Integrated Hypertension and HIV Care Cascades in an HIV Treatment Program in Eastern Uganda: A Retrospective Cohort Study

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Background: Persons living with HIV (PLHIV) are at increased risk of cardiovascular disease. Integration of services for hypertension (HTN), the primary cardiovascular disease risk factor, into HIV care programs is recommended in Uganda, though, uptake has been limited. We sought to compare the care cascades for HTN and HIV within an HIV program in Eastern Uganda.

Methods: We conducted a retrospective cohort study of all PLHIV enrolled in 3 HIV clinics between 2014 and 2017. We determined the proportion of patients in the following cascade steps over 12 months: Screened, Diagnosed, Initiated on treatment, Retained, Monitored, and Controlled. Cascades were analyzed using descriptive statistics and compared using $\chi^2$ and t tests.

Results: Of 1649 enrolled patients, 98.5% were initiated on HIV treatment, of whom 70.7% were retained in care, 100% had viral load monitoring, and 90.3% achieved control (viral suppression).

Four hundred fifty-six (27.7%) participants were screened for HTN, of whom 46.9% were diagnosed, 88.1% were initiated on treatment, 57.3% were retained in care, 82.7% were monitored, and 24.3% achieved blood pressure control. There were no differences in any HIV cascade step between participants with HIV alone and those with both conditions.

Conclusions: The HIV care cascade approached global targets, whereas the parallel HTN care cascade demonstrated notable quality gaps. Management of HTN within this cohort did not negatively impact HIV care. Our findings suggest that models of integration should focus on screening PLHIV for HTN and retention and control of those diagnosed to fully leverage the successes of HIV programs.

Key Words: integrated, care cascades, hypertension, HIV treatment and Uganda

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INTRODUCTION

HIV has become a chronic condition in low- and middle-income countries (LMIC), because of the success of vertically oriented HIV treatment programs.1 Leveraging the infrastructure and lessons learned from these HIV programs to support the care of persons with chronic noncommunicable diseases (NCDs) is a widely recognized global priority and has received recent attention in the literature.1,2 Persons living with HIV (PLHIV) and receiving antiretroviral therapy (ART) are at increased risk of cardiovascular disease (CVD), the leading cause of premature morbidity and mortality globally.3 This is due to direct effects of ART and HIV itself, compounded by traditional CVD risk factors such as increased life expectancy and Western diet.4,5 Hypertension (HTN) is the most important preventable risk factor for CVD.6 The prevalence of HTN in the setting of HIV may be higher than in the HIV-negative population.7 High blood pressure (BP) is associated with mortality among PLHIV whose HIV disease is not advanced.8 Concordant with World Health Organization (WHO) guidelines, the Uganda National HIV guidelines have recommended the integration of HTN care into HIV programs since 2014.9,10 There has been limited uptake of this recommendation in practice in Uganda, despite successful efforts to integrate other programs such as tuberculosis, malaria, nutrition, maternal-child health, and family planning into that
of HIV.\textsuperscript{11,12} Within HIV programs that have attempted HTN integration in Uganda, there has been limited documented experience in evaluating the quality of care delivery in these settings.

Care cascades are useful frameworks for assessing the quality of health service delivery for specific diseases by documenting the proportion of individuals who proceed through the multiple steps along a defined sequence of care. Cascades allow policymakers, researchers, or clinical supervisors to visualize gaps in health care delivery to efficiently direct resources and develop strategies for bridging these gaps.\textsuperscript{13} Cascades have been extensively used to evaluate quality of care for HIV, rheumatic heart disease, type 2 diabetes mellitus, hepatitis C, tuberculosis, and prevention of mother-to-child transmission.\textsuperscript{5,13–16} However, to the best of our knowledge, cascades have not previously been used to evaluate 2 conditions simultaneously. Doing so could serve to illustrate gaps and strengths of each program and their impact on each other. With the goal of identifying opportunities for developing contextually appropriate integrated care models, we conducted a retrospective cohort study within an HIV program in Uganda and mapped the care cascades for both HTN and HIV.

**METHODS**

**Study Design, Setting, and Participants**

We conducted a retrospective cohort study using data abstracted from medical records of PLHIV who were enrolled in 1 of 3 high-volume HIV clinics in Tororo District in Eastern Uganda.

Uganda is a low-income country in East Africa with a population of 34.6 million, of whom 18 million (52.1\%) are 15 years and older. The prevalence of HIV among adults aged 15–49 years is 6.5\%, and the prevalence of HTN is 26.4\% among adults aged 18–69 years.\textsuperscript{17,18} Tororo is 1 of 116 districts and had a population of 517,080 as of the 2014 census.\textsuperscript{19}

In Uganda, ART clinics are the designated treatment centers for HIV and HIV-associated opportunistic infections and comorbidities. They are physically situated as outpatient departments within health centers and hospitals. The 3 ART clinics included in this study were located in The AIDS Support Organization (TASO) Tororo, Nagongera Health Centre IV, and Mulanda Health Centre IV. We selected these 3 clinics because they are the largest in Tororo District, providing care to 4000, 1400, and 1000 PLHIV, respectively. They are housed within public sector facilities with support from both the Government of Uganda and HIV implementing partners (USAID and the PEPFAR Program). The clinics are staffed by multiple cadres of health workers including clinicians, nurses, midwives, and peer counselors. Each clinic offers a full spectrum of HIV services including screening, ART, viral load testing, and opportunistic infection testing and treatment. In accordance with 2014 WHO and Uganda national guidelines, each also is supposed to provide HTN services.\textsuperscript{10,20}

According to guidelines, within a given clinical encounter, BP was measured by the clinician at his/her discretion. A person was considered to be hypertensive if they had a documented BP $\geq$ 140/90 mm Hg or documented use of antihypertensive medications or documented history of HTN.\textsuperscript{10,21,22} If a patient is diagnosed with HTN (by measurement or previous history), the clinician typically prescribes both ART and antihypertensives simultaneously and the client is given one follow-up appointment for both conditions. As these are public sector facilities, all medicines at facility pharmacies are obtained from the centralized National Medical Stores. The PEPFAR program provides funds to the National Medical Stores to procure medicines specifically for HIV and opportunistic infections. Medicines for HTN and other NCDs are procured through general funds allocated to each health facility by MoH. If medicines are out of stock at the facility pharmacy, the patient is typically advised to purchase them from a private sector pharmacy.

Before this study, as part of their routine work, health workers at the clinic sites were oriented to national and WHO HIV treatment guidelines, which recommend screening for HTN and its risk factors. Clinical support discussions about challenging HIV/NCD cases were also used, as a matter of routine work, to build capacity among clinicians for NCD integration.

We empaneled all patients 18 years and older who enrolled into HIV care at any of the 3 study sites between January 2014 and January 2017. All were previously screened and diagnosed with HIV. We followed up each participant for 12 months from the time of enrollment. Data collection was performed between January and May 2018. This study was approved by institutional review boards at TASO Uganda and The Uganda National Council for Science and Technology.

**Study Procedure**

Ten research assistants (RAs), comprised 3 clinicians and 7 data clerks, were trained to abstract data from paper patient charts into a tablet-based data collection instrument (KoBo Collect). RAs were distributed in proportion to clinic volume, but each data collection team contained one clinician at all times to assist with chart interpretation and data abstraction. The instrument was designed to include demographic information and relevant clinical data for both HIV and HTN. Internal quality assurance was conducted by double-entering data for the first 100 participants per study site, reviewing, and providing feedback to the RAs.

**Study Variables, Cascade Indicators, and Measurements**

We defined each step in the HIV cascade based on widely accepted definitions.\textsuperscript{23} We then defined corresponding, clinically relevant cascade steps for HTN based on the WHO Technical Package for Cardiovascular Disease Management in Primary Health Care and the American Society of Hypertension and International Society of Hypertension clinical practice guidelines.\textsuperscript{10,21,24} Our definition for retention in HTN care was adopted from the Uganda Consolidated HIV
TABLE 1. Definitions, Indicators, and Measurements for the Steps of the HIV and HTN Cascades of Care

| Cascade Step               | Definition (HIV Care Cascade)                                                                 | Indicators Denominator | Definition (HTN Care Cascade)                           | Indicators Denominator |
|----------------------------|-----------------------------------------------------------------------------------------------|------------------------|--------------------------------------------------------|------------------------|
| Screening                  | No. of individuals who received HIV testing services and received their test results: Evidenced by documented HIV test results in the patient’s file. | No. of individuals who received HIV testing services and received their test results | Among PLHIV in the cohort 2014–2017: Evidence of measurement of BP in 1 yr as documented in the patient file or documented use of antihypertensive medications or documented history of HTN21,23 | No. of PLHIV screened for HTN in 1 yr |
|                            |                                                                                              | N/A                    | Total number of PLHIV in the cohort                     | Total number of PLHIV in the cohort |
| Diagnosis                  | Among individuals tested for HIV: Documented HIV-positive test results according to the standard national testing algorithm. | No. of confirmed HIV-positive individuals | Among PLHIV screened for HTN: A Documented BP ≥ 140/90 mm Hg or documented use of antihypertensive medications or documented history of HTN21-23 | No. of PLHIV diagnosed with HTN |
|                            |                                                                                              | Total number of individuals tested for HIV |                                    | Total number of PLHIV screened for HTN |
| Initiation of treatment    | Among individuals with confirmed HIV-positive status: Started on ART.                          | No. of HIV-positive individuals started on ART | Among PLHIV diagnosed with HTN: Documented prescription of antihypertensive medication(s), and/or lifestyle modification of weight reduction, exercise, smoking cessation, and dietary modification21,23 | No. of PLHIV and hypertensive initiated on treatment for HTN |
|                            |                                                                                              | Total number of confirmed HIV-positive individuals |                                    | Total number of PLHIV diagnosed with HTN |
| Retention                  | Among PLHIV started on ART: Not missed his/her appointment or if missed appointment, has not been out of care for more than 90 days after their last missed appointment in the 1-year period. | No. of PLHIV retained in care | Among PLHIV and HTN and started on treatment for HTN: Retained in HIV care and having HTN management addressed within 90 days (ie, prescription of antihypertensive)1 | No. of PLHIV and hypertensive retained in care |
|                            |                                                                                              | Total number of HIV-positive individuals started on ART |                                    | Total number of PLHIV and hypertensive who are initiated on treatment for HTN |
| Monitored                  | Among PLHIV and retained: Has had at least one viral load test conducted in 1 year.            | No. of PLHIV monitored | Among PLHIV and HTN and retained in HTN care: Has had BP monitored at least once in 6 months21,23 | No. of PLHIV and hypertensive monitored |
|                            |                                                                                              | No. of PLHIV retained in care |                                    | No. of PLHIV and hypertensive retained in care |
| Control                    | Among PLHIV on ART: Viral suppression was defined as having less than 1000 HIV copies/mL in a patient with HIV. | No. of PLHIV on ART with viral suppression | Among PLHIV monitored for HTN: Last documented BP of less than 140/90 mm Hg21,23 | No. of PLHIV and hypertensive who are treated for HTN and controlled |
|                            |                                                                                              | Total number of PLHIV in the cohort 2014–2017 |                                    | Total number of PLHIV and hypertensive who are initiated on treatment for HTN |

N/A, not applicable

Guidelines because PLHIV are retained for both HIV and HTN care at the clinic level10 (Table 1).

Statistical Analysis

We first conducted univariate analyses to describe demographic and baseline characteristics of the cohort. Means and SDs were obtained for continuous variables, whereas percentages and frequencies described categorical variables. We then stratified the data into 2 subpopulations: HIV and HIV/HTN and compared baseline characteristics of these 2 subgroups using \( \chi^2 \) or Fisher exact tests for categorical characteristics and \( t \) tests for continuous characteristics.

To estimate proportions along each cascade, we conducted descriptive analyses and obtained frequencies and percentages of patients at each previously defined step compared with the preceding step. We then stratified the cascades by HIV (participants with HIV alone) and HIV/HTN (participants diagnosed with both HIV and HTN). Each percentage in the cascades was accompanied by corresponding 95% confidence intervals (CIs). We analyzed the data using Stata (version 13). The study was registered in clinicatrials.gov (NCT03605043), and we followed STROBE.
Role of Funding Source

The sponsor of the study had no role in study design, data collection, analysis, and interpretation or writing of the manuscript. The corresponding author/principal investigator had full access to all the data in the study and had final responsibility for the decision to submit for publication.

RESULTS

A total of 1649 PLHIV were enrolled in the cohort, of whom 387 (23.5%) participants were enrolled at Mulanda HC IV, 448 (27.2%) at Nagongera HC IV, and 814 (49.4%) at TASO Tororo. The mean age of the cohort was 37.6 years (SD = 11.2) and 975 (59.1%) were women. The mean baseline CD4 count of the cohort was 365.4 (SD = 239.8) cells per mm3. The mean systolic and diastolic BP were 134.6 (SD = 29.2) mm Hg and 82.4 (SD = 18.6) mm Hg, respectively. Most participants, 1384 (85.2%), were prescribed tenofovir/lamivudine/efavirenz (TDF/3TC/EFV) as the initial HIV treatment regimen (Table 2). Of patients diagnosed with HTN, 181 (94.3%) were prescribed antihypertensive medicines and 11 (5.7%) were prescribed lifestyle modification. Among patients who received an initial prescription for antihypertensive medicines, the commonest choice was the combination of calcium channel blocker and angiotensin-converting enzyme inhibitor (69; 35.9%) (Table 3).

For the HIV cascade, 1625 (98.5%) were initiated on HIV treatment, of whom 1148 (70.7%) were retained in care, 1148 (100%) had viral load monitoring, and 1037 (90.3%) were controlled (viral suppression) (Table 4). With regard to the HTN cascade, 465 (27.7%) were screened for HTN, 218 (47.8%) were diagnosed with HTN, 192 (88.1%) were initiated on treatment, 110 (57.3%) were retained in care, 91 (82.7%) were monitored for HTN, and 53 (58.2%) of these were controlled. This control rate represents 24.3% of those diagnosed with HTN (Table 5). The care cascades for both HIV and HTN among the 218 participants with HIV/HTN are juxtaposed in Figure 1. TASO Tororo achieved better HTN cascade outcomes compared with Mulanda and Nagongera in all the cascade steps apart from BP control. There was no statistically significant difference in BP control across the 3 HIV clinics (Tables 6 and 7).

| TABLE 2. Baseline Characteristics for Study Participants |
|---|
| Characteristic | Overall Cohort (n = 1649) | HIV (n = 1431) | HIV/HTN (n = 218) | P* |
|---|---|---|---|---|
| Age, yrs | 37.6 (SD = 11.2) | 36.7 (SD = 10.8) | 43.6 (SD = 11.5) | <0.0001 |
| Age category, yrs | 18–30 | 500 (30.3%) | 473 (33.1) | 27 (12.4%) | <0.0001 |
| 31–50 | 933 (56.6%) | 801 (55.9) | 132 (60.5%) | 0.0001 |
| >50 | 216 (13.1%) | 157 (11.0) | 59 (27.1%) | 0.6460 |
| Sex | Male | 647 (40.9%) | 588 (41.1) | 86 (39.4%) |
| Female | 975 (59.1%) | 843 (58.9) | 132 (60.6%) | <0.0001 |
| Health facility | TASO Tororo | 814 (49.3%) | 623 (43.5) | 191 (87.6%) | 0.0001 |
| Nagongera HC IV | 448 (27.2%) | 443 (31.0) | 2 (2.3%) |
| Mulanda HC IV | 387 (23.5%) | 365 (25.5) | 22 (10.1%) |
| Baseline BP, mm Hg | 134.6 (SD = 29.2) | 116.8 (SD = 19.4) | 158.4 (SD = 22.2) | <0.0001 |
| Systolic | 82.4 (SD = 18.6) | 72.2 (SD = 14.0) | 96.1 (SD = 14.8) | <0.0001 |
| Diastolic | 134.6 (SD = 29.2) | 116.8 (SD = 19.4) | 158.4 (SD = 22.2) | <0.0001 |
| Baseline CD4 count, cells/mm3 | 347.6 (SD = 244.1) | 345.4 (SD = 244.6) | 365.4 (SD = 239.8) | 0.4270 |
| Baseline ART regimen, % | TDF/3TC/EFV | 1384 (85.1) | 1213 (86.2) | 171 (78.8) |
| AZT/3TC/NVP | 93 (5.7) | 68 (4.8) | 25 (11.5) |
| AZT/3TC/EFV | 44 (2.7) | 40 (2.8) | 4 (1.8) |
| TDF/3TC/NVP | 43 (2.7) | 34 (2.4) | 9 (4.2) |
| Others | 61 (3.8) | 53 (3.8) | 8 (3.7) |
| BMI, kg/m2 (n = 552) | 186 (33.7%) | 175 (33.7) | 11 (33.3%) | 0.0140 |
| Underweight (<19.0) | 331 (56.0%) | 315 (60.7) | 16 (48.5%) |
| Normal weight (19.0 to <25.0) | 28 (5.0%) | 24 (4.6%) | 4 (12.1%) |
| Overweight (25.0 to <30.0) | 7 (1.3%) | 5 (1.0%) | 2 (6.1%) |

Data are presented as means with SDs, frequencies, and percentages.

* Differences between groups are reported using the Pearson χ² test statistic (for categorical variables) and Student independent t test (for continuous variables).

3TC, lamivudine; AZT, zidovudine; EFV, efavirenz; HC, health center; NVP, nevirapine; TDF, tenofovir.

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TABLE 4. HIV Care Cascade for all PLHIV Enrolled Into Care From January 2014 to January 2017

| Cascade Step | Freq. (n) | Denominator | Percent | CI       |
|--------------|----------|-------------|---------|----------|
| Initiated    | 1625     | 1649        | 98.5    | 97.8 to 99.0 |
| Retained     | 1148     | 1625        | 70.7    | 68.4 to 72.8 |
| Monitored    | 1148     | 1148        | 100.0   | 99.7 to 100.0 |
| Controlled   | 1037     | 1148        | 90.3    | 88.5 to 91.9 |

Freq., frequency.
a wide week-to-week variability in screening patterns. Once participants in this cohort were screened for HTN, 46.9% were diagnosed. One prospective study in Uganda found a prevalence of HTN among PLHIV in an HIV clinic to be 27.9%. Other studies in SSA have found a HTN prevalence of 11.0%–29.0% among PLHIV. One prospective cohort study in the Netherlands identified a higher prevalence of HTN of 48.2% among PLHIV on ART, a figure similar to our findings. Studies that report a low prevalence of HTN among PLHIV are dominated by ART-naïve populations. Our population of PLHIV included those on ART for variable durations before HTN screening and diagnosis. The low

![FIGURE 1. Integrated care cascades for HIV and HTN: The bars above each cascade step represent the number of participants included in each step, whereas the bars below each cascade step represent the percentage of participants lost from the previous step. The gray bar represents the entire cohort of 1649 participants with HIV, the light blue bar represents the HIV cascade for those with HIV and HTN, and the red bar represents the HTN cascade for those with HIV and HTN. Error bars reflect the 95% CI.](image)

| Cascade Step | Freq. (n = 1649) | Denominator | % CI (Estimated Range) |
|--------------|------------------|-------------|------------------------|
| Screened     | 456              | 1649        | 27.7                   | 25.5 to 29.9 |
| Diagnosed    | 218              | 456         | 47.8                   | 43.1 to 52.5 |
| Initiated    | 192              | 218         | 88.1                   | 83.0 to 92.1 |
| Retained     | 110              | 192         | 57.3                   | 49.9 to 64.4 |
| Monitored    | 91               | 110         | 82.7                   | 74.3 to 89.3 |
| Controlled   | 53               | 91          | 58.2                   | 47.4 to 68.5 |

Freq., frequency.

| Cascade Step | TASO; n (row %) | Nagongera; n (row %) | Mulanda; n (row %) | P      |
|--------------|-----------------|----------------------|-------------------|--------|
| Screened     | 258 (56.6)      | 38 (8.3)             | 160 (35.1)        | <0.0001* |
| Diagnosed    | 191 (87.6)      | 5 (2.3)              | 22 (10.1)         | <0.0001† |
| Initiated    | 172 (89.6)      | 5 (2.6)              | 15 (7.8)          | 0.022†  |
| Retained     | 105 (95.5)      | 1 (0.9)              | 4 (3.6)           | 0.007†  |
| Monitored    | 89 (97.8)       | 1 (1.1)              | 1 (1.1)           | 0.016†  |
| Controlled   | 52 (98.1)       | 0 (0.0)              | 1 (1.9)           | 0.619†  |

*χ² P value.
†Fisher’s exact P value.
screening rate in this study suggests that 46.9% is an overestimation of prevalence within the study population. Older patients were more likely than younger patients to be screened for HTN in our cohort, and there was a trend toward more frequent screening of overweight and obese patients for HTN. Clinicians were likely to have been biased in their approach to HTN screening and to have prioritized screening among those patients who they deemed to be at high risk of HTN or CVD. Future work should explore clinicians’ and patients’ perspectives on screening, including preferred setting for screening, the tools and qualifications needed for screening, and the preferred modalities for promoting linkage to care.

Among those diagnosed with HTN, 88% were initiated on treatment with either lifestyle changes or medicines. This far exceeds global LMIC estimates of 29%. One study in Uganda found treatment rates for HTN in the HIV clinic to be 83.0%, a figure similar to our findings. These findings support the integration of HTN management within a high-functioning chronic care delivery system in which a treatment plan directly follows a diagnosis. Owing to the retrospective nature of this study, initiation could only be ascertained by chart documentation of a prescription or discussion. Thus, the adherence to initiated treatment plans is likely to have been highly variable. This likely explains why retention, the next step, represented another large gap in the HTN cascade.

Retention in SSA HIV programs at 12 months after ART initiation approximates 70%–80%. In our study, HIV retention was greater than HTN retention (70.7% vs. 57.3%, respectively). According to our definition of HTN retention, a patient initiated on HTN therapy must have had their HTN addressed within 90 days. The difference between HIV and HTN retention within this HIV program is likely due to providers not addressing HTN during follow-up visits. A provider might have initiated HTN management and the patient might have returned for follow-up, but if HTN was not addressed during that follow-up visit, the patient was not considered to have been retained in HTN care. This represents another focused area of improvement for future implementation efforts of integrated care delivery.

Not surprisingly, there was little drop-off between the Retained and Monitored stages in our parallel cascades. This is because all patients who were retained in care had a viral load checked during follow-up and most (82.7%) had a BP check. The greater losses in monitoring of those with HTN, relative to HIV, might be attributable to unavailability of BP machines, providers not recognizing or prioritizing the previous diagnosis and treatment plan for HTN, or failure by clinicians to document subsequent BP readings.

BP control represented the second largest gap in our HTN cascade. Although 90.3% of those monitored (and 63.8% of those initiated on treatment) for HIV achieved viral suppression during 12-month follow-up, only 58.2% of those monitored (and 27.6% of those initiated on treatment) for HTN achieved a measured BP of 140/90 mm Hg or lower. BP control in Uganda and other parts of SSA has remained very low, ranging from 7.0% to 28.0%. This is much lower

### TABLE 7. HIV Care Cascades for Participants With HIV Alone and Combined HIV/HTN Based on the Definitions Presented in Table 1

| Cascade Step | HIV Cascade for HIV Alone (n = 1431) | HIV Cascade for HIV/HTN (n = 218) |
|--------------|--------------------------------------|----------------------------------|
| Freq. (n)    | Denominator | % (CI)  | Freq. (n) | Denominator | % (CI)  | P  |
| Initiated    | 1408       | 1431    | 98.4 (97.6 to 99.0) | 217       | 218    | 99.5 (97.5 to 99.9) | 0.2075 |
| Retained     | 1005       | 1408    | 71.4 (68.9 to 73.7) | 143       | 217    | 65.9 (59.2 to 72.2) | 0.2205 |
| Monitored    | 1005       | 1005    | 100.0 (99.6 to 100.0) | 143       | 143    | 100.0 (97.5 to 100.0) | 0.1660 |
| Controlled   | 906        | 1005    | 90.2 (88.1 to 91.9) | 131       | 143    | 91.6 (85.8 to 95.6) | 0.4707 |

### TABLE 8. Logistic Regression Analysis for Factors Associated With Screening for HTN Among PLHIV

| Variable          | Not Screened for HTN, n (%) | Screened for HTN, n (%) | Unadjusted ORs (95% CI) | Adjusted OR (95% CI) |
|-------------------|-----------------------------|-------------------------|-------------------------|----------------------|
| Age category, yrs |                             |                         |                         |                      |
| 18–30             | 382 (32.7)                  | 103 (22.6)              | 1.0                     | 1.0                  |
| 31–50             | 656 (56.1)                  | 271 (59.4)              | 1.53 (1.16 to 2.03)*    | 1.56 (1.18 to 2.08)* |
| >50               | 131 (11.2)                  | 82 (18.0)               | 2.32 (1.69 to 3.18)*    | 2.37 (1.71 to 3.29)* |
| Sex               |                             |                         |                         |                      |
| Male              | 477 (40.8)                  | 189 (41.4)              | 1.0                     |                      |
| Female            | 692 (59.2)                  | 267 (58.6)              | 0.97 (0.86 to 1.10)     | 1.09 (0.97 to 1.22)  |
| BMI, kg/m² (n = 552) |                             |                         |                         |                      |
| Underweight (<19.0) | 136 (33.7)                  | 49 (34.0)               | 1.0                     |                      |
| Normal weight (19.0 to <25.0) | 243 (60.2)                  | 85 (59.0)               | 0.97 (0.71 to 1.33)     |                      |
| Overweight (25.0 to <30.0) | 20 (4.9)                    | 8 (5.6)                 | 1.11 (0.52 to 2.36)     |                      |
| Obese (≥30.0)     | 5 (1.2)                     | 2 (1.4)                 | 1.11 (0.27 to 4.63)     |                      |

*P value < 0.05.
TABLE 9. Recommended Areas of Focus for Future Research and Policy in HIV/NCD Integrated Care Delivery

| Qualitative research on knowledge, motivations, and skills of both providers and patients to inform interventions for integrated HIV/NCD care; |
| Task redistribution for NCD screening and treatment within HIV clinics and communities. Such redistribution might use HIV peer counselors, community health care workers, patient groups, and/or community-based organizations; |
| Training and skills development on clinical integration for health workers, community health workers, and patients within HIV clinics; |
| Mechanisms to promote patient retention; |
| Developing and supporting patient-driven goals (ie, advocacy, improved retention and/or adherence, and mitigating medicine stockouts); |
| Establishing robust monitoring and evaluation frameworks coupled with target setting and performance review for NCD cascades; |
| Provision of FDCs of generic medicines for NCDs within HIV clinics; |
| Implementation science research to help design, implement, and evaluate multilevel interventions. |

does not have a significant impact on NCD care systems. Thus, the low rate of HTN control is likely largely attributable to the silent nature of HTN and to limited access to medicines. Despite its contribution to the global burden of disease, its impact on CVD, renal disease, stroke, and premature disability and mortality, HTN is largely asymptomatic.37 Patients who have been screened, diagnosed, monitored, and retained in care still must be educated about the condition and the importance of adherence to lifestyle and medical management to achieve BP control. Importantly, even among those who have been informed and aim to adhere to medical therapies, there are numerous barriers to access for medicines used to treat HTN and other NCDs. Availability and affordability of these medicines in LMIC remains poor.38 Within Uganda, we have previously demonstrated disparities in availability by sector, geography, and level of health facility as well as substantial variability in availability and price over time.39 Access barriers also contribute to poor performance of the more proximal cascade steps. For example, it is common for clinicians to not screen patients for HTN because they know that the medicines are not available and/or not affordable.40 Vertical HIV programs have achieved consistently high stock of ART because of highly functional supply chains and consistent funding. However, NCD medicine supply chains have not achieved these levels of success. As is standard with HIV, HTN management often necessitates the use of multiple medicines. Finally, fixed-dose combination (FDC) therapy offers the potential to simplify medication regimens for HTN treatment and improve adherence, as it has done for HIV treatment.41,42 An application for antihypertensive FDC is currently under review for addition to the WHO Essential Medicines List and Model Formulary.43

To achieve BP control in the HIV setting and elsewhere, innovative, multilevel approaches are necessary. Population-level health promotion and prevention efforts, such as the WHO Best Buys, are critical for decreasing the impact of HTN on society. Community engagement, which involves participation, mobilization, and empowerment, has positively impacted HIV care through engaging providers, clients, and local policy makers.42 Community support systems and mobile health platforms show promise in promoting follow-up, medication adherence, health education, and fostering linkages between clinicians and patients.42 Nonphysician health worker programs should be implemented and bolstered. Evidence from Uganda has shown that community health workers desire a role in the NCD care spectrum but are demotivated by their clients’ experiences of low quality of care at health facilities and poor community outreach by facility-based clinicians.44 Task redistribution, driven by clear guidelines, protocols, and close oversight, should be an area of investment.21,42,45,46 Evidence suggests that some defined clinical tasks such as BP measurement can even be shared by lay persons such as HIV expert clients.21 Finally, at the health system level, improvements are needed in the health information infrastructure such that the performance quality of HTN and other NCD service delivery is driven by specified indicators and targets for all cascade steps, routine performance reviews, and standardized reporting mechanisms, as is done with HIV. In addition, integrating HTN cascade indicators into routinely used electronic health records with decision support tools is likely to help clinicians optimize chronic care for both HTN and HIV. In Table 9, we present a summary of our recommendations for future research and policy related to integrated care delivery based on our findings.

This study was limited by the retrospective data collection, as the quality and comprehensiveness of written clinical records are often suboptimal in this and similar settings. For example, we know that lifestyle modifications are often not recorded in the clinical chart as part of the care plan. This may have led to an underestimation of the frequency of recommended lifestyle change in managing HTN. However, our team of trained data collectors abstracted data from all available sources including clinic notes, prescription forms, and laboratory results, thereby strengthening the findings of our retrospective analysis. In addition, the study was conducted in a limited geographic area within a single HIV program, which could limit the generalizability of our findings. However, our findings are representative of those from the national data, which demonstrate that 99.5% of all individuals diagnosed with HIV are started on ART, 76% are retained after 1 year of ART initiation, and 88.4% are virally suppressed.37-49

In conclusion, in this first published study of parallel HIV and HTN care cascades, we demonstrate that, in the context of a high-functioning HIV program in Eastern Uganda, there remain many areas for improvement in the quality of HTN service delivery. Given the burden of HTN globally, it is imperative that we understand such gaps and work to address them. More vertical programs are not needed or would they be cost-effective, at least in the case of HTN.37 HTN can serve as a model NCD in this context; however, comprehensive chronic care delivery models are needed. As many have suggested, and as this study demonstrates, great potential lies in leveraging the successes of HIV programs to
provide NCD care as an integrated comprehensive package of services without compromising the quality of HIV care. Future work should use innovative quality improvement and implementation science approaches to rigorously study such integrated models of care delivery.

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REFERENCES

1. El-Sadr WM, Goosby E. Building on the HIV platform: tackling the challenge of noncommunicable diseases among persons living with HIV. AIDS. 2018;32:S1–S3.
2. Njuguna B, Vorkoper S, Patel P, et al. Models of integration of HIV and noncommunicable disease care in sub-Saharan Africa: lessons learned and evidence gaps. AIDS. 2018;32:S3–S42.
3. Forouzanfar MH, Afinan A, Alexander LT, et al. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the global burden of disease study 2015. Lancet. 2016;388:1659–1724.
4. Haldane V, Legido-Quigley H, Chuah FLH, et al. Integrating cardiovascular diseases, hypertension, and diabetes with HIV services: a systematic review. AIDS Care. 2018;32:103–115.
5. Magafu MG, Moji K, Igumbor EU, et al. Non-communicable diseases/hivaids/national-h-4. Accessed September 20, 2018.
6. Mills KT, Bundy JD, Kelly TN, et al. Global disparities of hypertension control: an analysis of electronic health records. Circulation. 2016;134:141–150.
7. van Zoest RA, van den Born BH, Reiss P. Hypertension in people living with HIV. Curr Opin HIV AIDS. 2017;12:513–522.
8. Bloomfield GS, Hogan JW, Keter A, et al. Blood pressure level impacts risk of death among HIV seropositive adults in Kenya: a retrospective analysis of electronic health records. BMC Infect Dis. 2014;14:284.
9. World Health Organization (WHO). March 2014 supplement to the 2013 consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Available at: http://www.who.int/hiv/pub/guidelines/arv2013/en/
10. Uganda Ministry of Health. Consolidated guidelines for prevention and treatment of HIV in Uganda. 2016. Available at: http://library.health.go.ug/publications/service-delivery-diseases-control-prevention-communicable-diseases/hiv/consolidated. Accessed September 30, 2018.
11. Uganda Ministry of Health. National HIV and AIDS priority action plan 2015/2016–2017/2018. Available at: http://library.health.go.ug/publications/service-delivery-diseases-control-prevention-communicable-diseases/hiv/consolidated.
12. Marais BJ, Lönnroth K, Lownsdell S, et al. Tuberculosis morbidity with communicable and non-communicable diseases: integrating health services and control efforts. Lancet Infect Dis. 2013;13:436–448.
13. Subbaraman R, Nathavitharana RR, Sanyanarayana S, et al. The tuberculosis cascade of care in India’s public sector: a systematic review and meta-analysis. PLoS Med. 2016;13:e1002149.
14. Gimbel S, Voss J, Mercer MA, et al. The prevention of mother-to-child transmission of HIV cascade analysis tool: supporting health managers to improve facility-level service delivery. BMC Res Notes. 2014;7:473.
15. Nosyk B, Montaner JSG, Colley G, et al. The cascade of HIV care in British Columbia, Canada, 1996–2011: a population-based retrospective cohort study. Lancet Infect Dis. 2014;14:40–49.
16. Longenecker CT, Morris SR, Alku T, et al. Rheumatic heart disease treatment cascade in Uganda. Circ Cardiovasc Qual Outcomes. 2017;10:e001797.
17. Joint United Nations Programme on HIV/AIDS (UNAIDS)/UGANDA; 2017: Available at: http://www.unaids.org/en/regionscountries/countries/uganda. Accessed September 30, 2018.
18. Guwatudde D, Mutungi G, Wesonga R, et al. The epidemiology of hypertension in Uganda: findings from the national non-communicable diseases risk factor survey. PLoS One. 2015;10:e0138991.
19. Uganda Bureau of Statistics (UBoS). National population and housing census 2014: area specific profiles—Tororo district. Available at: http://www.ubos.org/onlinefiles/uploads/ubos2014CensusProfiles/TORORO.pdf. Accessed July 29, 2018.
20. World Health Organisation (WHO). Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Available at https://www.who.int/hiv/pub/guidelines/arv2013/en/. Accessed March 23, 2019.
21. World Health Organization (WHO). Technical package for cardiovascular disease management in primary health care: evidence-based treatment protocols. Available at: https://creativecommons.org/licenses/by-nc-sa/3.0/igo. Accessed July 26, 2018.
22. Rabkin M, Palma A, Aderonke ML, et al. Integrating cardiovascular disease risk factor screening into HIV services in Swaziland: lessons from an implementation science study. AIDS. 2018;32:S43–S46.
23. Billieux VG, Chang LW, Reynolds SJ, et al. Human immunodeficiency virus care cascade among sub-populations in Rakai, Uganda: an observational study. J Int AIDS Soc. 2017;20:21590.
24. Weber MA, Schiffirin EL, White WB, et al. Clinical practice guidelines for the management of hypertension in the community: a statement by the American Society of Hypertension and the International Society of Hypertension. J Clin Hypertens (Greenwich). 2014;16:14–26.
25. Joint United Nations Programme on HIV/AIDS (UNAIDS). 90–90–90— an Ambitious Treatment Target to Help End the AIDS Epidemic; 2017. Available at: http://www.unaids.org/en/resources/documents/2017/90-90-90
date Accessed July 29, 2018.
26. Haas AD, Zaniewski E, Anderegg N, et al. Retention and mortality on antiretroviral therapy in sub-Saharan Africa: collaborative analyses of HIV treatment programmes. J Int AIDS Soc. 2018;21:e25084.
27. Chami G, Kwarisima D, Clark TD, et al. Leveraging rapid community-based HIV testing campaigns for non-communicable diseases in rural Uganda. PLoS One. 2012;7:e43400.
28. Mateen FJ, Kantes S, Kalyesubula R, et al. Hypertension prevalence and Framingham risk score stratification in a large HIV-positive cohort in Uganda. J Hypertens. 2013;31:1372–1378.
29. Patel P, Rose CE, Collins PY, et al. Noncommunicable diseases among HIV-infected persons in low-income and middle-income countries: a systematic review and meta-analysis. AIDS. 2018;32:85–820.
30. Kwarisiima D, Balzer L, Heller D, et al. Population-based assessment of hypertension epidemiology and risk factors among HIV-positive and general populations in rural Uganda. PLoS One. 2016;11:e0156309.
31. Kazooba P, Kasamba I, Mayanja BN et al. Cardiometabolic risk among HIV-positive Ugandan adults: prevalence, predictors and effect of long-term antiretroviral therapy. Pan Afr Med J. 2017;27:40.
32. van Zoest RA, Wit FW, Kooij KW, et al. Higher prevalence of hypertension in HIV-1-infected patients on combination antiretroviral therapy is associated with changes in body composition and prior stavudine exposure. Clin Infect Dis. 2016;63:205–213.
33. Sander JD, Newall K, Sibbowa P, et al. Hypertension, cardiovascular risk factors and antihypertensive medication utilisation among HIV-infected individuals in Rakai, Uganda. Trop Med Int Health. 2015;20:391–396.
34. Rosen S, Fox MP, Gill CJ. Patient retention in antiretroviral therapy programs in sub-Saharan Africa: a systematic review. Plos Med. 2007;4:e298.
35. Sinabulya I, Nabunnya Y, Kiggundu B, et al. Hypertension control and survival in Mulago Hospital ambulatory clinic, Kampala-Uganda. BMC Res Notes. 2016;9:487.
36. Antignac M, Diop IB, Macquet de Terline D, et al. Socioeconomic status and hypertension control in sub-Saharan Africa: the multimination eight study (evaluation of hypertension in sub-Saharan Africa). Hypertension. 2018;71:577–584.

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37. World Health Organization (WHO). A Global Brief on Hypertension: Silent Killer, Global Public Health Crisis: World Health Day, 2013. Available at: http://www.who.int/iris/handle/10665/79059. Accessed September 28, 2018.

38. Cameron A, Roubos I, Ewen M et al. Differences in the availability of medicines for chronic and acute conditions in the public and private sectors of developing countries. Bull World Health Organ. 2011;89:412–421.

39. Armstrong-Hough M, Kishore SP, Byakika S, et al. Disparities in availability of essential medicines to treat non-communicable diseases in Uganda: a Poisson analysis using the Service Availability and Readiness Assessment. PLoS One. 2018;13:e0192332.

40. Leung C, Aris E, Mhalu A, et al. Preparedness of HIV care and treatment clinics for the management of concomitant non-communicable diseases: a cross-sectional survey. BMC Public Health. 2016;16:1002.

41. Bangalore S, Kamalakkannan G, Parkar S, et al. Fixed-dose combinations improve medication compliance: a meta-analysis. Am J Med. 2007;120:713–719.

42. Vedanthan R, Bernabe-Ortiz A, Herasme OI, et al. Innovative approaches to hypertension control in low-and middle-income countries. Cardiol Clin. 2017;35:99–115.

43. Kishore SPSA, Rodgers A, Jaffe MG, et al. Fixed-dose combinations for hypertension. Lancet. 2018;392:819–820.

44. Ojo TT, Hawley NL, Desai MM, et al. Exploring knowledge and attitudes toward non-communicable diseases among village health teams in Eastern Uganda: a cross-sectional study. BMC Public Health. 2017;17:947.

45. Rabkin M, de Pinho H, Michaels-Strasser S, et al. Strengthening the health workforce to support integration of HIV and noncommunicable disease services in sub-Saharan Africa. AIDS. 2018;32:S47–S54.

46. World Health Organization (WHO). Technical package for cardiovascular disease management in primary health care: team-based care. Available at: https://creativecommons.org/licenses/by-nc-sa/3.0/igo. Accessed July 26, 2018.

47. Uganda Ministry of Health. Uganda viral load dashboard: suppression rate. 2019. Available at https://vldash.cphluganda.org/. Accessed March 30, 2019.

48. Uganda AIDS Commission. Mid-term review of the national HIV and AIDS strategic plan (NSP) 2015/2016-2019/2020. 2018. Available at http://library.health.go.ug/publications/service-delivery-diseases-control-prevention-communicable-diseases/hivaids/national-h-1. Accessed March 23, 2019.

49. Uganda Ministry of Health; AIDS Control Program. HIV implementing partners coordination meeting. Progress towards achieving the UNAIDS 90-90-90 goals. Kampala, Uganda. 2019.