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Costs of HIV/AIDS outpatient services delivered through Zambian public health facilities

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Summary

OBJECTIVE To present evidence on unit and total costs of outpatient HIV/AIDS services in ZPCT-supported facilities in Zambia; specifically, to measure unit costs of selected outpatient HIV/AIDS services, and to estimate total annual costs of antiretroviral therapy (ART) and prevention of mother-to-child transmission (PMTCT) in Zambia.

METHODS Cost data from 2008 were collected in 12 ZPCT-supported facilities (hospitals and health centres) in four provinces. Costs of all resources used to produce ART, PMTCT and CT visits were included, using the perspective of the provider. All shared costs were distributed to clinic visits using appropriate allocation variables. Estimates of annual costs of HIV/AIDS services were made using ZPCT and Ministry of Health data on numbers of persons receiving services in 2009.

RESULTS Unit costs of visits were driven by costs of drugs, laboratory tests and clinical labour, while variability in visit costs across facilities was explained mainly by differences in utilization. First-year costs of ART per client ranged from US$278 to US$523 depending on drug regimen and facility type; costs of a complete course of antenatal care (ANC) including PMTCT were approximately US$114. Annual costs of ART provided in ZPCT-supported facilities were estimated at US$14.7–$40.1 million depending on regimen, and annual costs of antenatal care including PMTCT were estimated at US$16 million. In Zambia as a whole, the respective estimates were US$41.0–114.2 million for ART and US$57.7 million for ANC including PMTCT.

CONCLUSIONS Consistent with the literature, total costs of services were dominated by drugs, laboratory tests and clinical labour. For each visit type, variability across facilities in total costs and cost components suggests that some potential exists to reduce costs through greater harmonization of care protocols and more intensive use of fixed resources. Improving facility-level information on the costs of resources used to produce services should be emphasized as an element of health systems strengthening.

keywords costs and cost analysis, human immunodeficiency virus, antiretroviral therapy, prevention of mother-to-child transmission, Zambia

Introduction

In recent years, services to prevent and treat HIV/AIDS have become more available in low- and middle-income countries. The number of persons receiving antiretroviral therapy (ART) increased from 300 000 in 2002 to more than three million by mid-2008, while the percentage of women in need and receiving prevention of mother-to-child transmission (PMTCT) nearly doubled from 2006 to 2008 (WHO 2010). While these are noteworthy accomplishments, the need for HIV/AIDS services continues to grow much faster than available resources. In 2008, an estimated 58% of persons needing ART did not receive it, along with an estimated 55% of pregnant HIV-infected women needing PMTCT (UNAIDS 2009). Also, although HIV incidence has declined slightly in recent years, an estimated 7400 new HIV infections occur worldwide every day (Henry J. Kaiser Family Foundation 2009), adding to the cumulative total of people who eventually will need ART. In 2008, global financing for the HIV/AIDS epidemic reached US$13.8 billion, but it is estimated that US$19.8 billion was needed in 2009 to meet the self-identified funding requirements of low- and middle-income countries, leaving a funding gap of approximately US$6 billion. In 2010, estimated need increases to US$25 billion, further widening the funding gap (UNAIDS 2010), while the current global economic crisis may slow or even reverse the upward trend in financing to combat HIV/AIDS in the developing world.

Against this backdrop of growing needs and insufficient resources, scant attention has focused on economic aspects of HIV/AIDS service delivery. For example, only seven per cent of the proposed U.S. President's Emergency Plan for AIDS Relief (PEPFAR) public health evaluations (PHE) in 2009 explicitly addressed economic dimensions of services (Bratt 2009). Economic evidence of the most basic type – i.e. the costs of resources used to provide HIV/AIDS services in African health care settings – is especially scarce. A 2006 literature review found 15 studies of the costs of delivering antiretrovirals (ARVs), of which only seven reported the full economic costs of services including personnel, drugs and supplies, and capital (equipment and infrastructure) (Rosen & Long 2006). The authors speculate that this paucity of evidence reflects a lack of interest in basic costing among health economists, who focus instead on modelling cost-effectiveness of ongoing or proposed interventions. Since 2006, few additional cost studies have appeared in the literature, suggesting that interest in programme-level costs of HIV/AIDS service delivery remains low.

Accurate data on full economic costs of providing HIV/AIDS services are essential for a wide range of policy and planning applications (Beck *et al.* 2008). First, HIV/AIDS programs must use existing resources more efficiently if there is any hope of meeting estimated need. But lacking information on how programmes are using resources currently, it is not possible to identify how those resources could be used more efficiently and how costs could be reduced. Second, empirical data on costs of delivering HIV/AIDS services – including ART, PMTCT and counselling and testing (CT) – are needed to estimate total programme costs and to budget for serving needs of future patients. Many factors influence costs of services, including programme setting (rural, urban, peri-urban), sector (public, private, non-governmental), type of facility (health centre, district hospital, outreach facility), staffing patterns (physician, medical officer, nurse, lay provider), treatment protocols (time spent with patients, drugs and tests used) and by the number of patients treated in a given unit of time (Rosen *et al.* 2008). Estimates of current unit costs can be used in conjunction with utilization and outcomes data to calculate a baseline ART cost per patient-year of care (Cleary *et al.* 2006; Hounton *et al.* 2008). Third, much of the literature comparing cost-effectiveness of alternative service approaches relies on cost estimates developed in different locales or for other purposes. Modelling exercises will produce better estimates for policy and programme applications when underlying cost data come from empirical studies of actual resource use in relevant programme settings. Finally, the global health community engaged in combating the HIV/AIDS epidemic should be promoting a culture of 'data for decision-making' as a part of its long-term strategy for moving country programmes towards sustainability. National HIV/AIDS programs eventually will graduate from intensive financial and technical assistance, and programme sustainability will depend on capacity to generate and use high-quality data on costs of services.

ZPCT program description

The Zambia Prevention, Care and Treatment Partnership (ZPCT), funded by PEPFAR through USAID, works with the Ministry of Health and provincial and district health offices to strengthen and expand HIV/AIDS clinical services in Central, Copperbelt, Luapula, Northern and North Western Provinces. ZPCT advances the Government of the Republic of Zambia (GRZ) goals of reducing prevalence rates and providing ART by initiating, improving and scaling up PMTCT, CT and clinical care services for people living with HIV/AIDS, including ART programs in all ZPCT-supported districts in these five provinces.

Since May 2005, ZPCT has worked to strengthen services in 219 health facilities in 35 districts. As of June 2009, ZPCT-supported facilities provided CT services to 481 022 persons and ART for 82 808 new clients (including 5970 paediatric clients) as well as PMTCT services for 339 842 pregnant women. ZPCT has produced these results by integrating simple but effective technical and management strategies into existing systems. For example, to improve access to HIV prevention, care and treatment services, ZPCT pioneered innovative strategies such as the outreach ART model where health facilities with weak infrastructural capacity (often in rural and peri-urban areas) receive support from relatively well-resourced sites to provide ART services to their catchment population. The need to increase uptake and expand services in the face of the country's serious shortage of trained health care workers spurred other innovative mechanisms, including the training of community volunteers to fill gaps – as lay counsellors, adherence support workers and PMTCT motivators (FHI 2008).

Study objectives

The overall goal of this study was to add to the evidence base on unit costs of outpatient HIV/AIDS services in the African context. Specific objectives included the following:

- to calculate unit costs of selected HIV/AIDS outpatient services in 12 ZPCT-supported facilities and to measure components of unit cost; and

Table 1 Study sites

Province	Facility name	Type	HIV/AIDS Services per month in 2008*
Copperbelt	Arthur Davison Children's Hospital	Urban	725
	Ndola Central Hospital	Urban	1397
	Chipokota Mayamba Clinic	Urban	269
Central	Kabwe General Hospital	Urban	1034
	Mahatma Gandhi Health Center	Urban	725
	Kasanda Health Center	Urban	345
Northwestern	Kabompo District Hospital	Rural	301
	St. Kalemba Clinic	Rural	110
	Mufumbwe Health Center	Rural	319
Luapula	Kawambwa District Hospital	Rural	347
	Mbereshi Mission Hospital	Rural	375
	Kawambwa Central Clinic	Rural	156

*Includes antiretroviral therapy (ART), prevention of mother-to-child transmission (PMTCT) and counselling and testing (CT).

- to use study findings to estimate the first-year cost per client for PMTCT and ART, and total annual costs of providing these services in the ZPCT-supported provinces and in Zambia as a whole.

Methods

Study design

The study was conducted from the perspective of the public-sector provider for the year 2008, and included costs of all resources used to produce outputs, regardless of whether costs were borne by the facility[1]. We used an 'ingredients' approach in which we identified relevant resources, measured resource use in natural units (hours, test kits, etc.), assigned values to resources and allocated shared resources to outputs.

Study sites

We purposively selected 12 ZPCT-supported facilities in four provinces for the study (Table 1). Facilities were selected to represent different locations (urban/rural) as well as different types of facilities (large hospitals, smaller hospitals and health centres).

Calculation of unit cost per service

The term 'unit cost' refers to the sum of all costs incurred to produce one unit of output. ZPCT-supported health facilities incur many types of costs, including clinical labour (providers) and non-clinical labour (administrators, secretaries, etc.), medical and office supplies, physical infrastructure (clinic rent, electricity, water, etc.), equipment and furniture, and miscellaneous expenditures such as insurance and building security. Excel-based spreadsheets were designed to collect information on all costs. Outputs were defined as HIV/AIDS-related outpatient consultations, including CT, PMTCT, and provision of ART. PMTCT visits were further subdivided into prenatal and post-natal consultations, while ART visits were subdivided into ART initiation and ART follow-up. Table 2 summarizes how costs of different types of resources were measured, valued and allocated to outputs.

Estimation of annual costs of ART and PMTCT

We estimated annual per-client costs of ART and antenatal care including PMTCT using specific assumptions regarding visit schedules and drug regimens. The ART treatment protocol included an initiation visit, a follow-up visit at two weeks, three monthly follow-up visits and then bi-monthly visits thereafter, for a total of nine visits in the first year of ART. Four different estimates of annual per-client cost were then made using different combinations of ARVs for first-line therapy. The package of antenatal care including PMTCT included an initial antenatal visit (plus PMTCT-related laboratory tests and

[1]Two frameworks are used in costing: 'financial costs' and 'economic costs'. Financial costs are actual expenditures that programmes make to purchase inputs, while economic costs include all resources used to produce output, regardless of whether the programme had to purchase them. For example, economic costs include such resources as donated drugs and volunteer labour, whereas financial costs include only resources that programmes pay for currently. Economic costs give a more accurate picture of the full resource requirements of the programme, and thus, what costs would be if there were no donors.

Table 2 Data collection and cost calculation for different types of resources

Resource type	Data collection and cost calculation
Clinical labour	*Direct clinical labour* is time spent in contact with a client. We recorded duration and type of all provider contacts with clients during a two-day period in each facility.* Direct cost of the consultation was calculated by multiplying the number of minutes of provider–client contact by the cost per minute of provider time. Averages for each service were calculated at each facility. *Indirect clinical labour* includes two elements: the proportion of provider time not spent in direct client contact and all of the time spent by clinical support staff such as nurses. The cost of indirect provider time per visit was calculated by multiplying the direct cost by the ratio of indirect time to direct time. Cost of clinical support was calculated by estimating the number of hours used in the clinic session, multiplying by the hourly salary and benefits costs of these staff, and dividing by the number of consultations
Administrative support labour (ASL)	These employees include housekeepers, pharmacists and administrators who support the entire facility. Average ASL cost per consultation was calculated by summing the total monthly salaries plus benefits of all staff in these categories and dividing by average monthly consultations in 2008, including HIV/AIDS, Maternal and Child Health (MCH) and other outpatient visits. For facilities with inpatient care, we used the patient-day equivalent method outlined in Cleary *et al.* (2006) to increase the denominator to reflect the efforts of these joint staff for inpatients
Drugs and clinical supplies	We interviewed providers and ZPCT technical staff to identify the type and quantity of medical supplies (gloves, cotton, antiseptics, etc.) and other disposable resources such as drugs and medicines used for each type of HIV/AIDS-related consultation. Unit costs for these items were obtained from the 2008 International Drug Price Indicator Guide and other sources. Total cost per consultation was calculated by multiplying the unit cost of each item by the quantity and summing the cost of all items used during the visit
Capital	Capital costs are associated with resources that have an expected useful life of one year or more. Study personnel visited all facilities to inventory all relevant equipment, furniture and infrastructure. Standard techniques were used to annualize capital costs; we estimated the current price of a new item of the same type, the useful life in years and annualized these costs assuming a discount rate of 12%.† Annualized capital costs for antiretroviral therapy, prevention of mother-to-child transmission and CT areas were summed, and then divided by the respective number of consultations to obtain an average cost per HIV/AIDS-related consultation; annualized equipment costs for shared areas were summed and divided by the total number of all consultations recorded in the facility
Miscellaneous expenditures	Other expenditures that do not fit into the above categories, such as utilities, office supplies, maintenance and insurance, were collected for the year 2008, and the sum for each facility was divided by the total number of outpatient visits to obtain an average cost per client visit.
Laboratory tests	ZPCT's senior technical officer for laboratory services estimated that 80 per cent of laboratory work across facilities was HIV/AIDS-related.‡ His estimates of the technician 'hands-on' time per test were used to allocate costs of laboratory technical staff and related equipment and infrastructure to each type of HIV/AIDS-related test. Resulting costs were then divided by the number of tests per month to obtain an average fixed cost for each type of test. Variable costs of reagents and other supplies were added to obtain a total cost per test
ZPCT support	Total 2008 expenditure for each of the four ZPCT provincial offices (Kabwe, Ndola, Mansa and Solwezi) was divided by the respective number of facilities supported in 2008 to obtain an average cost per facility. This amount was then divided across the total number of outpatient visits in each facility to obtain a cost per visit
DHO support	Monthly 2008 salaries plus benefits of three DHO staff members (Planning and Development Manager, District Medical Officer, and District Health Information Officer) were divided by the total number of client consultations per facility to obtain a cost per visit

*The form was based on two instruments from the Patient Flow Analysis (PFA) package. PFA is a tool developed by the Centers for Disease Control (CDC) for measuring contact time and waiting time experienced by clients during a visit to a health facility. http://origin.cdc.gov/Reproductivehealth/ProductsPubs/PFA_support, accessed 12 April 2010.

†The discount rate reflects the real interest rate (net of inflation) based on the official Zambian Central Bank figures for 2008 http://www.zamstats.gov.zm/mone.php. This rate reflects interest that could have been earned if the organization had invested the funds instead of purchasing the capital item. Higher discount rates result in higher capital costs.

‡Ideally, we would have used information on the total number and type of laboratory tests conducted at each facility to make the initial allocation of laboratory costs to the two categories of HIV/AIDS-related tests and non-HIV/AIDS-related tests. Unfortunately, this information was not available, so we used the key informant approach.

drugs), three routine prenatal visits thereafter, and if the mother was HIV positive, a post-natal visit with additional drugs and laboratory tests for both mother and infant. The cost of a routine antenatal visit was assumed to be equal to the cost of the PMTCT antenatal visit minus the cost of the PMTCT-related drugs and laboratory tests.

Total annual costs of providing ART and antenatal care including PMTCT in ZPCT-supported facilities were estimated using ZPCT data for 2009 on number of individuals newly initiating ART, the number of persons currently receiving ART and the number of pregnant women receiving PMTCT services (counselled, tested, received test results and post-natal visit if HIV positive). For ART, we modelled the cumulative costs for the year assuming that persons newly initiating ART in 2009 entered the programme in 12 equal groups at one-month intervals. Costs of first-year ART follow-up visits were adjusted to reflect different drug costs depending on the length of time between visits. For patients already on treatment at the end of 2008, we assumed that all were on the long-term bi-monthly treatment plan. For antenatal care including PMTCT, we multiplied the annual cost of antenatal care including PMTCT by the number of women registered as receiving PMTCT in 2009, and adjusted the proportion of women receiving the PMTCT post-natal visit by the proportion of pregnant women testing positive for HIV in the initial PMTCT visit. National-level estimates were made by substituting GRZ data on the numbers of persons on treatment and the number of pregnant women receiving antenatal care.

Results

Unit Costs of HIV/AIDS services, by type of facility

Table 3 presents information on unit cost of outpatient HIV/AIDS services in the 12 study facilities. In five facilities, all of the selected HIV/AIDS services were available, while the remaining seven facilities provided observations for 1–4 of the selected services. Overall, highest-cost visits were PMTCT antenatal visits, followed by ART follow-up, PMTCT post-natal visits, ART initiation, and counselling and testing. There were substantial differences in unit costs within visit types, and major sources of this variation included indirect costs of clinical labour, laboratory fixed costs and ZPCT and DHO support. Facilities with lower utilization had fewer units of output across which to spread these costs, resulting in higher costs overall. Unit costs per visit tended to be slightly lower in health centres than in hospitals for all visits except for counselling and testing. But ranges of costs were larger and upper bounds of costs higher in health centres for all visits except for PMTCT post-natal. Interpreting differences between costs of hospital-based and health centre–based services is problematic because of the small number of observations and the influence of outlying values such as Ndola Central for ART Initiation and CT, Mufumbwe for ART and St. Kalemba for PMTCT Antenatal.

Components of costs of ZPCT-supported HIV/AIDS services

Table 4 presents information on composition of service costs, broken down by main categories of laboratory tests,

Table 3 Cost per visit by type of facility and location (in 2008 US dollars)

	Antiretroviral therapy (ART) initiation	ART follow-up	Prevention of mother-to-child transmission (PMTCT) antenatal	PMTCT post-natal	Counselling and testing
Hospital					
Ndola Central	16.54	28.57	48.55	26.52	9.56
Mbereshi	23.93	33.36	54.37	29.53	19.61
Kabompo	34.39	37.95	59.86	36.50	21.10
Kabwe	26.40	29.42			13.99
Kawambwa	32.06	35.87			
Arthur Davison		30.34			8.92
Health Centre					
Chipokota	16.10	26.49	47.96	18.91	23.72
Mufumbwe	38.20	42.24	56.00		29.24
Mahatma Ghandi	21.24	29.80	45.89	24.22	16.58
Kasanda	22.54	32.32		18.54	18.59
St. Kalemba			71.04		25.17
Kawambwa					14.20

Table 4 Cost components by type of visit and facility (in 2008 US dollars)

Hospital	Antiretroviral therapy (ART) initiation (n = 5)	ART follow-up (n = 6)	Prevention of mother-to-child transmission (PMTCT) Prenatal (n = 3)	PMTCT post-natal (n = 3)	CT consultation (n = 5)
Drugs and supplies	2.79	22.14	23.54	5.95	0.00
Laboratory tests	17.66	4.93	10.48	3.98	8.13
Clinical labour	3.17	2.40	13.13	13.80	3.67
Other fixed costs	1.48	1.72	5.47	5.47	1.55
ZPCT support	1.16	1.03	1.23	1.23	0.98
DHO support	0.40	0.37	0.41	0.41	0.30
Total	26.67	32.59	54.26	30.85	14.64
Health centre	(n = 4)	(n = 4)	(n = 4)	(n = 3)	(n = 6)
Drugs and supplies	2.59	21.79	23.02	5.97	0.00
Laboratory tests	15.28	4.57	15.46	3.95	10.46
Clinical labour	2.16	1.85	7.26	6.84	3.99
Other fixed costs	2.09	2.09	6.12	2.55	3.93
ZPCT support	1.61	1.61	2.36	0.67	1.91
DHO support	0.79	0.79	1.01	0.58	1.08
Total	24.52	32.71	55.22	20.56	21.37

drugs and supplies, clinical labour, other fixed costs, ZPCT provincial office support and DHO support. Largest-cost components are laboratory tests, drugs/supplies and clinical labour, which taken together accounted for 77–90% of costs in hospitals and 68–86% in health centres. Some variation across facilities was noted in these cost components, mainly reflecting differences in the amount of output over which fixed cost elements of laboratory tests and clinical support labour could be spread, but we also noted some small differences in local prices for laboratory supplies and drugs. Costs of external supervision and support provided by ZPCT and the District Health Management Team comprised between 3% and 9% of the costs of services in hospitals, and 6–14% of costs in health centres. These costs were lower in hospitals because of economies of scale, whereby the average cost of supervision and support per facility was spread across a larger number of visits.

Table 5 Costs of first year of antiretroviral therapy (ART) and a complete course of antenatal care including prevention of mother-to-child transmission (PMTCT), by type of facility (in 2008 US dollars)

	Service delivered through	
	Hospital	Health Centre
First year of ART		
New guidelines most common*	$360	$358
New guidelines least expensive†	282	278
New guidelines most expensive‡	523	518
Old guidelines§	214	210
Complete course of antenatal care including PMTCT	$120	$108

*TDF/FTC (generic) and EFV (generic).
†TDF/3TC/NVP (generic).
‡TDF/FTC (originator) and EFV (generic).
§d4T/3TC/NVP (generic).

Estimation of annual costs of ART and antenatal care including PMTCT

Combining information on unit costs of services with the number and type of visits made under idealized clinical care protocols allows for estimation of the annual cost of providing ART (in the first year) and PMTCT to one client. Table 5 shows the resulting cost estimates for hospitals and health centres. The least costly regimen is associated with the old drug combination guidelines that are being phased out. Newer drug combinations more effectively manage HIV infection but have higher costs. As seen in the table, the first-year cost of ART under the new guidelines varied from US$278 when the least expensive generic drugs are used, to US$523 when non-generics comprise part of the regimen[2]. Costs did not differ markedly across the different facility types. For PMTCT, the cost of a complete course of

[2]Subsequent-year costs of patients remaining on first-line therapy under new guidelines would range from US$228 to US$480, but these figures do not include costs of addressing treatment failure.

Table 6 Estimated total cost of providing antiretroviral therapy (ART) and ANC with prevention of mother-to-child transmission (PMTCT) in the five ZPCT-supported provinces and Nation-wide (in 2008 US dollars)

	2009 Caseload	
	ZPCT only	National
Annual cost of ART		
New guidelines most common*	$27 146 833	$75 739 664
New guidelines least expensive†	20 482 439	57 146 004
New guidelines most expensive‡	40 931 962	114 200 170
Old guidelines§	14 699 895	41 012 707
Annual cost of ANC including PMTCT		
Actual caseload	$15 986 188	$57 665 755

*TDF/FTC (generic) and EFV (generic).
†TDF/3TC/NVP (generic).
‡TDF/FTC (originator) and EFV (generic).
§d4T/3TC/NVP (generic).

prenatal care including PMTCT was approximately $US114 and was slightly higher in hospitals than in health centres.

Using data from Table 5 in conjunction with ZPCT and GRZ data on the numbers of persons receiving services yields estimates of the total annual costs of providing ART and antenatal care including PMTCT in the facilities supported by ZPCT (Table 6). The economic impact of different drug regimens is clearly seen in the annual costs of ART under the new guidelines, where treatment costs vary by a factor of more than two depending on the specific regimen used. But ZPCT-supported facilities comprise a subset of all GRZ sites in Zambia; national-level costs of ART and ANC including PMTCT are substantially higher. According to GRZ figures for 2009, a total of 262 743 adults were on ART; using our total cost estimates for ZPCT-supported sites and extrapolating these costs to the entire national population on ART yields annual cost estimates ranging from US$41.0 to US$114.2 million. Annual costs of providing comprehensive antenatal services including PMTCT in ZPCT-supported sites is estimated to be US$16.0 million; the estimated cost of providing this package to all 505 000 Zambian women who were counselled, tested and received results in 2009 would be US$57.7 million.

Discussion

This study measured average unit costs of five outpatient HIV/AIDS services delivered through 12 ZPCT-supported public-sector facilities throughout central and northern Zambia. These findings add to the small evidence base on economic costs of resources used to produce HIV/AIDS services and the components of these costs. Consistent with other studies (Hounton *et al.* 2008; Rosen *et al.* 2008; Martinson *et al.* 2009), we found total costs of services to be dominated by the costs of drugs, laboratory tests and clinical labour. For each visit type, variability in average unit costs and cost components across facilities suggests that some potential may exist to reduce costs through harmonization of care protocols and also by using fixed resources more intensively, particularly at PMTCT service points and laboratories. For ART, the main cost drivers continue to be variable costs of drugs and laboratory tests, and these costs must be further reduced if unit costs of ART services are to decline substantially.

The study also found substantial variation in unit cost of clinical labour across different services. ART providers exhibited the lowest labour cost per service, even though their salaries tended to be higher. ART providers typically worked alone or with minimal clinical support, attended larger numbers of clients per session and left their service area immediately after clearing their caseloads; these factors resulted in low indirect labour costs per visit. PMTCT providers on the other hand generally worked in teams of two or three and provided these services over longer periods of 4–6 h per day. This staffing pattern combined with lower output per clinic-hour (compared to ART) resulted in higher indirect labour costs per visit for PMTCT than for ART. High indirect labour costs may be unavoidable for PMTCT because of the degree to which these services are integrated into antenatal care. Costs of staff providing counselling and testing services tended to be lower because many providers were volunteers who received a small monthly stipend rather than a formal salary and benefits[3].

The annual treatment costs and total cost figures for ZPCT-supported areas and nationwide should be considered as rough estimates because of limitations inherent in our methodology. First, our use of standard treatment protocols and 'typical' consumption of drugs, supplies and laboratory tests assumes that all patients follow the same treatment path and remain on first-line drug regimens. In reality, some patients require more frequent medical attention (including hospitalization in some cases) and many patients are transitioning to more costly second-line drug regimens. Our approach does not capture this diversity of patient experience in treatment. Longitudinal

[3]Estimating a shadow price for volunteer labour is especially difficult in this context where employment opportunities are scarce. We used the volunteer stipend of US$25 per month as an estimate of the opportunity cost of volunteer time, recognizing that this value may be on the lower end of the range.

data from clinical experience with actual patients would yield more accurate cost estimates, but this approach was not feasible for our study given that the ZPCT electronic patient records system was not yet operational in 2008.

A second limitation of the methodology concerns its inability to account for scale effects. Unit costs assume a fixed level of output, but it is possible that the 12 service delivery points could have produced more output with the same resources, leading to lower unit costs and lower total costs. In the case of ART, we believe any scale-related distortion in projected total costs is small because of the predominance of variable costs in the unit cost estimates, and the higher level of utilization of fixed resources. Scale effects could play a larger role in the case of PMTCT because of uncertainty about staffing patterns in some ANC facilities. We interviewed clinic staff regarding the number and types of providers nominally assigned to an area, but were not always able to confirm that scheduled working hours corresponded to actual hours worked. If we assume that clinic staff remained 'on the clock' and physically present during scheduled ANC clinics, then we conclude that substantial unallocated time exists in these facilities, and lower unit costs could be obtained with higher volumes of clients. Given the importance of the cost of human resources in overall unit costs, future cost studies should invest more effort to ensure accurate recording of the time that staff is physically present in the service area.

Differences between total costs of different treatment guidelines do give a sense of the financial impact in Zambia of the 2009 World Health Organization (WHO) recommendations regarding new drug combinations. Replacing stavudine with tenofovir in first-line therapy increases annual treatment costs by 42%, and other drug combinations bring even higher costs. Recent WHO recommendations to begin treatment at CD4 counts of $<350/mm^3$ rather than the previous threshold of $<200/mm^3$ will also require additional resources, but these are not reflected in our estimates. Where this additional funding for treatment will come from is unclear, especially in the light of recent USG decisions to stabilize PEPFAR funding at approximately US$7 billion per year.

Per-visit costs of capital (including clinic buildings and basic equipment) were very low compared to the costs of drugs, laboratory tests and clinic personnel. Substantial research effort is required to collect information on costs of capital, and this effort may not be justified given the small contribution of capital cost to total cost of services. Complexity and duration of future cost studies could be reduced by developing a consensus on a standard capital cost per square meter that would be based on a review of typical clinical infrastructure and equipment in various African health care settings. Use of such a standard for clinic-based services would free up scarce research resources to focus more intensively on inputs that most strongly influence total costs and could reduce the overall time needed to produce unit cost estimates.

In a dynamic epidemic where the number of persons initiating ART and moving to second-line therapy is constantly changing, unit and total cost estimates soon become out of date. Countries are using PEPFAR indicators and other metrics to monitor and evaluate initiatives to slow the spread of HIV/AIDS, but similar intensity of effort is lacking on the cost side. We see three main reasons for this inattention to costs: first, relatively plentiful HIV/AIDS funding combined with the urgency associated with saving lives has pushed concerns about efficiency into the background; second, country programmes have been reticent to undertake costing studies that are seen as the domain of technical experts and third, health systems do not currently produce basic information on resource use at the facility level that would be needed to generate estimates of unit cost. For example, in our study, we could not find information such as staff rosters with information on normal working hours, and numbers of non-HIV-related visits and laboratory tests. Data on expenditures for rent, water, electricity, overtime allowances and call allowances were pieced together from various sources, but confidence is low that all of these costs are accurate and complete. Creation of a standard reporting format for facility staffing, clinical outputs and monthly recurrent costs would represent a substantial step forward for the GRZ to be able to monitor and evaluate costs and outputs at the facility level. This information could be supplemented with periodic studies of time-use and utilization of drugs and laboratory tests to produce accurate measures of unit costs on an ongoing basis. Higher priority should be placed on improving basic facility-level information on utilization and resource use, especially in the context of lower HIV/AIDS funding and the growing global emphasis on health systems strengthening.

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