening [23]. Estimates of transmission rates in non-acutely infected aware and unaware PLWH were derived from a model based on epidemiologic data (Table 1) [24].

The second model estimated costs averted when treatment was initiated earlier, according to strata of CD4 cell count (Table 2). Treating HIV sooner is associated with fewer costs because healthcare expenditures rise in patients with lower CD4 cell counts [25-28]. In the base case, 2 in 10 activity participants would return to their practice and apply what they learned, leading to earlier treatment of PLWH. The base case allowed for 20% of patients to be treated, based on data from the National HIV Surveillance System and accounting for up to 5% loss to follow up [2]. We compared costs averted by initiating ART in patients with CD4 cell counts of 350-500 cells/μL compared with either 201-350 cells/μL or < 200 cells/μL. Costs for healthcare utilization at CD4 strata were taken from the HIV Research Network [13].

SENSITIVITY ANALYSIS

One-way sensitivity analysis and probabilistic sensitivity analysis (PSA) with second-order Monte Carlo simulation were used to evaluate parameter uncertainty in each of the models. One-way sensitivity analysis was used to determine the impact of varying a single parameter on the model estimates. PSA was used to quantify the level of confidence in the results of the model estimate. In contrast to one-way sensitivity analysis, PSA allows all parameters in the model to be varied independently and simultaneously within their likely ranges and according to their probability distributions [29]. The software selects each parameter independently from a random point in its probability distribution, places the values in the model, and calculates the estimated value. This is repeated for a cohort of 10,000 and parameter estimates are used to calculate a mean and nonparametric 95% confidence interval (CI). Table 1 lists the base case and lower and upper limits used in the sensitivity analysis.

All currency values were adjusted to 2014 US dollars using the medical care component of the Consumer Price Index. The time frame of the estimates was 1 year. OIA model analysis and PSA were conducted using TreeAge Pro Software 2014 R1.0 (Williamstown, MA).

Table 2. Formulas Used to Calculate Hypothetical Costs Averted by CME Activity Participants Who Incorporate Learning into Clinical Practice

Model	Competence/Rationale	Formula
Model 1	Increased testing/costs averted by decreased transmission from awareness of serostatus	Cases averted = [N x (Pt x NHIV) x TU x A] – [N x (Pt x NHIV) x TA x A] Costs averted per year = cases averted x cost per case per year
Model 2	Increased treatment/costs averted by treating earlier before CD4 cell decline	Costs averted per year = (N x NHIV x Ptx x TΔ)

CME = continuing medical education; N = number of activity participants; Pt = proportion of patients in panel tested; NHIV = number of patients in panel with HIV = (no. patients in panel) x (estimated prevalence rate in panel); TU = transmission rate in unaware patients; A = proportion accepting an HIV test; TA = transmission rate in aware patients; Ptx = proportion of patients treated; TΔ = difference in treatment costs per year at different CD4 levels when diagnosed.

RESULTS

Live-activity participants for the Georgia (n=34) and Texas (n=30) workshops were primarily family practice and internal medicine physicians and nurses. The online activity sample consisted of primary care physicians and nurses (n=230) who completed both the pre-activity and post-activity case vignette. In all groups, the proportion of participants answering questions correctly increased significantly between the pre- and post-activity administration of the case vignette ($P \leq 0.01$ for all; Figure 1). These results demonstrated improved competence in the goals of the activity, which were to enhance testing, linkage to care, and evidence-based treatment of HIV. Overall, no significant differences were found between the live and online groups with regard to pre- and post-activity test results or other survey results such as knowledge questions and satisfaction ratings.

MODEL 1

The economic models included all participants from the live and online activities who completed the activity and earned CME credit (n = 3432). Based on the assumed panel (number of patients seen annually) of 2,300 [30] and an undetected prevalence of HIV of 0.01 [31], the number of PLWH in the model population was estimated to be 78,936 (range, 63,148-94,723). The first

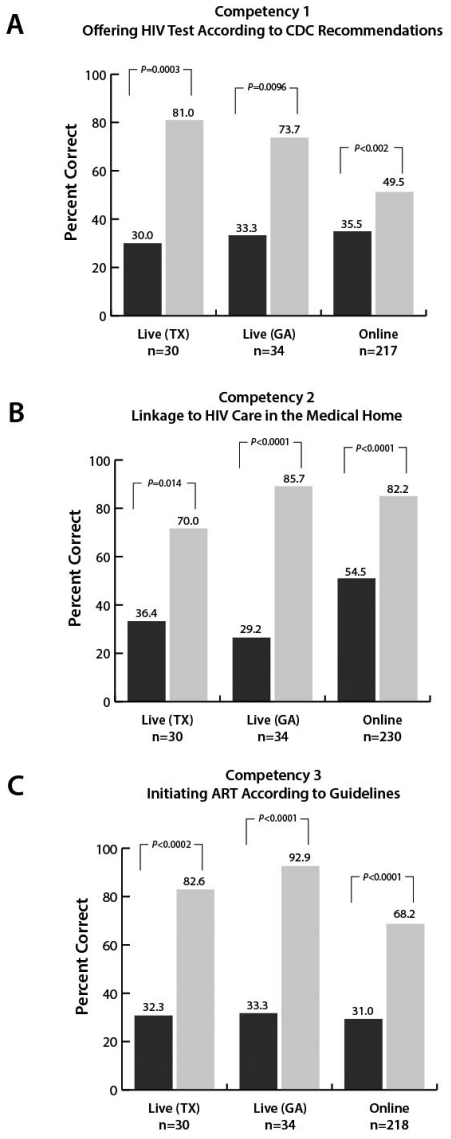

Figure 1. Pre-activity (black bars) and post-activity (gray bars) case vignette test scores for live and online activity participants. Competencies of the CME activity measured were (A) offering HIV test according to CDC recommendations, (B) linkage to HIV care in the medical home, and (C) evidence-based treatment. CDC = Centers for Disease Control and Prevention; ART = antiretroviral therapy.

economic model estimated costs averted by preventing new cases through awareness of infection. The base case was 2 in 10 participants testing PLWH in their practice and 40% of patients accepting tests. The base case estimated the prevention of 394.048 cases for costs averted of $10,731,517 (Table 3). PSA resulted in a mean estimate of cost savings of $10,717,423 (95% CI $4,363,588-$20,934,408). The estimate was relatively sensitive to the transmission rate for aware and unaware PLWH and the proportion of patients accepting tests. The results showed that a substantial cost savings would be likely even if a modest number of participants tested and identified PLWH in their practices.

TABLE 3. Estimated Annual Costs Averted in the Base Case and Probabilistic Sensitivity Analysis

Outcome	Base Case	Probabilistic Sensitivity Analysis, Mean (95% CI)
Cases prevented resulting from awareness of infection	$10,731,517	$10,717,423 ($4,363,588–$20,934,408)
Care initiated at CD4 of 351-500 vs 201-350 cells/μL	$11,685,686	$11,792,646 ($6,661,485–$18,924,573)
Care initiated at CD4 of 351-500 vs <200 cells/μL	$39,521,676	$39,879,700 ($23,675,719–$61,982,621)

MODEL 2

The second model estimated costs averted with treatment initiated at a CD4 count of 351-500 cells/μL, compared with 201-350 cells/μL. The base case was 2 in 10 participants returning to their practice and initiating early treatment in 20% of patients. The patient population for this model was 3157.44. The estimated costs averted were $11,685,686 (Table 3). PSA estimated the mean savings to be $11,792,646 (95% CI $6,661,485-$18,924,573). For treatment initiated at a CD4 count of 351-500 cells/μL compared with < 200 cells/μL, the estimated costs averted were $39,521,676 for the base case. PSA estimated the mean savings to be $39,879,700 (95% CI $23,675,719-$61,982,621). Both early treatment models were most sensitive to the number of participants who changed their behavior and the number of patients receiving treatment. One-way sensitivity analysis was used to evaluate the impact of baseline HIV prevalence on the model outcomes; it was found that varying the prevalence from 0.005 to 0.08 had a proportional but not considerable impact on the model outcomes. It can be seen from the sensitivity analysis that even if a small proportion of activity participants treat earlier, substantial expenditures can be prevented.

DISCUSSION

The results from the case vignette showed that a significant proportion of participants improved in each of the 3 activity competencies following the learning intervention (Figure 1). The differences between pre- and post-activity test scores were both statistically and educationally significant. These results were reflected in self-assessments provided by the participants in the evaluation. For example, 91%-97% of activity participants stated that they could apply the recommendations for screening, diagnosis, and treatment of HIV. Among online participants, 73% said the activity had improved their competence. Several studies have demonstrated that continuing education can improve knowledge related to HIV [4,32-34]. Another study has demonstrated that educational interventions like the present one can enhance clinical competence [35].

OIA was used to estimate the costs averted resulting from these CME activities, thereby predicting the economic impact of improved testing or treatment of HIV. Although it is ideal to measure economic outcomes at the individual level, such as in a closed system, this activity had thousands of participants from geographically dispersed institutions

[9]. It would not be possible to obtain data on participants' patients, their payers, costs, and health records. In the absence of such data, it is possible to provide a reasonable estimate through modeling [14].

The results of the first model suggest that costs averted by the outcomes of this activity would be substantial, even if only a small proportion of participants incorporate learning into their practices. For example, enhanced testing can increase awareness, which is important because persons who are unaware of their infection contribute disproportionately to HIV transmission [11]. One study suggested that the transmission of HIV from unaware PLWH is 3.5 times more than that from aware PLWH [11]. A recent study using the Progression and Transmission of HIV/AIDS model showed that early diagnosis and treatment reduce the number of new infections transmitted by 50% [36].

The second model showed that provider education leading to earlier initiation of ART when patients have a higher CD4 cell count could lead to substantial cost savings. Several studies have shown late entry into care to be associated with higher costs [12,37,38]. This study had a time horizon of 1 year and therefore did not consider issues such as long-term costs [36]. However, for those starting treatment at CD4 cell counts below 350 cells/μL, higher costs persisted for 5 years despite increased CD4 cell counts with treatment [37]. Studies have shown that the high cost of starting therapy at lower CD4 counts is sustained for up to 15 years [12,38]. The higher cost of late treatment reflects the increased risk of opportunistic infection, hospitalization, and progression to AIDS [13].

Another limitation of the OIA model is that it requires valid cost data and adequate information about the impact of a measurable outcome objective or health-state change. Cost data were taken from a large cross-sectional, expertly performed review of medical records at 10 sites in the HIV Research Network [13]. Similar studies have been performed with comparable cost results [12,25,37,38]. The rates of HIV transmission in aware and unaware PLWH were derived from disease progression models and have been confirmed and updated by several investigators [11,22,24,36]. Model 1 used a simplified transmission model when in fact transmission may be more complex, involving partner mixing, concurrency, condom use, baseline prevalence, frequency of coitus, etc. The current report includes only direct medical costs and does not consider factors such as productivity, nonmedical costs, and quality of life. Additionally, this application of OIA was not cost inclusive, which may be desirable when comparing programs or calculating the return on education (ratio of savings to costs). The time horizon of one year was chosen for this study as this is the duration of learning activities. It is not clear if behavioral change from learning persists for the full year or beyond the one year measured.

CONCLUSIONS

In conclusion, we have shown that a live and online educational intervention led to improved competence in areas of HIV testing and treating, as demonstrated by improved performance evaluated with a case vignette. Modeling the economic outcomes showed that the implementation of learning would be expected to be associated with substantial cost savings. Estimated costs averted were $10,731,517 using a model of earlier testing leading to awareness-related decreased transmission. The estimated costs averted were $11,685,686 for a model of learning leading to earlier treatment that compared ART initiation at 351-500 CD4 cells/μL versus 201-350 CD4 cells/μL. The costs averted were estimated to be $39,521,676 when comparing initiating ART at 351-500 CD4 cells/μL versus < 200 CD4 cells/μL. These data suggest that CME-related learning influencing even a small number of learners could have a considerable impact on the economic aspects of HIV care by saving costs related to healthcare utilization.

DISCLOSURES

The authors have no competing interests. Partial support for the analysis was provided by Bristol-Myers Squibb.

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