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Cost analyses of peer health worker and mHealth support interventions for improving AIDS care in Rakai, Uganda

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Abstract

A cost analysis study calculates resources needed to deliver an intervention and can provide useful information on affordability for service providers and policy makers. We conducted cost analyses of both a peer health worker (PHW) and a mHealth (mobile phone) support intervention. Excluding supervisory staffing costs, total yearly costs for the PHW intervention was $8,475, resulting in a yearly cost per patient of $8.74, per virologic failure averted cost of $189, and per patient lost to follow-up averted cost of $1025. Including supervisory staffing costs increased total yearly costs to $14,991. Yearly costs of the mHealth intervention were an additional $1046, resulting in a yearly cost per patient of $2.35. In a threshold analysis, the PHW intervention was found to be cost saving if it was able to avert 1.50 patients per year from switching to second-line antiretroviral therapy. Other AIDS care programs may find these intervention costs affordable.

Keywords

cost analysis; mHealth; community health workers; Uganda; antiretroviral treatment

Introduction

A cost analysis study calculates the resources needed to deliver an intervention and can provide useful information on affordability for service providers and policy makers, as well as inform future research (Trentacoste, Holtgrave, Collins, & Abdul-Quader, 2004). Knowing cost information about interventions performed in research settings allows for increased transparency and better economic contextualization in resource-constrained environments (Beck, Harling, Gerbase, & DeLay, 2010). Such studies also provide important background for cost-effectiveness and cost-utility studies (Gold, Siegel, Russell, & Weinstein, 1996; Holtgrave, 1998).

A recent cluster-randomized trial was conducted on the effect of a peer health worker (PHW) intervention on AIDS care in Uganda (Arem et al., 2011; Chang et al., 2010). The

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primary findings were that the PHW intervention was associated with both decreased virologic failure rates among patients on antiretroviral therapy (ART) ≥96 weeks and decreased lost to follow-up (LTFU). An exploratory substudy embedded within this trial on the impact of a mHealth (mobile phone) support intervention used by PHWs did not show any clear quantitative benefits, but a qualitative analysis found several positive effects (Chang et al., 2011). The present study's objectives were to perform cost analyses of the PHW and mHealth interventions.

Methods

Intervention Background

PHWs are people living with HIV and a valuable human resource to assist with task shifting (Chang et al., 2009; WHO, 2007). From 2006 to 2008, a cluster-randomized trial was conducted to determine whether PHWs improved AIDS care outcomes. Details of this intervention and trial results are reported elsewhere (Chang et al., 2010). In brief, PHWs provided clinical and adherence monitoring and psychosocial support to fellow patients at clinics and during monthly home visits. The mHealth Intervention substudy consisted of some PHWs receiving a mobile phone for texting patients' clinical data to centralized staff and improving communication (Chang et al., 2011; Chang et al., 2008).

Cost Analysis Methods

To address the primary study question of intervention affordability, this evaluation employed a service provider perspective to determine costs incurred by a program implementing the interventions. A societal perspective where all costs consumed are accounted for regardless of who pays, e.g. including costs that would be incurred by patients but not by funding organizations, was felt to be less relevant and were difficult to appropriately value (Gold et al., 1996). For example, clients received most of the interventions at their home, there were no clear child care needs to consider, no subsidized or donated items were used, and client time spent receiving the interventions was typically brief (<1 hour per month).

We conducted these analyses using established retrospective cost analytic techniques (Gorsky, 1996). The key methodological steps included: (1) Selecting an analysis time period; (2) Counting patients served during the time period; (3) Inventorying resources consumed in specific units; (4) Estimating cost per unit of each resource type; (5) Counting the number of units consumed in each resource category; (6) Calculating total costs of the intervention; and, (7) Expressing this cost on a per client basis. Additionally, we calculated a summary cost per patient for estimated virologic failures averted and LTFU averted in addition to calculating per PHW costs.

Using these methods, the time period selected was 27 months (the duration of the original trial). The total number of patients served was 970 for the PHW Intervention and 446 for the mHealth Intervention. A participation rate of 100% was assumed. Resources consumed, specific units, and unit costs were analyzed from prospectively captured line item budgets utilized during the study with review of expenditure and purchasing records. Unit costs were determined by actual amount paid. The number of virologic failures and LTFUs averted was calculated by applying the control arm rates to the intervention arm to calculate absolute numbers and then subtracting these absolute numbers from the original intervention arm numbers. Total costs were calculated by multiplying unit costs by the number of units utilized. These costs were then summed, converted to a yearly cost, and divided by the number of patients, PHWs, yearly virologic failures averted, and yearly LTFUs averted.

Costs were originally exclusively in Uganda shillings (UGX) which had a variable exchange rate with the United States Dollar (USD) during the study period (1555 to 1835 UGX:1 USD). We calculated an average exchange rate (ww.oanda.com) over the study period (1736 UGX:USD) and used this rate to convert all costs to USD for ease of interpretation.

Sensitivity Analyses

We calculated the total costs with and without supervisory staff costs and emphasized the latter in presenting our results. Because we felt our supervisory staff costs at a research-focused institution may not be representative, staff costs for most programs would be highly variable, and some programs might not need extra staff to implement these interventions. Finally, for the mHealth intervention, because the program evolved significantly throughout the trial (e.g. the charging of mobile phones was outsourced to local businesses and airtime needs were adjusted), we performed a sensitivity analysis where only costs needed for intervention implementation as it was being practiced at trial conclusion were included.

Threshold Analysis

A threshold analysis was conducted to provide an example of how performance standards can be used by programs to assess an intervention's potential to be cost-saving and provide contextualization of cost analysis results. The threshold analysis we conducted focused on the PHW intervention impact on reducing virologic failure and the need for second-line ART. In our scenario, we estimated 25% of patients experiencing virologic failure would be switched to second-line ART (Mermin et al., 2012). We then calculated, using our own program costs, the 10 year increased cost of second-line ART treatment over the cost of generic first-line ART as a reasonable long-term expectation for a program to continue delivering care (Mills et al., 2011). We calculated how many second-line ART switches the PHW intervention would then have to avert each year to be considered cost-saving. A net intervention cost analysis was performed by subtracting the increased cost of 10 years of second-line ART Treatment (T) expressed in net present value terms at a standard 3% discount rate, a standard procedure in economic evaluations for adjusting for the differential timing of costs and consequences so that the decision maker can compare each from the same temporal baseline (Gold, Siegel, Russell, & Weinstein, 1996), and the number of persons needing treatment averted (A) by the intervention, from the total program costs (C). Using this formula, Net Cost = C – AT, an intervention is cost saving if the Net Cost is less than zero. By setting the Net Cost at zero, one can then calculate A. By using the net present value for T, one can standardize the costs to a present day value (Holtgrave, 1998).

Results

Tables 1 and 2 present cost analyses for the PHW and mHealth Support interventions respectively. The total cost of the PHW intervention was $33,729.34 with supervisory staff and $19,070.59 without supervisory staff costs. The yearly cost of the PHW intervention without staff was $8,475.85, resulting in a yearly cost per patient of $8.74, per virologic failure averted of $188.77, and per LTFU averted of $1025.30.

The total cost of the mHealth intervention was $2,353.24. The yearly cost was $1045.88, resulting in a yearly cost per patient of $2.35. By the end of the study, the PHWs were no longer using the battery, adaptors, and chargers to charge their phones, but instead using local kiosks which provided charging services at a cost of about $1.00/month/PHW. Additionally, the costs of mobile phones had decreased significantly to about $20.00 for equivalent phones, SIM cards were available for $2.00, and airtime costs had dropped dramatically. Total costs for implementing this intervention for all patients in mid-2011 are estimated to be $1,105.97, a 53% reduction in total intervention costs compared to the trial period, resulting in a yearly cost per patient of $1.10.

Threshold analysis were calculated with Net Cost=0, C=$8,475.85, and undiscounted T= $6,625.00 (10 years of second-line ART at $959.40 per year – 10 years of first-line ART at $296.90 per year). The discounted value of T was $$5,651.26. Using this value, A=1.50 meaning that over the course of one year, this intervention would have to avert greater than 1.50 future second-line ART switches to be cost saving.

Discussion

Cost analyses of a PHW intervention found yearly per patient costs of about $8.74. Adding a mHealth support intervention to the PHW intervention resulted in $2.35 additional yearly per patient costs. These costs are potentially affordable to many AIDS care programs. However, a number of important considerations are relevant when considering implementing these interventions.

This study was not a formal cost-effectiveness study and is unable to account for complex clinical and programmatic scenarios and disability-adjusted life-years. Nevertheless, certain results may be helpful. For example, the yearly costs to avert one virologic failure ($189) may be considered reasonable for many organizations. LTFU was more expensive to avert ($1025), likely due to the high retention rate of this program (>95%). A study found that interventions to prevent LTFU that were 12%–41% efficacious would be cost-effective for programs experiencing 18% annual incident LTFU (Losina et al., 2009).

These intervention costs need to be considered contextually with other costs associated with caring for people on ART. For example, a study on the cost of HIV treatment in PEPFAR-supported programs found annual per patient costs, excluding antiretrovirals, to be $185 in Uganda with personnel accounting for roughly 40% ($78) of these costs (Menzies et al., 2011). Threshold analyses are another method for contextualizing costs to specific settings and provide a means of establishing performance standards for these interventions. The example we provided for averting 10 years of second-line ART costs is one of many which could be considered by other programs. Programs may choose additional and/or different input parameters than this example and calculate relevant thresholds using the simple formula provided.

Another consideration is that mixed methods research strongly demonstrated that these interventions resulted in task shifting (Arem et al., 2011; Chang et al., 2011). As a result, there may have been potential cost savings that we were unable to quantify. For example, if one less clinical officer needed to be hired ($8,884 yearly salary), then this intervention would have been nearly cost neutral to the program. Also not considered is that the PHWs may have relieved costs of care for caregivers, which a study in Botswana found was almost equivalent to the entire income of caregivers, by shifting caregiver tasks and costs onto themselves and the care program (Ama & Seloilwe, 2010).

In summary, a PHW intervention was found to have costs which will likely be affordable to many AIDS care programs. A mHealth support intervention for the PHWs will likely add minimal implementation costs, though its impact is more difficult to quantify. Further research incorporating these and other similar interventions into more complex economic models will contribute greater insights into costs and value for organizations and further contribute to this important type of implementation science.

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Table 1

Cost Analysis for Implementing Peer Health Worker Intervention*

Resource (A)	Cost/Unit (B)	Number of Units (C)	Total Cost (D) = (B × C)
Supervising Staff			
Project Coordinator	$542.92/month	27	$14,658.75
Startup Supplies			
Pens	$5.76/package	2	$11.52
Notebooks	$1.15/each	29	$33.41
Raincoats	$8.64/each	29	$250.58
Bicycles	$67.79/each	29	$1,965.92
T-Shirts	$3.46/each	29	$100.23
Gum Boots	$8.64/each	29	$250.58
Clipboards	$2.30/each	29	$66.82
Calculators	$6.91/each	29	$200.46
Transparencies	$6.91/package	3	$20.74
Carrying Bags	$17.28/each	29	$501.15
Paper	$4.90/ream	3	$14.69
Initial Training (2 Days)			
Accommodation	$15.00/PHW	29	$250.48
Meals and Snacks	$6.61/PHW	29	$191.83
Per Diem	$7.20/PHW	29	$208.76
Transport Allowance	$6.36/PHW	29	$184.33
Expert Trainer Hire	$385.25/each	1	$385.25
Hall Rental	$11.52/day	2	$23.04
Banner	$23.04/each	1	$23.04
Startup and Initial Training Costs			$4682.84
Refresher Trainings (2 Total, Over 3 Days Total)			
Accommodation	$15.00/PHW	29	$435.01
Meals and Snacks	$7.48/PHW	29	$216.81
Per Diem	$12.27/PHW	29	$355.75
Transport Allowance	$12.39/PHW	29	$359.45
Maintenance Costs			
PHW Stipend	$445.24/PHW	29	$12,911.87
Paper	$4.03/month	27	$108.87
Maintenance and Retraining Total			$14,387.75
Grand Total With Supervising Staff*			$33,729.34
Grand Total Without Supervising Staff			$19,070.59
Yearly Total Cost			$8,475.85
Yearly Cost Per Patient (n=970)			$8.74

Resource (A)	Cost/Unit (B)	Number of Units (C)	Total Cost (D) = (B × C)
Yearly Cost Per Virologic Failure Averted			$188.77
Yearly Cost Per Lost to Follow-Up Averted			$1025.30
Yearly Cost Per PHW			$292.27

[*] Costs are for implementing intervention to 970 patients over 27 month period. Conversions to yearly costs are presented at the bottom of the table.

Table 2

Cost Analysis for Implementing mHealth Intervention*

Resource (A)	Cost/Unit (B)	Number of Units (C)	Total Cost (D) = (B × C)
Startup			
PHW Mobile Phones	$47.22/each	9	$424.98
Administrative Phone	$47.22/each	1	$47.22
SIM Cards	$5.60/each	10	$56.00
Lead-Acid Battery	$109.39/each	1	$109.39
Charger Adaptors	$8.69/each	2	$17.38
Car Charger	$14.48/each	2	$28.96
AC Charger/Converter	$72.42/each	1	$72.42
Training (Half-day)			
Accommodation	$2.88/PHW	9	$25.92
Meals and Snacks	$3.34/PHW	9	$30.07
Per Diem	$2.88/PHW	9	$25.95
Hall Rental	$11.52/day	1	$11.52
Startup and Training Total			$849.78
Maintenance Costs			
PHW Airtime	$132.49/PHW	9	$1,192.40
Administrator Airtime	$311.06/Administrator	1	$311.06
Maintenance Total			$1503.46
Grand Total			$2,353.24
Yearly Total Cost			$1045.88
Yearly Cost Per Patient (n=446)			$2.35
Yearly Cost Per PHW			$116.21

*Costs are for implementing intervention to 446 patients over 27 month period. Conversions to yearly costs are presented at the bottom of the table.