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Patient Volume, Human Resource Levels and Attrition from HIV Treatment Programs in Central Mozambique

Barrot H. Lambdin, PhD, MPH¹, Mark A. Micek, MD, MPH^{2,3}, Thomas D. Koepsell, MD, MPH^{4,5}, James P. Hughes, PhD, MS⁶, Kenneth Sherr, PhD, MPH^{2,3}, James Pfeiffer, PhD, MPH^{2,3,5}, Marina Karagianis, MBChB⁷, Joseph Lara, MPH⁸, Stephen S. Gloyd, MD, MPH^{2,3,5}, and Andy Stergachis, PhD, MS^{2,4,9}

¹Pangaea Global AIDS Foundation, Oakland, CA, USA

²Department of Global Health, University of Washington, Seattle, WA, USA

³Health Alliance International, Seattle, WA, USA

⁴Department of Epidemiology, University of Washington, Seattle, WA, USA

⁵Department of Health Services, University of Washington, Seattle, WA, USA

⁶Department of Biostatistics, University of Washington, Seattle, WA, USA

⁷Ministry of Health, Mozambique, Beira, Sofala, MZ

⁸Health Alliance International, Beira, Sofala, MZ

⁹Global Medicines Program, University of Washington, Seattle, WA, USA

Abstract

Introduction—Human resource shortages are viewed as one of the primary obstacles to provide effective services to growing patient populations receiving antiretroviral therapy (ART) and to expand ART access further. We examined the relationship of patient volume, human resource levels and patient characteristics with attrition from HIV treatment programs in central Mozambique.

Methods—We conducted a retrospective cohort study of adult, ART-naïve, non-pregnant patients who initiated ART between January 2006 and June 2008 in the national HIV care program. Cox proportional hazards models were used to assess the association of patient volume, clinical staff burden, and pharmacy staff burden with attrition, while adjusting for patient characteristics.

Results—A total of 11,793 patients from 18 clinics were studied. After adjusting for patient characteristics, patients attending clinics with medium pharmacy staff burden (HR= 1.39 [95% CI:

Correspondence to: Barrot H. Lambdin, PhD, MPH, Director of Implementation Science, Pangaea Global AIDS Foundation, 472 Ninth St, Oakland, CA 94607, blambdin@pgaf.org.

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Conflicts of interest statement

We declare that we have no conflicts of interest.

Portions of these data have been previously reported as an abstract at the International AIDS Conference (Vienna, Austria; 2010) and the American Public Health Association meeting (Philadelphia, PA; 2009)

1.07–1.80]) and high pharmacy staff burden (HR = 2.09 [95% CI: 1.50–2.91]) tended to have a higher risk of attrition (p-value for trend: <0.001). Patients attending clinics with higher clinical staff burden did not have a statistically higher risk of attrition. Patients attending clinics with medium patient volume levels (HR= 1.45 [95% CI: 1.04–2.04]) and high patient volume levels (HR = 1.41 [95% CI: 1.04–2.92]) had a higher risk of attrition, but the trend test was not significant (p=0.198).

Discussion—Patients attending clinics with higher pharmacy staff burden had a higher risk of attrition. These results highlight a potential area within the health system where interventions could be applied to improve the retention of these patient populations.

Keywords

Mozambique; antiretroviral therapy; health system; patient volume; human resources; attrition

Introduction

In Mozambique, a country with a high burden of HIV, over 170,000 people were receiving antiretroviral therapy (ART) at the end of 2009, a dramatic increase from the 7,000 receiving ART in 2004 [1,2]. As the number of people receiving ART has rapidly increased, more strain has been placed on the health system and its workforce. Larger patient populations can bottleneck the existing infrastructure and overwhelm the clinicians and pharmacy staff providing services. An overstrained health system could result in longer wait times and shorter, lower quality patient-provider interactions, leading to patient dissatisfaction [3,4] and potentially higher attrition from ART programs.

Many view inadequate human resource capacity as one of the biggest obstacles with regard to effective ART delivery in resource-limited settings [5–15]. Mozambique faces one of the lowest provider-to-population ratios in the world with 3 doctors, 21 nurses and 3 pharmacy staff per 100,000 people [12]. Understanding the influence of patient volume and health workforce levels on retention in ART programs in resource-poor settings is crucial for the effective delivery of HIV treatment services.

We conducted a retrospective cohort study to examine the association of patient volume, clinical staff burden, pharmacy staff burden and patient characteristics with attrition from ART programs in Manica and Sofala provinces of Mozambique.

Methods

Study Setting

At the end of 2004, central Mozambique had one of the heaviest HIV burdens in the country with an estimated 20.4% of the adult population infected with HIV [16]. The first ART delivery site in the two provinces opened in Sofala's Beira Central Hospital in 2003 while a second one opened in Manica's Chimoio Provincial Hospital in 2004. In 2006, the Ministry of Health integrated ART services into primary health care clinics distributed throughout 23 districts in Manica and Sofala provinces to improve access to HIV care and treatment, with primary funding through the President's Emergency Plan for AIDS Relief (PEPFAR).

Study Population

Study subjects were adult (≥ 15 years of age), ART-naïve patients who initiated ART between January 1, 2006 and June 1, 2008 in 18 public sector clinics which had electronic clinic databases in Sofala or Manica province. For two study clinics, we excluded patients enrolling into treatment after December 31, 2007, and March 1, 2008, due to two distinct historical events—flooding and temporary closure of the clinic, respectively. Patients who were pregnant at enrollment were excluded from the study.

Data Sources

This study utilized electronic clinic databases which contained socio-demographic characteristics, pharmacy and clinical data and human resources information. These databases were primarily used by clinic management as tools for routine clinic monitoring and evaluation. Numerous range checks and cross-checks were regularly applied to the databases to minimize data errors. Database managers performed queries to monitor data quality and provided on-the-job training to technicians if discrepancies arose. Additional data about personnel working at the ART sites was collected from routine health systems data supplemented with recording systems from the non-governmental organization, Health Alliance International (HAI), which provided technical support to the sites. The databases were collected in May of 2009 which provided approximately eleven months for peer counselors to track patients who may have missed appointments toward the end of the study. This approach made outcome ascertainment and data transcription more comparable throughout the study period.

To evaluate the validity of data used in our study, we compared data from the clinic databases to a randomly selected sample of 520 paper-based patient medical records from the clinics that were included in the study. Key variables were found to agree between 92.6% and 99.2% of the time with kappa scores ranging from 0.91 to 0.97, indicating ‘almost perfect’ agreement [17].

Measures

Patient Volume and Human Resource Levels—The primary clinic-level exposures of interest were the monthly number of clinical and pharmacy visits (Patient Volume), the monthly number of clinical visits per clinician (Clinical Staff Burden) and the monthly number of pharmacy visits per pharmacy staff (Pharmacy Staff Burden). The number of clinicians, including physicians, nurses and clinical officers, was determined from the clinic databases. Clinicians who saw at least one patient on a particular day were classified as providing one working-day. If a clinician saw one patient or ten patients on a given day, he or she would be classified as contributing one working-day. For a particular month, the number of working-days provided by clinicians were aggregated and divided by the number of days the clinic was open to obtain the monthly average number of clinicians treating patients. We combined physicians, nurses and clinical officers into one clinician category due, in part, to previous research showing similar levels of quality of care delivered by physicians and non-physician clinicians [18]. The number of pharmacy staff working each month and whether they worked on a part-time or full-time basis was abstracted from the routine, NGO health systems data. The number of clinic visits and the number of pharmacy

visits were then divided by the estimated number of clinical staff and pharmacy staff working for a given month, respectively.

Patient volume, clinical staff burden, and pharmacy staff burden were treated as time-varying exposures over six month intervals beginning with when a site initiated ART-delivery. For each interval, we took the average of the monthly patient volume, number of clinical visits per clinician and number of pharmacy visits per pharmacy staff as the estimates. The six month time interval was chosen to allow enough follow-up time for outcomes to occur for a given exposure level. Pharmacy staffing data were unavailable in the routine health systems data for the study period for one clinic, but was available for the remaining 17 clinics. Other clinic-level covariates included the clinic model of care-whether the clinic operated as a stand-alone HIV care and treatment clinic (vertical) or was integrated within primary health centers (integrated); the clinic location-whether the clinic was in a rural or urban setting; and clinic experience-whether the clinic was in its first six months of offering HIV treatment or after its first six months of offering treatment. Patient-level data were also provided by the clinic databases.

Outcomes—If a patient failed to return for ART medication refill, *activistas* (clinic-based peer counselors) are notified and begin actively tracing patients. The peer counselors visited the patient's residence and encouraged them to return for treatment at the clinic if the patient was still alive. If the patient had died, the date of death was documented. Outcomes for patients who initiated HIV treatment were defined as 1) transferred—patients who transferred to receive treatment at another facility; 2) suspended—a patient who suspended HIV treatment per clinician's recommendation but remained in care; 3) dead—a patient who died due to any cause while receiving ART which was ascertained by active tracing of patients who missed a pharmacy visit and reports from family members who informed the clinic of the patient's death; and 4) lost to follow-up—a patient who had failed to return for treatment for two months beyond their missed ART refill visit for reasons unrelated to patient death. Patients who continued to receive ART were considered to be maintained on ART until they either experienced one of the terminating events or reached the end of study. For patients who met the definition of lost to follow-up but then decided to reinstate treatment at a later point in time, they were still considered lost to follow-up and their person-time after reinitiating treatment would be excluded from the study since one of the inclusion criteria specifies that patients are ART-naïve.

We defined our outcome measure of attrition from care as patients classified as either dead or lost to follow-up. One of the principal reasons for combining the two outcomes was that differential ascertainment between those patients who were lost to follow-up and those who died could occur at clinics with larger patient volumes. Essentially, the workload for peer counselors could have compromised their ability to determine whether or not patients who had failed to return for a pharmacy refill actually died, and therefore, they could be incorrectly classified as lost to follow-up. The date of attrition was defined as the last pharmacy refill date for those who were lost to follow-up and the date of death for those who died.

Statistical Analysis

Cox proportional hazards models were used to analyze time until attrition, defined as death or lost to follow-up. Individuals who were categorized as transferred and suspended were treated as censored observations at the time of transfer or suspension. Follow-up time began at initiation of HIV treatment and ended with the date of death, transfer, treatment suspension, loss to follow-up (date of last clinic or pharmacy visit), or June 30, 2008, whichever came first. Patients attending the two clinics with historical events were censored on dates corresponding to the event—December 31, 2007, and March 1, 2008. Given that survival times were clustered at the clinic-level, robust variances were used [19].

The primary analysis tested the association of patient volume, clinical staff burden and pharmacy staff burden with time until attrition. We modeled these exposures as three-level categorical variables, split at the tertile of the distribution (Patient Volume – Low: <393, Medium: 393 – <982, High: 982; Clinical Staff Burden – Low: <77, Medium: 77 – <157, High: 157; Pharmacy Staff Burden-Low: <164, Medium: 164 – <539, High: 539). Each of these analyses adjusted for the following a priori specified potential confounders: pre-ART CD4 count, pre-ART WHO stage, age at enrollment at the ART clinic, education, gender and clinic model of care. We evaluated whether the associations of patient-level characteristics with patient attrition varied between early follow-up (four months) and later follow-up (> four months) [20]. Patient characteristics with an interaction p-value less than 0.2 between early and later follow-up were retained in the models. We used residual plots to guide the choice of the best-fitting transformation for continuous variables. In exploratory analysis, we evaluated the impact of adjusting for clinic experience, location of the clinic and calendar time in our models. Variables that changed the coefficient estimates for the primary exposures by 10% were considered important confounders and retained in the model.

Data were missing for some patients on CD4 count (5%), education (7%) and WHO stage (9%). To address this, we utilized multiple imputation procedures to fill in missing values in the dataset. Ten imputations were done, using fully conditional specifications including pre-ART CD4 count, pre-ART WHO stage, age at enrollment, gender, education, attrition status and survival time (log form) [21]. Results from the imputations were combined into a single set of parameter estimates for the ‘final’ proportional hazards regression model that incorporated the uncertainty from the imputations [21,22].

The study was approved by the institutional review boards of the Mozambique Ministry of Health and the University of Washington. All analyses were conducted in Stata version 11.1 (College Station, TX, USA).

Results

A total of 18 of the 36 HIV care and treatment clinics recognized by the Ministry of Health from Manica and Sofala provinces were included in the analysis. The remaining 18 were not included since they did not have electronic patient tracking systems. Table 1 describes characteristics of these clinics. During the study period, one clinic shifted from a vertical model of HIV treatment delivery to a model integrated with primary health care, resulting in

three clinics providing patient follow-up time under a vertical model and 16 clinics providing patient follow-up time under an integrated model.

Of the 15,232 patients receiving ART at the 18 study clinics between January 1, 2006 and June 1, 2008, we excluded 810 who were transferred in from another facility, 1,138 who were under 15 years of age and 1,491 who were pregnant at the time of enrollment. Thus, 11,793 met the inclusion criteria of the study and were considered in the analysis, representing 77% of those that initiated ART. Characteristics of these patients are outlined in Table 2. Study participants provided 9,120 person-years of follow-up with an overall attrition rate of 39.22 per 100 person-years. At the end of the study period, 7,491 (63%) study patients were alive and receiving ART from the clinics where they initiated ART. Of the remaining patients, 720 (6%) transferred to another clinic, 5 (<1%) suspended treatment, 1,932 (16%) were lost to follow-up and 1,645 (14%) were known to have died. At 12 and 24 months, the proportion of patients retained in care was 68.1% (95% CI: 67.1% – 69.0%) and 58.7% (95% CI: 57.4% – 60.1%), respectively.

Table 3 illustrates the variability of patient volume and human resource levels of the clinics. The median number of monthly patient visits at the study clinics was 562 (IQR: 264 – 1,141). The average number of clinicians per month providing clinical care was 2.89, and the mean number of pharmacy staff providing pharmacy services per month was 1.31. As a result, the median monthly number of clinical visits per clinician was 111 (IQR: 61 – 214) and the median monthly number of pharmacy visits per pharmacy staff was 359 (IQR: 142 – 609) among HIV care and treatment clinics.

Table 4 shows the hazard ratios (HR) for the association of patient characteristics with attrition. Pre-ART CD4 count was more predictive of attrition in early follow-up than later follow-up. The relationship of patient volume, clinical staff burden and pharmacy staff burden with attrition are illustrated in Table 5. Patients attending clinics with medium patient volume levels (HR = 1.45 [95% CI: 1.04 – 2.04]) and high patient volume levels (HR = 1.41 [95% CI: 1.04 – 2.92]) had a higher risk of attrition compared to patients attending clinics with low patient volume levels, but the test for trend was not significant ($p=0.198$). Patients attending clinics with medium pharmacy staff burden (HR= 1.39 [95% CI: 1.07 – 1.80]) and high pharmacy staff burden (HR = 2.09 [95% CI: 1.50 – 2.91]) tended to have a higher risk of attrition than patients attending clinics with low pharmacy staff burden (p -value for trend: <0.001). Patients attending clinics with higher clinical staff burden did not have a higher risk of attrition.

We also performed a sensitivity analysis. Findings were not dependent on categorization into tertiles and were similar to the complete-case analysis. After adjusting for year of treatment initiation, clinic experience and clinic location in exploratory analysis, the relationship between pharmacy staff burden and attrition became stronger. HR estimates did not significantly differ between early attrition and late attrition for patient volume or clinical staff burden. However, pharmacy staff burden had more attenuated risk estimates in early follow-up (medium pharmacy staff burden: HR = 1.66 [95% CI: 1.27 – 2.16], high pharmacy staff burden: HR = 2.42 [95% CI: 1.57 – 3.74]) compared to later follow-up

(medium pharmacy staff burden: HR = 1.91 [95% CI: 1.21 – 3.01], high pharmacy staff burden: HR = 3.44 [95% CI: 1.95 – 6.08]; p-value for interaction = 0.092).

Discussion

With data from 18 public sector HIV care and treatment clinics in Mozambique, we evaluated the impact of patient volume, clinical staff burden and pharmacy staff burden on attrition from HIV treatment programs. No significant association was seen between clinical staffing burden and attrition, and while patients attending clinics with higher patient volumes did have an elevated risk of attrition, there was not a dose-response relationship. However, this study did show that patients attending clinics with higher pharmacy staff burden had a higher risk of attrition. This is an important finding as our results highlighted an additional potential area within the health system where interventions could be applied to improve the retention of these rapidly increasing patient populations in HIV treatment programs.

Strengths of the study included the standardization of protocols for care delivery, patient tracing and data recording across the clinics included in the study. Additionally, we were able to assess associations between these characteristics and attrition with a large population of patients among clinics across different levels of the Mozambican health system. Furthermore, the databases had high levels of agreement with data from patient charts.

The principal limitation of our study was due to the observational nature of the research. Although we adjusted for measured patient characteristics to address concerns of confounding, the potential for unmeasured patient factors to bias our results existed. In addition, other unmeasured clinic-level factors correlated with our exposures could have driven the association. Another limitation was the sensitivity of the outcome. We used attrition due to our concern of differential outcome ascertainment; however, by doing so, we included an outcome, mortality, which was less sensitive to our clinic-level exposures of interest. The generalizability of these results to other settings should require careful consideration. Clinics were included in the study based on whether they utilized an electronic database and were not selected through a random process. The potential for exposure misclassification also existed. We did not have information regarding the number of working-hours of clinicians and pharmacy staff. However, we would expect this misclassification to be non-differential with respect to outcome status which would attenuate our results toward the null on average.

This analysis built on our previous studies of the quality of HIV care in Mozambique with a larger number of health facilities [18,23,24]. The clinics had substantial variability regarding the number of months offering treatment, number of adults initiating treatment, patient volume and human resource levels. Disease severity metrics had larger hazard ratios during early follow-up but attenuated in later follow-up since they were measured at baseline. Education and year of treatment initiation had larger hazard ratios during later follow-up after the more clinically severe patients at enrollment either died or were lost to follow-up from the HIV treatment program.

With HIV care and treatment, the Mozambican health system implemented a chronic care intervention within facilities originally established for more acute or sub-acute care conditions. Attrition estimates of 32% and 41% in the HIV treatment program at 12 and 24 months after starting ART, respectively, was not optimal and was likely a result of patients starting ART late in their disease process as well as the presence of health system bottlenecks. Patients who received appointments for a particular day typically arrived to the clinic in the morning to begin their visit process. In this context, larger patient volumes could have stressed the general ability of the health system to cope, resulting in bottlenecked administrative systems and overwhelmed infrastructure. Our analysis of patient volume did not account for differences in facility infrastructure (i.e. number of outpatient consultation rooms) or human resources. This could explain in part why the trend test for patient volume was not statistically significant as clinics with larger patient volumes could have more space and resources to accommodate them.

Mozambique faced a critical shortage of pharmacy personnel with only 3 pharmacy staff per 100,000 people [12]. In our analysis, pharmacy staff burden was an important predictor of attrition. Larger number of patients per pharmacy staff could result in longer wait times as well as shorter and lower quality patient-provider interactions. Monthly pharmaceutical visits to the clinic could be a substantial obstacle for patients to remain in treatment over the long-term. A qualitative study of patients attending some of these clinics also identified pharmacy waiting times and transportation costs as barriers to ART retention [25]. Research in other settings showed that length of wait and visit times as well as transportation costs influenced patient satisfaction and willingness to return for care [4,26,27]. Clinical staff burden was not an important predictor of attrition which could be explained partly by the increase in available providers after task shifting of clinical responsibilities to non-physician clinicians [23,28]. In addition, fewer visits were recommended for clinical monitoring compared to returning monthly for pharmacy refills. A recent study by Bakanda et al. in Uganda also found that clinician density did not affect attrition from ART programs [29].

The Mozambican Ministry of Health successfully scaled-up HIV care and treatment services in Manica and Sofala provinces of Mozambique. Challenges remain regarding the quality and efficiency of care delivery and retention in treatment. In conclusion, our study found a higher risk of attrition among patients attending clinics with larger numbers of patients per pharmacy staff. Our results highlight the key role that pharmacy staff play in providing HIV treatment services and argue for more initiatives to alleviate pharmacy staff burden in these settings. The encouraging preliminary findings of a community ART group model in Mozambique highlight an example of an out-of-clinic strategy which could reduce the frequency of patient visits to ease the impact of pharmacy staff burden on retention in treatment [30]. Further understanding of the implementation process and the role health centers should continue to have in encouraging optimal use of medications and ensuring the health of patients is needed. If patients receive their refills outside of the clinic, other quality of care measures could potentially be compromised. Health systems strengthening measures, especially in the area of supply chain management, would need to compliment policy changes to more effectively and efficiently implement modifications. Additional research should identify the mechanisms by which pharmacy staff burden could result in attrition

from HIV treatment and continue to identify potential interventions to alleviate the bottleneck.

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Table 1

Characteristics of Clinics Included in the Study

Patient Volume, N	
Low	12
Medium	10
High	8
Clinician Staff Burden[†], N	
Low	11
Medium	9
High	8
Pharmacy Staff Burden[†], N	
Low	11
Medium	11
High	8
Delivery Model, N[*]	
Vertical	3
Integrated	16
Setting, N (%)	
Urban	10 (55%)
Rural	8 (45%)
Type, N (%)	
Hospital	6 (33%)
Health Center	12 (67%)

[†] # of Clinics providing person-time for the different categories. Clinics can provide person-time for more than one category. Low, Medium and High represent the tertiles of the distribution;

* 1 clinic changed from vertical model to integrated model

Table 2

Characteristics of Patients Included in the Study

Total	11,793
Age (years), N (%)	
15 – <25	1,475 (12.51)
25 – <35	4,654 (39.46)
35 – <45	3,535 (29.98)
45	2,098 (17.79)
Female, N (%)	6,775 (57.45)
CD4 Count (cells/μL), N (%)	
<100	3,428 (29.07)
100 – <200	4,294 (36.41)
200 – <300	2,180 (18.49)
300	1,286 (10.90)
WHO Stage, N (%)	
I/II	2,708 (25.79%)
III	6,812 (64.87%)
IV	981 (9.34%)
Time from Enrollment into Care to Treatment Initiation (days), Median (IQR)	62 (35–149)
Initial ART Regimen, N (%)	
D4T+3TC+NVP	10,319 (88.04%)
D4T+3TC+EFV	1,228 (10.48%)
AZT+3TC+NVP	174 (1.48%)
Follow-up Time	
Cumulative (Person–Years)	9,120
Median (IQR), (days)	224 (76–452)
Attrition, N (%)	3,577 (30.33%)
Lost to Follow-up, N (%)	1,932 (16.38%)
Dead, N (%)	1,645 (13.95%)

Table 3
Patient Volume and Human Resource Levels of ART Clinics Included in the Study

Clinic	Months Offering ART	Median # of Adults Initiating ART (IQR) [*]	Median Volume of Patients (IQR) [*]	Median Clinical Staff Burden (IQR) [*]	Median Pharmacy Staff Burden (IQR) [*]
Clinic 1	48	93 (71–124)	4,873 (4,533–5,282)	281 (222–360)	658 (579–731)
Clinic 2	48	94 (82–105)	3,730 (2,718–4,187)	429 (379–548)	803 (606–1,072)
Clinic 3	38	31 (22–40)	1,323 (1,027–1,453)	267 (235–331)	503 (321–607)
Clinic 4	26	15 (10–23)	460 (347–506)	83 (60–101)	215 (132–292)
Clinic 5	28	31 (21–37)	840 (508–1,105)	128 (104–153)	596 (219–848)
Clinic 6	37	35 (25–45)	752 (559–882)	111 (96–120)	454 (303–568)
Clinic 7	31	16 (13–21)	315 (183–386)	74 (62–85)	153 (85–185)
Clinic 8	25	37 (30–44)	851 (277–1,126)	153 (33–316)	261 (146–359)
Clinic 9	22	39 (31–54)	823 (562–989)	127 (108–168)	384 (266–581)
Clinic 10	22	41 (32–49)	898 (658–1,033)	144 (134–153)	894 (482–1,132)
Clinic 11	20	18 (15–22)	403 (274–471)	69 (60–83)	293 (94–450)
Clinic 12 [†]	20	3 (1–7)	47 (35–85)	22 (17–26)	–
Clinic 13	17	8 (5–13)	144 (69–164)	34 (31–37)	61 (11–89)
Clinic 14	13	3 (1–3)	31 (25–37)	11 (9–15)	19 (16–30)
Clinic 15	10	38 (25–46)	716 (448–1,096)	140 (119–185)	248 (188–322)
Clinic 16	9	9 (7–11)	229 (185–251)	85 (73–88)	406 (56–112)
Clinic 17	6	4 (3–5)	84 (72–131)	47 (35–58)	13 (8–25)
Clinic 18	22	28 (24–37)	471 (159–801)	120 (29–197)	530 (250–742)

Clinical Staff Burden - the number of clinical visits per clinician; Pharmacy Staff Burden - the number of pharmacy visits per pharmacy staff;

^{*} per Month;

[†] No Pharmacy data available.

Table 4
Association of Patient Characteristics with Attrition in Early Follow-up and Later Follow-up

	Early Attrition HR (95% CI)	p-value	Late Attrition HR (95% CI)	p-value	Interaction p-value
CD4 Count* (per log increase)	0.75 (0.71–0.81)	<0.001	0.94 (0.90–0.98)	<0.008	<0.001
WHO Stage					
I [Ref]	1.00 (reference)		1.00 (reference)		
II	1.30 (0.88–1.92)		1.13 (0.94–1.37)		
III	1.77 (1.32–2.37)		1.42 (1.21–1.66)		
IV	3.49 (2.62–4.65)	<0.001 [†]	1.89 (1.45–2.46)	<0.001 [†]	0.400
Age (per 10 years)	0.56 (0.45–0.71)	<0.001	0.42 (0.32–0.55)	<0.001	0.229
Age-squared (per 10 years)	1.01 (1.00–1.01)	<0.001	1.01 (1.00–1.01)	<0.001	<0.001
Education (per 5 yrs)	0.74 (0.69–0.79)	<0.001	0.63 (0.52–0.76)	<0.001	0.136
Female	0.67 (0.61–0.73)	<0.001	0.59 (0.53–0.67)	<0.001	0.395
Year of Initiation					
2006 [Ref]	1.00 (reference)		1.00 (reference)		
2007	1.06 (0.91–1.24)		1.25 (0.95–1.64)		
2008	1.13 (0.89–1.43)	0.265 [†]	2.15 (1.12–4.14)	0.070 [†]	0.051

* natural log transformation;

[†] test for trend from group-linear term

Table 5

Association of Patient Volume and Human Resource Levels with Attrition

	Adjusted HR* (95% CI)	p-value for trend [†]	Adjusted HR** (95% CI)	p-value for trend [†]
Patient Volume				
Low [Ref]	1.00 (reference)		1.00 (reference)	
Medium	1.45 (1.04–2.04)		1.40 (1.03–1.92)	
High	1.41 (1.04–1.92)	0.198	1.34 (0.95–1.89)	0.471
Clinician Staff Burden				
Low [Ref]	1.00 (reference)		1.00 (reference)	
Medium	1.04 (0.83–1.31)		1.01 (0.78–1.32)	
High	1.09 (0.77–1.54)	0.668	1.02 (0.69–1.52)	0.913
Pharmacy Staff Burden				
Low [Ref]	1.00 (reference)		1.00 (reference)	
Medium	1.39 (1.07–1.80)		1.68 (1.29–2.19)	
High	2.09 (1.50–2.91)	<0.001	2.63 (1.70–4.06)	<0.001

* a priori specified analysis: adjusted for CD4 count (log transformed), WHO Stage, education, gender, age, age-squared and clinic model; CD4 count and education were allowed to have varying HR in early/late follow-up.

** additionally adjusted for year of treatment initiation, clinic experience and location of clinic; year of treatment initiation was allowed to have varying HR in early/late follow-up.

[†] test for trend from group-linear term.