Similar costs and outcomes for differentiated service delivery models for HIV treatment in Uganda

Teresa Guthrie[1], Charlotte Muheki[2], Sydney Rosen[1,3*], Shiba Kanoowe[2], Stephen Lagony[2], Ross Greener[1], Jacqueline Miot[1], Hudson Balidawa[4], Josen Kiggundu[4], Jacqueline Calnan[5], Seyoum Dejene[5], Thembi Xulu[6], Ntombi Sigwebele[6], Lawrence C Long[1,3]

1. Health Economics and Epidemiology Research Office, Department of Internal Medicine, School of Clinical Medicine, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa
2. HealthNet Consult, Kampala, Uganda
3. Department of Global Health, School of Public Health, Boston University, Boston, Massachusetts, United States of America
4. Ministry of Health, Kampala, Uganda
5. USAID, Kampala, Uganda
6. Right To Care, Centurion, South Africa

Corresponding author: sbrosen@bu.edu

Abstract

Background: Like many countries in sub-Saharan Africa, Uganda has scaled up differentiated service delivery models (DSDMs) for HIV treatment, but little information is available about the relative costs of the models. We estimated the total annual cost per patient and total cost per patient virally suppressed in five DSDMs, including facility- and community-based models and the standard of care.

Methods: We conducted a cost/outcome study from the perspective of the service provider, using retrospective patient record review of a cohort of patients over a two-year period, with bottom-up collection of patients' resource utilization data, top-down collection of above-delivery level and delivery-level providers' fixed operational costs, and local unit costs. We enrolled adults on ART (>18 years old) enrolled in 47 DSDMs located at facilities or community-based service points in four regions of Uganda with at least 24 months of follow-up data. DSDMs assessed included facility-based groups (FBG); fast-track drug refills (FDR); community client-led ART delivery (CCLAD); community drug distribution points (CDDP); and facility-based individual management (FBIM), which is the standard of care model for new, complex, and virally unsuppressed patients. Viral suppression was defined as <1000 copies/ml.

Results: Retention in care was 98% for the sample as a whole [96-100%]. Over viral suppression was 91%, which varied from 86% among patients in FBIM (with the largest share of complex / virally unsuppressed patients) to 93% among CDDP patients. The mean cost to the provider (Ministry of Health or NGO implementers) was $152 per annum per patient treated, ranging from $141 for FBG to $166 for FDR. Differences among the models' costs were largely due to patients' ARV regimens and proportions of patients on second line regimens. Service delivery costs, excluding ARVs, other medicines and laboratory tests, were modest, ranging from $9.66-16.43 per patient.

Conclusions: Differentiated ART service delivery in Uganda achieved excellent treatment outcomes at a cost similar to the standard of care (FBIM). While large budgetary savings might not be immediately realized, the reallocation of "saved" staff time could improve health system efficiency as facilities and patients gain more experience with DSD models.

Keywords: HIV; ART; Differentiated Service Delivery; Uganda; economic evaluation; costs; outcomes.

INTRODUCTION

In 2019, there were an estimated 1.5 million adults living with HIV (PLHIV) in Uganda, equivalent to an HIV adult prevalence of 5.8% [5.4–6.2%] [1]. Approximately 84% of the HIV-positive population were reported to be on antiretroviral therapy (ART), and of those, 75% were virally suppressed [1,2]. In Uganda, as in other high HIV prevalence countries, there is a need to adapt service delivery approaches to the needs and preferences of PLHIV, with the goal of maintaining good clinical outcomes, reducing costs to patients, and improving efficiency in service delivery [3].
The Ugandan Ministry of Health (MOH) began piloting and scaling-up "differentiated ART service delivery models" (DSDMs) in 2016, becoming one of the first sub-Saharan African countries to develop and implement a comprehensive DSDM program. National guidelines for DSDMs were issued in 2017 [3]. As of 2018, there were five officially approved DSDMs in Uganda for both stable and complex ART patients (Box 1): facility-based individual management (FBIM), which is similar to the previous non-differentiated standard of care; facility-based groups (FBG); fast-track drug refills (FDR); community client-led ART delivery (CCLAD); and community drug distribution points (CDDP). By June 2020, roughly 79% of all adult ART patients had been enrolled in one of the five models: 42% in FDR, 34% in FBIM, 12% in FBGs, 7% in CCLAD, and 5% in CDDP [4]. (The remaining 21% of patients were not recorded as being enrolled in a DSDM and are assumed to have been receiving standard of care treatment at facilities.) [Text Box 1].

There have been a few prior evaluations of the clinical outcomes of early versions of DSDMs in Uganda [5-9], but there is little program-wide evidence on costs and effectiveness, a dearth that limits national budgeting, resource mobilization, implementation planning, and scale-up. At the request of the Ugandan MOH, the PEPFAR-funded EQUIP Project conducted a cost-outcome analysis of the five DSDMs to estimate the annual cost per person retained in care and per patient virally suppressed in each model.

METHODS

Box 1: Differentiated ART service delivery models in Uganda

i. Facility-based individual management (**FBIM**): for patients needing extra attention, such as unstable/complex patients, those who have recently been initiated in care, and those who chose to continue to receive their services at the facility. FBIM is the conventional standard-of-care model of ART delivery.
ii. Facility-based groups (**FBG**): for stable or complex patients needing peer support, such as adolescents, pregnant and breastfeeding women (PBFW), and discordant couples. The frequency of their ARV refills depends on patients' stability.
iii. Fast-track drug refills (**FDR**): for stable patients who pick-up their ARVs directly from clinics (and these can include patients on second-line regimens).
iv. Community client-led ART delivery (**CCLAD**): stable patients form groups within their communities. One person is selected (on rotational basis) to collect the ARV refills for the whole group from the facility.
v. Community drug distribution points (**CDDP**): stable patients pick up their ARVs from a community outreach point, including private pharmacies [4].

Longer appointment spacing and multi-month scripting can be offered to stable patients in all models.

In this study, we estimated the annual cost per patient outcome of a cohort of Ugandan ART patients enrolled in the five official DSDMs in 2017. The cost to providers for individual patient resource use was estimated using a bottom up, micro costing approach, with retrospective data drawn from patients' medical records using methods previously described [10, 11, 12]. Public and non-public (private not-for-profit) providers' and implementing partners' fixed and shared operational, management, and supervisory costs were estimated using a top-down approach. We refer to two periods of observation (study periods): 0-12 months after study enrolment, which corresponds to calendar year 2017 (1

January 2017-31 December 2017), and 13-24 months after study enrolment, which corresponds to calendar year 2018 (1 January 2018-31 December 2018). These are study observation periods only; they do not refer to patients' duration on ART or time in the DSDM. Costs are reported from the provider's perspective only.

Study sites

Study sites were selected to capture the variation in settings, implementing partners, and other characteristics of ART services in Uganda. We define a "site-model" as one model being implemented by one ART facility, though model services may be delivered at non-facility locations. Using this definition, a facility can have more than one site-model if more than one differentiated model is offered there. Our sampling frame included any site-model which had been in operation for ≥6 months by January 2017. Site-models that were considered outliers in terms of size (number of patients) or access (extreme locations that were physically difficult to reach) were excluded from the sampling frame.

In January 2017, there were 605 site-models that met our sample criteria at 297 facilities in Uganda. From these, multi-stage purposive sampling was used to select 47 site-models so as to reflect variation according to model type, facility ownership (public and private-not-for-profit), patient volume, geographic location, and implementing partner (further details on the sampling criteria are included in Supporting information S1 File). We note that many of the public facilities in the study were supported by a non-governmental "implementing partner" receiving external donor support largely from PEPFAR. These implementers played a major role in establishing and maintaining the DSDMs. We thus captured their operational costs, as well as those of the MOH.

Fixed costs for providers and implementers were collected for all 47 site-models. Twenty of the 47 (4 per DSDM) were then selected for the collection of patient level resource usage and treatment outcomes.

Study population

Our study population included all adult ART patients (≥18 years) who were enrolled in a DSDM on or before 1 January 2017. In Uganda, all PLHIV are eligible for DSDMs, but their specific model options depend on model availability and clinical stability. A "stable" patient is defined as one who is a) on their current ART regimen for ≥12 months; b) virally suppressed; c) in WHO Stage I/II; d) adherent (> 95%) over the last 6 months; and e) if a TB patient, past the intensive TB treatment phase (2 months) and sputum negative [4]. (We note that Uganda refers to ART patients as "clients," but we have chosen to use "patients" here for consistency with the international literature.) Patients who met these eligibility criteria were selected consecutively from DSDM registers kept by the facilities starting in January 2017 and then sequentially earlier in time (December 2016, November 2016, and so on) until the target sample size of 30-33 patients was reached for each of the 20 sites. Patients with a record of formal transfer out of a selected health facility before the 12-month study endpoint were excluded. For the FBG sites, only groups for pregnant and breastfeeding women (PBFW) were selected because of more rigorous ethical clearance requirements for accessing pediatric and youth groups and the small number of sero-discordant couple groups.

Participants in each of the models except FBGs were followed longitudinally for 24 months starting on January 1, 2017. This follow-up period was broken into two periods: 0-12 months after study enrolment and 13-24 months after study enrolment, with data accessed retrospectively at the end of each period. For the FBGs, two different samples of PBFW were followed for each 12 month period (FBG1 and FBG2) because they only remained in their FBG for the duration of their pregnancy and postnatal period.

Data collection

All data for the study were collected locally from three sources. First, research assistants retrospectively extracted demographic characteristics, medical histories, treatment outcomes, dates of and reasons for clinic visits, ARVs and non-ARV medications dispensed, TB status, WHO clinical stage, laboratory tests, and counselling sessions from study participants' ART care cards, which were maintained by facility staff. Second, from model-specific DSDM registers, participants' attendance at any DSDM-related event were recorded (adherence counselling, group support meetings, FBG meetings, community medication collection/distribution meetings, community viral load sessions etc). Third, we interviewed programme and financial managers at each of the site-models', collected the estimated length of time spent by the different cadre for each service, obtained expenditure records, asset registers and undertook spacial measurements of the buildings used in providing the DSDM services.

Treatment outcomes

Retention in care and viral suppression as reported in individual participants' medical records were the primary treatment outcomes of interest in this analysis. Retention was measured as not having missed a scheduled appointment (clinic or DSDM) for >90 consecutive days [13]. Viral suppression was based on the latest viral load (VL) test in each study period (12/24 month ± 3-month window) being <1000 copies/ml [3]. For the cost analysis, we defined four mutually exclusive outcomes as follows: Retained in care and known to be virally suppressed (RIC, suppressed); retained in care and known to be not virally suppressed (RIC, unsuppressed); retained in care and VL unknown (RIC, VL unknown); not in care (NIC). ARV adherence, as proxied by an annual medical possession ratio (MPR) (total days dispensed/365), was reported as a secondary treatment outcome and categorised using the MOH's scale (good ≥95%; fair 85%-94%; poor 75%-84%; non-adherent ≤74%). Patients in the cohort who switched between models during the study period were retained in their original models for analysis.

Resource utilization, cost data and cost analysis

To calculate direct resource utilization for each patient, we identified and quantified all resources utilized within the two 12-month study periods. Patient-level resource utilization data were identified and quantified from patients' ART care cards and DSDM registers, as described above. The cost per unit of each resource were collected from price lists, salary scales, tender documents, and implementers' expenditure logs. Staff costs per facility visit or DSDM event were calculated based on the estimated time per visit or DSDM event for each staff member at the average cost of that cadre's time, based on total remuneration. The estimated time per visit was estimated from staff interviews. Quantities of resources used were multiplied by unit costs and summed to obtain an average direct cost per patient. (Details of prices and costing methods are described in Supporting information S1 Table and S2 Table).

We also estimated indirect (fixed and shared) costs, including facility and DSDM management, administration, oversight and supervision, staff training, equipment, building/ rental and all operational and overhead costs at the facility and above-facility levels. These indirect costs, varying by model type, were attributed to each DSDM patient using an allocation factor based on facility annual headcount (out-patient visits) and each patient's number of visits.

Finally, we summed the direct and indirect cost/patient to generate a total cost per patient, stratified by DSDM-type and patient outcome. We also estimated the "production cost" of achieving one patient who was virally suppressed by dividing the total cost (any outcome) per model by the proportion of patients with viral suppression in that model.

Unit costs reflect 2018 market prices and were converted from Uganda shillings to United States dollars (USD) using the annual average Bank of Uganda exchange rate for 2018 of $1:UGX 3728 [14]. Costs are reported in 2018 USD.

Ethical considerations

The study was approved by the Ugandan TASO Research Ethics Committee (TASOREC/049/18-UG-REC-009) and the Ugandan National Council for Science and Technology (SS4746), and permission was also obtained from the MOH to access district health regions and ART sites.

RESULTS

Study population

A total of 653 patients from four regions of Uganda were enrolled in the study, divided roughly evenly among the five DSDM types (Table 1). During the two-year study period, 29 patients switched back to FBIM due to viral failure, while 6 FBIM patients switched to other DSDMs. As explained above, these patients were retained in their original models for purposes of analysis.

The majority (72%) were female, a slightly higher proportion than in the national ART cohort (65%) [15], due to our sampled FBG participants being all female. The facility-based individual models (FDR and FBIM) had the highest proportions of male participants (44% and 36%, respectively). The median age for all the models except FBG ranged from 41 to 44 years; FBG patients were younger, with a median age of 29 years. The median duration on ART was 5 years; FBIM and FBG patients had been on ART for less time (2 and 3 years respectively), while FDR patients had spent a median of 8 years on ART. At study enrolment, the median length of time in a differentiated model was one year, and 91% of patients were on first line (FL) ARV regimens. Only the FDR model cohort reported more than 10% of participants on a second line (SL) regimen (17%). (Table 1).

Table 1. Characteristics and treatment outcomes by model of ART delivery

Sample characteristics (n, % unless otherwise specified)	FBIM (n=128)	CCLAD (n=131)	CDDP (n=132)	FBG1 /2 (n=129, 115)[a]	FDR (n=133)	Total (n=653)
Sex (female)	82 (64%)	92 (70%)	95 (72%)	129 (100%)	75 (56%)	473 (72%)
Age, years (median, IQR)*	41 (34-51)	44 (40-49)	44 (38-52)	29 (25-34)	44 (35-51)	41 (33-48)
Duration on ART, years (median, IQR)*	3 (2-5)	5 (2-8)	7 (5-10)	2 (1-3)	8 (5-10)	5 (2-8)
Duration in DSDM, years (median, IQR)[b]	3 (2-5)[c]	1 (1-1)	1 (1-6)	1 (1-1)	2 (1-4)	1 (1-3)
Patients on first-line regimens [b]	117 (91%)	124 (95%)	121 (92%)	120 (93%)	111 (83%)	593 (91%)
Patients on second-line regimens [b]	11 (9%)	7 (5%)	11 (8%)	9 (7%)	22 (17%)	60 (9%)
Baseline CD4 count, cells/µl (median, IQR)[d]	310 (199-430)	221 (128-353)	210 (143-328)	433 (250-629)	234 (118-349)	272 (152-414)
Outcomes at 12 months						
Retained in care	126 (98%)	127 (97%)	130 (98%)	120 (93%)	133 (100%)	636 (97%)
Unsuppressed (viral load>1000 copies/ml)	12 (9.4%)	4 (3.1%)	3 (2.3%)	6 (4.7%)	4 (3%)	29 (4.5%)
Suppressed (viral load<1000 copies/ml)	110 (86%)	125 (95%)	123 (93%)	115 (89%)	118 (89%)	591 (91%)
Unknown viral status	6 (5%)	2 (2%)	1 (1%)	8 (6%)	11 (9%)	28 (4.3%)
Outcomes at 24 months						
Retained in care[e]	122 (97%)	127 (98%)	132 (100%)	110 (96%)	131 (99%)	622 (98%)
Detectable viral load (>1000 copies/ml)	10 (7.9%)	2 (1.5%)	3 (2.3%)	4 (3.5%)	3 (3%)	22 (3.5%)
Undetectable viral load (<1000 copies/ml)	111 (88%)	117 (90%)	121 (92%)	108 (94%)	119 (90%)	576 (91%)
Unknown viral status	5 (4%)	11 (9%)	8 (7%)	3 (3%)	10 (8%)	37 (6%)

[a]Sample characteristics and 12-month outcomes are for the FBG1 cohort; 24 month outcomes are for the FBG2 cohort.
[b]Age, duration on ART, duration on DSDM and regimen are measured at the time of enrollment in the study (January 2017).
[c]For FBIM, the duration on DSDM is equivalent to the duration on ART. Some patients switched from their DSDM back to FBIM when becoming unsuppressed, but they were retained in their original models for purposes of analysis.
[d]Baseline CD4 count at time of ART initiation. Data missing for <10% of patients in all models.
[e]Not retained in care (in 2nd year period) included one death (FBIM); the rest were LTFU.

Treatment outcomes

Overall retention in care and viral suppression rates were high for all the models (Table 1). For the sample as a whole, retention in care was 97% and 98% at 12 and 24 months, respectively; average viral suppression was 91% for both periods. FBIM patients had the highest proportion of known non-suppressed patients (9.4% and 7.9%) and was the only model to report a death, which occurred in the second study period, while FBG had the highest suppression rate at 94%. The majority of patients in both study periods (80% and 83%, respectively) were classified as having "good" adherence (≥95%), based on the MPR and the scale provided by the MOH (results not shown).

Resource utilization

Antiretroviral medications and laboratory tests

A range of ARV formulations were prescribed and dispensed to our study participants. The most common at 24 months were TDF-3TC-EFV for first line therapy, which accounted for 50% of first line formulations, and TDF-3TC-ATV/r for second line therapy, accounting for 27% of second line regimens (Supporting information S3 Table). Dolutegravir (DTG) became available in 2018; 8.2% of patients had switched to DTG formulations by the 24th study month. Patients received an average of 1-2 months of ARVs at a time—there was little adoption of multi-month dispensing during the study periods.

Viral load testing appeared consistent with guidelines: study participants received an average of one viral load test per year, and with only minor variation by model (Table 2). There was a reduction in other laboratory investigations between the study periods, from 0.62 tests per patient in 0-12 months to 0.28 tests per patient in 13-24 months (refer to Supporting information S4 Table).

Table 2. Resource utilization per patient, by model and study period (mean per patient per annum)

Service/item (Mean frequency per patient/annum)	FBIM (n=128)	CCLAD (n=131)	CDDP (n=132)	FBG1/2 (n=129, 115)[a]	FDR (n=133)	Total (n=653)
Months 0-12						
Laboratory investigations						
Viral load tests[b]	1.05	1.15	1.18	1.09	1.02	1.09
All other (non-VL) tests	0.38	0.84	0.24	1.19	0.44	0.62
Facility visits / DSDM events						
Mean duration of dispensing interval (months)	1.6	1.9	1.7	1.6	2.0	1.7
Facility visits[c]	7.74	6.44	6.91	7.57	6.12	6.95
DSDM events[d]	0.00	3.60	4.16	6.12[e]	0.00	2.77
Total interactions	7.74	10.04	11.07	13.69	6.12	9.72
Months 13-24						
Laboratory investigations						
Viral load tests[b]	0.98	0.83	0.92	1.15	0.92	0.95
All other (non-VL) tests	0.29	0.42	0.05	0.54	0.15	0.28
Facility visits / DSDM events						
Mean duration of dispensing interval (months)	1.6	2.0	2.0	1.3	2.1	1.8
Facility visits[c]	7.63	5.92	6.07	9.05	5.82	6.84
DSDM events[d]	0.00	2.00	1.92	6.6[e]	0.00	2.01
Total interactions	7.63	7.92	7.99	15.70	5.82	8.85

[a] Months 0-12 are FBG1 data. Months 13-24 are FBG2 data.

[b]Viral load test frequency is guided by the MOH Treatment Guidelines. Other tests are done if clinically indicated.

[c]Facility visits could be either scheduled ARV collections or unscheduled visits for other needs. Included ARV collections for all DSDM patients, even if collected by a community/group member on behalf of the patient – and costs of pharmacy and nurse time were split between group members.

[d]DSDM events count excluded the ARV pickups from facilities which were counted as facility visits.

[e]FBG support groups could occur in community or at facilities, but are all labelled here as DSDM events.

Frequency of facility visits and DSDM events

Patients visited healthcare facilities during the study period either for a scheduled (routine) appointment to collect their ARVs (individual collection, group collection, or fast-track drug refill) or for unscheduled visits for HIV-related illnesses, opportunistic illnesses, or other comorbidities (Table 2). In addition to facility visits, the CCLAD, CDDP, and FBG models held DSDM-specific events, or interactions, such as community-based clinical/TB assessments, group viral load sessions, ARV collections, and adherence support meetings (Supporting information S5-S6 Tables). The available data indicated a reduction of almost half (48%) in the total recorded DSDM events between the two study periods, which may reflect actual changes in patients' participation, deterioration in record keeping, or both. Actual implementation of the DSDM models differed slightly from MOH guidelines [4] in the frequency of facility ART visits, DSDM interactions, and viral load tests. These differences diminished over the two-year study period, as greater standardisation occurred in DSDM implementation.

Total cost per patient and cost per outcome

Unit costs of the resources utilized by participating patients are available in Supporting information S1, S3-S6 Tables). For the second study period, which may better reflect costs going forward, the annual mean cost per patient treated was $141, $146, $150, $152 and $166 for the FBG, CDDP, CCLAD, FBIM (standard of care) and FDR models, respectively (Table 3). FBIM and FDR costs were largely driven by having greater proportions of patients on second-line regimens (9% and 17% respectively, by the end of the study period). The mean annual cost per second-line (SL) patient across all models was more than double that of first-line (FL) patient ($135 FL vs. $343 SL). The mean cost per virally suppressed patient (at 24 months after study enrolment) was $150, $158, $167, $173 and $184, for FBG, CDDP, CCLAD, FBIM and FDR respectively.

ARVs and laboratory tests were the main cost drivers for all models – 74% and 9% respectively of total costs (Table 3) - followed by the prevention and treatment of opportunistic infections which included Isoniazid and Pyridoxine (8% on average). If these three cost components are removed from the totals, the mean annual service delivery cost per patient was $10 for FDR, $12 CDDP, $14 FBIM, $16 FBG, and $16 for CCLAD. Human resource costs for facility visits (3% on average) varied across the models, based on the different staff involved, their salary scales, and the length of time and frequency of each interaction. Participants in the FBGs (pregnant and breastfeeding women) appeared to have a greater proportion of personnel costs, due to more frequent facility visits and interactions. Human resource costs for the DSDM events/interactions were low (0.1%) because most were group events for which staff costs were shared among the group participants. Site overhead costs (3%) and above-site costs (3%), for supervision, training, management, and implementing partners' headquarter costs, varied between models but generally account for only a small share of the total per patient. CCLAD had slightly higher above-site costs than the other models, in part due to their greater supervision, monitoring and headquarters' operating costs, while CDDP and FDRs had the lowest above-site costs (Table 3).

Table 3. Annual average cost per patient by cost component, by model and period (US$ 2018)

Mean cost per patient per annum (US$)	FBIM		CCLAD		CDDP		FBG		FDR		Overall	
	0-12m (n=128)	*13-24m (n=126)*	*0-12m (n=131)*	*13-24m (n=130)*	*0-12m (n=132)*	*13-24m (n=132)*	*FBG1 (n=129)*	*FBG2 (n=115*	*0-12m (n=133)*	*13-24m (n=132)*	*0-12m (n=653)*	*13-24m (n=635)*
ARVs (including SCM[a] costs)	108.31	115.33	104.48	103.20	116.89	112.76	104.75	96.88	136.83	133.96	114.38	112.84
Non-ARV meds (including SCM costs)	20.17	9.99	16.71	20.10	22.17	10.12	22.07	13.13	23.44	11.10	20.92	12.89
Laboratory tests	14.10	13.04	14.99	11.21	14.96	11.40	14.75	14.85	13.84	11.75	14.52	12.38
Facility visits (HR costs[b])	6.27	5.00	4.09	2.55	2.02	1.47	11.26	6.90	6.22	4.77	5.95	4.06
DSDM events (HR costs)	[c]	[c]	0.29	0.17	0.31	0.17	0.16	0.06	[c]	[c]	0.15	0.08
Site-level costs: transport, overheads	4.50	4.50	7.40	7.40	7.86	7.86	4.51	4.22	2.10	2.10	5.27	5.24
Above-site costs: supervision, training, materials, management	4.58	4.62	5.44	5.44	2.65	2.65	5.28	5.24	2.77	2.79	4.13	4.11
DSDM cost ($) per patient per year (mean, SD)	157.93 (62.51)	152.49 (72.04)	153.39 (57.78)	150.07 (54.94)	166.85 (82.34)	146.42 (59.52)	162.77 (79.53)	141.29 (33.7)	185.20 (104.47)	166.48 (82.51)	165.33 (79.76)	151.61 (63.65)
Service delivery costs (excl. ARVs, labs, non-ARV meds)	15.35	14.12	17.22	15.56	12.84	12.14	21.20	16.43	11.09	9.66	15.51	13.50

[a]SCM = supply chain management.

[b]Facility visits included human resource costs for ARV refills, fast-track refills, clinical assessments, TB assessments, counselling, drawing blood for lab tests, and unscheduled visits.

[c]FBIM and FDR did not have any community-based DSDM events.

DISCUSSION

By 2018, Uganda had developed and implemented five differentiated models of ART service delivery, including the standard of care, known as facility-based individual management (FBIM). In this two-year observational study, we found that, on average, all five DSDMs achieved good outcomes and cost the provider (Ministry of Health or NGO implementers) an average of $152 per year per patient treated. Retention in care averaged a surprisingly high 98% for the sample as a whole, with a tight range of 96-100%. Viral suppression, which averaged 91%, varied between a low of 88% among patients in FBIM, which served as the primary model for treating complex patients, and a high of 94% among FBG patients. These good outcomes are consistent with other reports on the CDDP [7,8] and CCLAD [6] models in Uganda. Similarly, in other African countries, a recent systematic review concluded that retention in care and viral suppression are roughly equivalent to those in conventional models of care [16].

Differences among the models' costs were explained largely by patients' ARV regimens and the costs of prevention and treatment of opportunistic infections and other co-morbidities. Service delivery costs, excluding ARVs, laboratory tests and other non-ARV medicines, were modest, ranging from $10-$16 per patient, with CCLADs being slightly higher due higher above-site costs while FBGs personnel costs were higher due to increased facility visits and interactions. This does not leave a lot of room for "savings" to the healthcare system, and indeed, we found the new Ugandan DSDMs were not much less expensive than FBIM, the model that most closely proxies the previous standard of care. This finding is similar to results of some other recent studies but not with others. A recent observational evaluation in Zambia, for example, found that the standard of care model was less expensive than community-based ART delivery [17]. In South Africa, in contrast, a study of adherence clubs where lower cadre staff (compared to the facility-based standard of care staff) dispensed ARVs to 25-30 members at club meetings found them cost-saving compared with the standard of care [18]. Evaluations of models implemented in cluster-randomized trials that explicitly emphasized multi-month dispensing of ARVs have also observed modest cost savings [19]. We note that in Uganda, over the period of this study, participants made more facility visits for medication collection than called for in guidelines. Since the study ended, Uganda has implemented longer dispensing intervals for ARVs, which may lead to lower costs for models that are able to dispense six-month supplies to a large share of patients. Numerous studies have also found that DSDMs do substantially reduce costs to patients, primarily for transport and time [9]. With equivalent or

better outcomes and large benefits to patients, the finding that differentiated models do not greatly reduce provider costs may not diminish their societal value.

Our study had a number of limitations, largely stemming from our reliance on routinely-collected, retrospective data. Because of incomplete electronic patient medical records at some sites, we relied on individual patients' paper ART Care Cards, which are removed from healthcare facilities when patients die. As a result, we likely undercounted deaths in the 0-12 month sample, and during the second study period, we identified only one death. Our outcomes measures were therefore limited to patients surviving at 24 months, possibly causing us to overstate rates of retention and viral suppression.

We also struggled with incomplete records of DSDM interactions, as model registers were poorly maintained and this worsened in the second study period. The decrease in DSDM interactions, from an annual average 2.85 in the first period to 2.05 in the second period, may thus reflect either an actual reduction in DSDM interactions or a worsening in record-keeping between the years. Finally, estimates of staff time spent for each type of event were obtained through interviews with staff. Self-reported time use may not be accurate, and we excluded non-patient-facing activities such as record keeping, stock management, and breaks. We thus may have underestimated these human resource costs for every model. In a separate facility-level analysis of total salary costs/patient, we estimated an additional personnel cost of $2.20 per patient per year, for these non-patient-facing activities. These could be added to the totals for each model in Table 3.

In conclusion, differentiated ART service delivery in Uganda achieved excellent treatment outcomes at a cost similar to standard of care (FBIM). While large budgetary savings might not be immediately realized, the reallocation of "saved" staff time due to multi-month dispensing and reduced facility visits could improve health system efficiency as facilities and patients gain more experience with the DSD models.

Supporting information

S1 Table. Unit costs for human resources for services, laboratory tests and ARV formulations
S2 Table. Methods for cost estimation by cost category
S3 Table. DSDM patient's ARV formulations (as at the end of 24-month study period)
S4 Table. Types and frequency of diagnostic tests performed
S5 Table. Types and frequency of facility-based services
S6 Table. Types and frequency of DSDM events (non-facility based)
S1 File. Sampling: Selection of sites

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Conflicts of interest

The authors declare no conflict of interest.

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Author contributions

Conceptualization: TG LL SR CM NS HB JK SD. Data Curation: TG CM SK SL RG. Formal Analysis: TG RG. Funding Acquisition: JC SD TX NS SR LL JM TG. Investigation: TG CM SK SL. Methodology: TG LL SR CM JM. Project Administration: TG CM LL. Resources: HB JK SD. Software: RG TG. Supervision: TG CM LL SR. Visualization: TG LL SR. Writing – Original Draft Preparation: TG LL SR CM. Writing – Review & Editing: TG LL SR CM JM SK SL HB JK[1] JC SD TX NS RG.

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SUPPLEMENTAL DIGITAL CONTENT

Similar Costs and Outcomes for Differentiated Service Delivery Models for HIV Treatment in Uganda

S1 Table. Unit costs for human resources for services, laboratory tests and ARV formulations

Service / event / item	Mean cost (US$ 2018)
Human resource costs for facility-based services	**Per service**
Drug refill	0.09
Fast-track drug refill	0.19
Comprehensive clinical assessment	1.21
TB assessment at clinic	1.52
Unscheduled clinic visit for OIs, co-morbidities, other	1.71
Drawing blood at clinic	0.23
FBG quick clinical assessment	0.09
Counselling: education on basic HIV prevention and disclosure	1.52
Counselling: ART preparation, initiation, support, monitoring	1.40
Counselling: Progression on treatment	1.34
Intensive adherence counselling	2.60
Human resource costs for community-based services	**Per service**
CCLAD pre-med/meds collection/support meetings*	- *
Viral Load testing meeting (CCLAD & CDDP)**	0.11
Counselling session (CCLAD & CDDP)**	0.04
Clinical assessment (CCLAD & CDDP)**	0.09
TB assessment (CCLAD & CDDP)**	0.09
CDDP TB Case Finding Guide**	0.04
CDDP Drug Pick Up at community**	0.04
*Volunteer time only, not valued.	
** Personnel time for group events, split between all patients in the group.	
Laboratory test	**Per test**
Viral Load	12.30
CD4	9.60
TPHA (Syphilis test)	2.10
Complete Blood Count (CBC)	1.20
Malaria RDT	0.80
Serum Crag	4.10
GeneXpert	11.80
Haemoglobin	1.00
Urinalysis	0.80
HCG (Pregnancy test)	0.30
First-line ARV regimens (fixed-dose combinations)	**12 month supply*** **
AZT/3TC/NVP	73.61
TDF/3TC/EFV	76.04
TDF/3TC/NVP	77.26
TDF/3TC/DTG	99.16
AZT/3TC/EFV	100.38
ABC/3TC/EFV	114.37
ABC/3TC/DTG	124.71
Second-line regimens	**12 month supply*** **
ABC/3TC/NVP	102.81
AZT/3TC/DTG	110.72
TDF/3TC/ATV/r	231.78
AZT/3TC/ATV/r	243.33
ABC/3TC/ATV/r	257.33
TDF/3TC/LPV/r	274.48
AZT/3TC/LPV/r	286.04
ABC/3TC/LPV/r	300.03

***Price includes supply chain management costs of 24.73%.

S2 Table. Methods for cost estimation by cost category

Resource Input	Quantification method (Q)	Valuation technique (P)
Variable costs (direct-patient resources reported in patient medical records and DSDM registers)		
Medicines	Prescribed medicines during the study period, including ARVs and non ARVs.	The US$ (2018) unit price of medicines were used, as provided by the MOH Quantification Procurement & Purchasing Unit (QPPU). Total cost of drugs was estimated as quantity multiplied by unit cost.
Supply chain management costs	All medicines prescribed during the study period had a supply management cost applied to them.	The actual supply chain management cost varied depending on the medicine. An average mark-up of 24.725% on drug costs across all medicines was applied at the recommendation of the QPPU.
Viral load and other laboratory tests	Number of viral load (VL) tests and other laboratory tests done during the study period.	Unit price of VL test and others (US$2018) provided by the Central Public Health Laboratories (CPHL), and multiplied by the number of tests done over the period.
Human resources	The frequency of facility services or DSDM community events attributed to each patient were obtained from their ART care cards and the DSDM registers. The different cadre engaged in providing specific types of facility services and DSDM events, and the average amount of time they each spent on these, were obtained through staff interviews – specific to each site and model-type. For group/community events, the average number of patients per group/ event were also obtained through staff interviews.	Public staff salaries were obtained from the public salary scales for 2017 and 2018. IP's staff annual gross salaries (full cost to company) were obtained from their expenditure records. The cost per minute per cadre was calculated and applied to the reported amount of time (minutes) spent on facility services and DSDM community events. The HR cost per service/ event was multiplied by the numbers of each used by each patient. For group/ community events, the HR cost was divided by the average number of patients in the group/ event, and attributed to individual sampled patients. A sensitivity analysis was performed to assess the possible range of under/over-reporting by staff.
Fixed costs (resources used for the facility and DSDM operation – both site-level and above-site)		
Per diem and travel allowances for expert patient and staff	The number of per diems per model was based on the length of stay away from the facility, obtained through interviews with programme staff and volunteers.	The Government per diem rate (2018) and transport rate was applied to the number of support visits.
Vehicle maintenance costs	Through staff interviews the numbers of vehicles that were used in the DSDM service delivery were identified, and % of their maintenance costs that should be apportioned to DSDM activities was obtained.	Actual maintenance costs were obtained from the IP expenditure records, and the % attributed to the DSDM. By step down costing approach, these were then attributed to each patient in the DSDM.
Printing and record keeping	Total stationary, printing and files consumed in each year and their costs were based on actual expenditure. Through staff interviews the relevant % that should be apportioned to DSDM activities was obtained.	A proportion of the actual annual expenditure was applied for each specific model based on staff interviews, and then attributed to each patient in the DSDM (step down allocation).
Training costs	These included venue hire, per diem, travel costs, meals and refreshments and the development and supply of all training materials. Through staff interviews the relevant % that should be apportioned to specific sites and models.	Valuation was based on actual expenditure by the selected site or implementing partner (IP). If training was a once-off cost before establishing the models, these costs were considered as capital investment and were discounted and annualized over a 3-year period.
Materials for repackaging of drugs	Actual quantities of the different materials used for repackaging of drugs were obtained through review of records. Through staff interviews the relevant % that should be apportioned to DSDM activities was obtained.	Quantities of different materials multiplied by their unit prices, obtained from the IP expenditure records.
Communication costs	Actual expenditure on communication that was relevant to DSDMs.	Where necessary, communication expenditure was apportioned to specific sites and models (if the expenditure was not separately kept for these models).
Overheads/ utilities	Actual expenditure on overheads for the site from expenditure records. Through staff interviews the relevant % that should be apportioned to DSDM activities was obtained.	Apportioned total overheads expenditure to DSDM using the relevant %.

Resource Input	Quantification method (Q)	Valuation technique (P)
Facility and DSDM programme management (PM) & administration costs, incl. oversight and supervision	Actual expenditure on programme managers/ admin staff from expenditure records. Through staff interviews the relevant % that should be apportioned to DSDM activities was obtained.	Apportioned total PM costs expenditure to DSDM using the relevant %. A proportion of all these shared costs was then allocated to each DSDM patient using an allocation factor, per site and model, to obtain an average indirect cost per patient. This allocation factor was calculated as the numbers of ART visits per annum / total number of out-patient visits per annum at the facility.
Materials and supplies	Actual quantities of the different materials used for DSDM start up and for on-going operations.	Quantities of different materials multiplied by their unit prices (from IP expenditure records).
IEC materials	Actual expenditure on IEC materials for DSDMs, shared across DSDMs if more than one was being implemented	Quantities of different materials multiplied by their unit prices (from IP expenditure records).
Community sensitization and mobilization	Actual expenditure on mobilization costs per site from records. Through staff interviews the relevant % that should be apportioned to DSDM activities was obtained.	Apportioned total IP expenditure to DSDM using the relevant %.
Capital Costs		
Vehicles / Motorcycles / Bicycles	Quantification of vehicles/motorcycles/bicycles were done through the KIIs, and their share of use for the specific models estimated (if not fully utilized by the model).	Current replacement costs for vehicles was obtained from MOH procurement price list. The estimated annual cost was annualized value of the vehicles.
Buildings	Space consumed by DSDM activities was measured in square meters.	A square meter was valued at UGX 61,240 (discounted and annualized), which was provided by the MOH (budget framework).

S3 Table. DSDM patient's ARV formulations (as at the end of 24-month study period)

ARV formulation	CCLAD (n=130	CDDP (n=132	FBG (Gp2) (n=115	FBIM (n=126	FDR (n=132	Total (n=635
First-line regimens	95%	92%	99%	90%	84%	92%
AZT/3TC/NVP	*28%*	*32%*	*12%*	*18%*	*21%*	*22.7%*
TDF/3TC/EFV	*35%*	*25%*	*82%*	*60%*	*32%*	*45.8%*
TDF/3TC/NVP	*13%*	*8%*	*4%*	*1%*	*12%*	*7.9%*
TDF/3TC/DTG	*12%*	*17%*	*1%*	*1%*	*8%*	*8.0%*
AZT/3TC/EFV	*5%*	*10%*	*0%*	*10%*	*11%*	*7.4%*
AZT/3TC/DTG	*1%*	*0%*	*0%*	*0%*	*0%*	*0.2%*
ABC/3TC/EFV	*1%*	*0%*	*0%*	*0%*	*0%*	*0.2%*
Second-line regimens	5%	8%	1%	10%	16%	8%
TDF/3TC/ATV/r	*1%*	*2%*	*1%*	*4%*	*3%*	*2.2%*
AZT/3TC/ATV/r	*0%*	*1%*	*0%*	*2%*	*2%*	*0.8%*
ABC/3TC/ATV/r	*2%*	*1%*	*0%*	*0%*	*6%*	*1.7%*
TDF/3TC/LPV/r	*2%*	*2%*	*0%*	*3%*	*3%*	*2.0%*
ABC/3TC/LPV/r	*0%*	*0%*	*0%*	*0%*	*2%*	*0.3%*
AZT/3TC/LPV/r	*1%*	*2%*	*0%*	*1%*	*1%*	*0.8%*

S4 Table. Types and frequency of diagnostic tests performed

Test/client/annum	CCLAD (n=131)	CDDP (n=132)	FBG1 (n=129)	FBIM (n=128)	FDR (n=133)	Total (n=653)
Months 0-12						
Viral load*	1.15	1.18	1.09	1.05	1.02	1.09
Haemoglobin	0.34	0.05	0.21	0.01	0.03	0.13
CD4 count	0	0	0.02	0.05	0.11	0.04
TB sputum	0.01	0.02	0.05	0.03	0.05	0.03
All other tests	0.5	0.17	0.91	0.29	0.26	0.43
Total tests/client	1.98	1.42	2.27	1.43	1.46	1.71
Total non-VL tests/client	0.84	0.24	1.19	0.38	0.44	0.62
Months 13-24			**FBG2 (n=115)**			
Viral load*	0.83	0.92	1.15	0.98	0.92	0.95
Haemoglobin	0.13	0	0.2	0.02	0.01	0.07
CD4 count	0.04	0	0	0.04	0.01	0.02
GeneXpert **	0.01	0.01	0.01	0.02	0.02	0.01
All other tests	0.25	0.05	0.33	0.2	0.11	0.18
Total tests/client	1.25	0.97	1.69	1.26	1.07	1.24
Total non-VL tests/client	0.42	0.05	0.54	0.29	0.15	0.28
% change in frequency of all tests between periods	-37%	-32%	-26%	-12%	-27%	-27%

S5 Table. Types and frequency of facility-based services

Facility services (0-12mths)	CCLAD (n=131)	CDDP (n=132)	FBG (n=129)	FBIM (n=128)	FDR (n=133)	Overall (n=653)
Retained in care (RIC), n (%)	*127 (96.9%)*	*130 (98.5%)*	*120 (93%)*	*126 (98.4%)*	*133 (100%)*	*636 (97.4%)*
Facility services, n (av/RIC client/ann)						
ART refill visits	837 (6.59)	910 (7)*	977 (8.14)	987 (7.83)	813 (6.11)	4524 (7.11)
Comprehensive clinical assessment (1/2/3/6/9 mths or annual assessment)	117 (0.89)	121 (0.92)	624 (4.84)	817 (6.38)	162 (1.22)	1841 (2.82)
Fast-track drug refill assessment	6 (0.05)	1 (0.01)	10 (0.08)	0 (0)	488 (3.67)	505 (0.77)
TB assessment at clinic	23 (0.18)	28 (0.21)	237 (1.84)	224 (1.75)	139 (1.05)	651 (1)
Unscheduled clinic visit/s for HIV-related illnesses, OI, co-morbidities	6 (0.05)	2 (0.02)	0 (0)	4 (0.03)	1 (0.01)	13 (0.02)
** ARV refills for CDDP clients occurred at non-facility pick-up points, but are included here for comparison of numbers of refills across DSDMs*						
Counselling session (n, av/RIC client/ann)	**73 (0.56)**	**28 (0.21)**	**388 (3.01)**	**174 (1.36)**	**210 (1.58)**	**873 (1.34)**
Education on basic HIV prevention and	19 (0.15)	5 (0.04)	257 (1.99)	64 (0.5)	120 (0.9)	465 (0.71)
Progression on Rx counselling	8 (0.06)	2 (0.02)	49 (0.38)	24 (0.19)	16 (0.12)	99 (0.15)
ART preparation, initiation, support,	34 (0.26)	5 (0.04)	56 (0.43)	15 (0.12)	46 (0.35)	156 (0.24)
Home based care counselling	5 (0.04)	0 (0)	1 (0.01)	1 (0.01)	5 (0.04)	12 (0.02)
Intensive adherence counselling	7 (0.05)	16 (0.12)	25 (0.19)	70 (0.55)	23 (0.17)	141 (0.22)

S6 Table. Types and frequency of DSDM events (non-facility based)

DSDM Events (0-12mths)	CCLAD (n=131)		CDDP (n=132)		FBG (n=129)		Total (CCLAD, CDDP, FBG) (N=392)	
DSDM event (n, av/client/ann)	**472**	***3.6***	**1320**	***10.0***	**789**	***6.1***	**2581**	***6.6***
CCLAD Viral Load testing meeting	12	0.09	n/a	n/a	n/a	n/a	12	0.03
CCLAD counselling session (in community)	100	0.76	n/a	n/a	n/a	n/a	100	0.26
CCLAD clinical assessment (in community)	125	0.95	n/a	n/a	n/a	n/a	125	0.32
CCLAD TB assessment (in community)	235	1.79	n/a	n/a	n/a	n/a	235	0.60
CDDP clinical assessment (in community)	n/a	n/a	229	1.73	n/a	n/a	229	0.58
CDDP counselling session (in community)	n/a	n/a	289	2.19	n/a	n/a	289	0.74
CDDP TB Case Finding Guide	n/a	n/a	2	0.02	n/a	n/a	2	0.01
CDDP TB community assessment	n/a	n/a	28	0.21	n/a	n/a	28	0.07
CDDP drug pick up (in community) (=ARV refills)	n/a	n/a	771	5.84	n/a	n/a	771	1.97
FBG Group meetings	n/a	n/a	n/a	n/a	627	4.75	627	1.60
FBG Quick clinical assessment	n/a	n/a	n/a	n/a	161	1.22	161	0.41
Home based care / palliative care / symptom management at home	n/a	n/a	1	0.01	1	0.01	2	0.01

DSDM Events (13-24mths)	CCLAD (n=130)		CDDP (n=132)		FBG (n=115)		Total (CCLAD, CDDP, FBG) (N=377)	
DSDM event (n, av/client/annum)	**260**	***2.0***	**253**	***1.9***	**765**	***6.7***	**1278**	***3.4***
CCLAD Viral Load testing meeting	0	-	n/a	n/a	n/a	n/a	0	-
CCLAD counselling session (in community)	23	0.18	n/a	n/a	n/a	n/a	23	0.06
CCLAD clinical assessment (in community)	71	0.55	n/a	n/a	n/a	n/a	71	0.19
CCLAD TB assessment (in community)	161	1.24	n/a	n/a	n/a	n/a	161	0.43
CDDP clinical assessment (in community)	n/a	n/a	199	1.51	n/a	n/a	199	0.53
CDDP counselling session (in community)	n/a	n/a	5	0.04	n/a	n/a	5	0.01
CDDP TB Case Finding Guide	n/a	n/a	3	0.02	n/a	n/a	3	0.01
CDDP TB community assessment	n/a	n/a	44	0.33	n/a	n/a	44	0.12
CDDP drug pick up (in community) (=ARV refills)	n/a	n/a	0	-	n/a	n/a	0	-
FBG Group meetings	n/a	n/a	n/a	n/a	764	5.79	764	2.03
FBG Quick clinical assessment	n/a	n/a	n/a	n/a	0	-	0	-
Home based care / palliative care / symptom management at home	n/a	n/a	1	0.01	1	0.01	2	0.01

n/a = not applicable - where that particular model does not have those particular types of events.

S1 File. Sampling: Selection of sites

The study population for Phase 1 (top-down collection of implementers' operational costs) were all the DSDMs in Uganda that would have been in operation longer than 6 months (by October 2017, the data collection point). There were 783 health facilities/sites that were implementing DSDMs in Uganda, serving a total number of 175,000 clients (according to IP reports).

Multi-stage purposive sampling was applied, since a randomized representative sample was beyond the time and resources available for this rapid study.

The DSDM site's operating length of time was considered: only sites that had been in operation for more than 6 months were included in the sampling frame. In addition, the size of the DSDM sites, in terms of the numbers of clients served by each model, was considered. Those that were defined as too large or too small (dependent upon the model type) were excluded. Table 1 shows the different DSDMs' average numbers of clients, and indicates the exclusion rules applied for each. Models that were outliers (i.e. very small or very large) were excluded, as determined below.

Table 1. Definition of DSDM sizes (based on numbers of clients by type of DSDM) and exclusion criteria

	CCLAD	CDDP	FBG	FDR
Average # clients per group or site	8	33	49	685
Rule for exclusion: min # of clients	<4	<10	<10	<100
Rule for exclusion: max # of clients	>12	>400	>100	>1000
# sites excluded from sampling frame	0	49	64	64

After these exclusions, 605 eligible sites remained in the sampling frame for inclusion. From these, 47 were selected through stratified purposive sampling.

The eligible models were first stratified by the type of model, and approximately 7%-8% from the CCLADs, CDDPs, FBGs and FDRs were selected. For the FBGs, additional effort was made to include their different client groups (pregnant and lactating women, children and adolescents, families). Only 4 FBIMs sites were added (at the request of the MOH), so as to include those clients who did not, or could not, join the other DSDMs, either by choice or by virtue of being complex (according to the Guidelines).

Within the model-types, the sites were then clustered according to their size (number of clients), and sites selected so as to have more or less similar amounts of each size, as shown in Table 2.

Table 2. Defining site size by client numbers, and sites selected in each cluster

Sites' number of clients	CCLAD	CDDP	FBG	FDR	Total in sample
Definition: Small	4-6	10-30	10-20	100-400	12
Definition: Medium	7-9	31-80	21-50	401-700	19
Definition: Large	10-12	81-400	51-100	701-1000	12

* NB. The size of the 4 selected FBIM's were not known at the time of sampling, and therefore the clustering by size did not apply to the FBIMs.

Sites were then purposively sampled based on their location, so as to ensure adequate amounts from each of the four Ugandan regions. The most extreme locations and hard to reach sites were omitted due to time and resource constraints. Finally, the selection of the 47 sites was made so as to include 10 different IPs, as shown in Table 3.

Table 3. Number of sites per IP and per model included in the sample

Service Provider	CCLAD	CDDP	FBG	FDR	FBIM	Total
ASSIST North	2					2
IDI		1	4	1	6	12
MILDMAY UGANDA	2	1	1			4
RHITES-EC	1					1
TASO	2	1	3	1		7
UEC/UCMB		2		3	1	6
UPMB		1	1			2
PIDC-COE-BAYLOR	1			1		2
RHITES-SW			6		2	8
REACH-OUT MBUYA		1		1	1	3
Total Ph1 sample sites	**8**	**7**	**15**	**7**	**10**	**47**

* Many of the Baylor-Uganda sites were excluded based on their short period of operation. Therefore, two of their 8 eligible sites were included.
IDI = Infectious Disease Institute]
UCMB = Uganda Catholic Medical Bureau
TASO = The AIDS Support Organization
UPMB = Uganda Protestant Medical Bureau
RHITES- EC = Regional Health Integration to Enhance Services- East and Central
RHITES- SW = Regional Health Integration to Enhance Services – South West

In summary, Table 4 indicates the characteristics of the DSDM sites that were considered in the stratified purposive sampling. Refer to the following Table 5 below for the detailed names of sites and their locations.

Table 4. Summary characteristics of sites

Site characteristic	Number included in sample	Percentage in sample
DSDM type:		
CCLAD	9	19%
CDDP	6	12.5%
FBG	22	47%
FDR	6	12.5%
FBIM	4	9%
Regional location:		
North	9	19%
Central	17	36%
East	5*	11%
West	16	34%
Implementing Partner:		
ASSIST NORTH	2	4.2%
BAYLOR	2	4.2%
IDI	12	25.5%

Site characteristic	Number included in sample	Percentage in sample
MILDMAY	4	8.5%
REACHOUT MBUYA	3	6.4%
RHITES-EC	1	2.1%
RHITES-SW	8	17%
TASO	7	15%
UCMB	6	12.8%
UPMB	2	4.3%
Facility type:		
Hospital	12	26%
Health Centre IV	11	23%
Health Centre III	13	28%
TASO sites	6	13%
Facility ownership:		
Government	26	55%
Private not for profit (PFNP)	21	45%

* East region had fewer sample sites due to the large number of DSDMs operated there by TASO, who are conducting their own cost-efficiency analysis and therefore did not require as many sites included in this study.

Table 5. List of 47 sampled sites

Implementing Partner	Region	District	Health Facility	Health facility ownership	Type of DSDM
ASSIST NORTH	NORTH	LIRA	OGUR HC IV	GOVT	CCLAD
ASSIST NORTH	NORTH	OYAM	ANYEKE HC IV	GOVT	CCLAD
BAYLOR	CENTRAL	KAMPALA	BAYLOR HOSPITAL	PNFP	CCLAD
BAYLOR	CENTRAL	KAMPALA	BAYLOR HOSPITAL	PNFP	FDR
IDI	CENTRAL	KAMPALA	KISWA HC III	GOVT	CDDP
IDI	CENTRAL	MASINDI	KYATIRI HC III	GOVT	FBG
IDI	CENTRAL	KAMPALA	KOMAMBOGA HC III	GOVT	FBG
IDI	CENTRAL	KAMPALA	KISUGU HC III	GOVT	FBG
IDI	CENTRAL	KAMPALA	KISWA HC III	GOVT	FBG
IDI	CENTRAL	KIBOGA	LWAMATA HC III	GOVT	FBIM
IDI	WEST	HOIMA	BUHIMBA HC III	GOVT	FBIM
IDI	NORTH	ADJUMANI	ADJUMANI HOSPITAL	GOVT	FBIM
IDI	NORTH	ADJUMANI	DZAIPI HC III	GOVT	FBIM
IDI	WEST	MASINDI	BWIJANGA IV	GOVT	FBIM
IDI	CENTRAL	KAMPALA	KISWA HC III	GOVT	FBIM
IDI	CENTRAL	KAMPALA	IDI MULAGO	PNFP	FDR
MILDMAY	CENTRAL	MITYANA	MITYANA GENERAL HOSPITAL	GOVT	CCLAD
MILDMAY	CENTRAL	WAKISO	MILD MAY HOSPITAL	PNFP	CCLAD
MILDMAY	CENTRAL	WAKISO	KAJJANSI HC IV	GOVT	CDDP
MILDMAY	CENTRAL	WAKISO	KIRA HC III	GOVT	FBG
REACHOUT MBUYA	CENTRAL	KAMPALA	REACHOUT MBUYA	PNFP	CDDP
REACHOUT MBUYA	CENTRAL	LUWERO	St. MARY'S KASALA	PNFP	FBIM
REACHOUT MBUYA	CENTRAL	LUWERO	St. MARY'S KASALA	PNFP	FDR
RHITES -EC	EAST	MAYUGE	KITYERERA HC IV	GOVT	CCLAD
RHITES -SW	WEST	IBANDA	NYAMAREBE HC III	GOVT	FBG

Implementing Partner	Region	District	Health Facility	Health facility ownership	Type of DSDM
RHITES -SW	WEST	BUSHENYI	BUSHENYI HC IV	GOVT	FBG
RHITES -SW	WEST	IBANDA	RUHOKO HC IV	GOVT	FBG
RHITES -SW	WEST	BUHWEJU	NSIIKA HC IV	GOVT	FBG
RHITES -SW	WEST	MITTOMA	MITOOMA HC IV	GOVT	FBG
RHITES -SW	WEST	SHEEMA	KITAGATA HOSPITAL	GOVT	FBG
RHITES -SW	WEST	ISINGIRO	NYARUBUNGO HC III	GOVT	FBG
RHITES -SW	WEST	IBANDA	NYAMAREBE HC III	GOVT	FBIM
RHITES -SW	WEST	BUSHENYI	BUSHENYI HC IV	GOVT	FBIM
TASO	WEST	MASINDI	TASO	PNFP	CCLAD
TASO	EAST	JINJA	TASO	PNFP	CCLAD
TASO	NORTH	GULU	TASO	PNFP	CDDP
TASO	EAST	TORORO	TASO	PNFP	FBG
TASO	EAST	JINJA	TASO	PNFP	FBG
TASO	EAST	MBALE	TASO	PNFP	FDR
UCMB	WEST	BUSHENYI	St. DANIEL COMBONI HOSPITAL	PNFP	CDDP
UCMB	NORTH	OYAM	POPE JOHN HOSPITAL ABER	PNFP	CDDP
UCMB	NORTH	OYAM	POPE JOHN HOSPITAL ABER	PNFP	FBIM
UCMB	WEST	BUSHENYI	St DANIEL COMBONI HOSPITAL	PNFP	FDR
UCMB	NORTH	OYAM	POPE JOHN HOSPITAL ABER	PNFP	FDR
UCMB	NORTH	GULU	LACOR HOSPITAL	PNFP	FDR
UPMB	WEST	HOIMA	AZUR HC IV	PNFP	CDDP
UPMB	WEST	MBARARA	RUHARO MISSIONARY HOSPITAL	PNFP	FBG

* IDI = Infectious Disease Institute]
* UCMB = Uganda Catholic Medical Bureau
* TASO = The AIDS Support Organization
* UPMB = Uganda Protestant Medical Bureau
* RHITES- EC = Regional Health Integration to Enhance Services- East and Central
* RHITES- SW = Regional Health Integration to Enhance Services – South West

PFNP = Private not for profit

HC= Health Centre

Sampling of the 20 sub-set: selection of sites

From the 47 sites, a sub-set of twenty sites were purposively selected for the collection of direct-patient resource utilization. This was primarily due to resource constraints which prohibited all 47 sites from being included. Four sites for each of the five types of DSDMs, i.e. CCLAD, CDDP, FDR, FBG, and FBIM were included, all of which had been in operation for at least a year by the time of the first study period (months 1-12) data collection and were being implemented by seven IPs.

Table 6. List of 20 Sampled sites for Phase 2

Implementing partner	Number of sites of each model included					Total
	CCLAD	CDDP	FBG	FBIM	FDR	
PIDC-COE-Baylor					1	1
IDI		1		1		2
MildMay			1	1		2
Reach Out Mbuya				1		1
RHITES – SW			2			2
TASO	4	2	1		1	8
UCMB		1		1	2	4
Total	**4**	**4**	**4**	**4**	**4**	**20**