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MAJOR ARTICLE

Impact of Pharmacist-Driven Antiretroviral Stewardship and Transitions of Care Interventions on Persons With Human Immunodeficiency Virus

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Background. Persons with human immunodeficiency virus (HIV) experience high rates of medication-related errors when admitted to the inpatient setting. Data are lacking on the impact of a combined antiretroviral (ARV) stewardship and transitions of care (TOC) program. We investigated the impact of a pharmacist-driven ARV stewardship and TOC program in persons with HIV.

Methods. This was a retrospective, quasi-experimental analysis evaluating the impact of an HIV-trained clinical pharmacist on hospitalized persons with HIV. Patients included in the study were adults following up, or planning to follow up, at the University of Illinois (UI) outpatient clinics for HIV care and admitted to the University of Illinois Hospital. Data were collected between July 1, 2017 and December 31, 2017 for the preimplementation phase and between July 1, 2018 and December 31, 2018 for the postimplementation phase. Primary and secondary endpoints included medication error rates related to antiretroviral therapy (ART) and opportunistic infection (OI) medications, all-cause readmission rates, medication access at time of hospital discharge, and linkage to care rates.

Results. A total of 128 patients were included in the study: 60 in the preimplementation phase and 68 in the postimplementation phase. After the implementation of this program, medication error rates associated with ART and OI medications decreased from 17% (10 of 60) to 6% (4 of 68) ($P = .051$), 30-day all-cause readmission rates decreased significantly from 27% (16 of 60) to 12% (8 of 68) ($P = .03$), and linkage to care rates increased significantly from 78% (46 of 59) to 92% (61 of 66) ($P = .02$).

Conclusions. A pharmacist-led ARV stewardship and TOC program improved overall care of persons with HIV through reduction in medication error rates, all-cause readmission rates, and an improvement in linkage to care rates.

Keywords. antiretroviral therapy; medication errors; stewardship; transitions of care.

Historical data demonstrate that persons with human immunodeficiency virus (HIV) experience high rates of medication errors when admitted to the inpatient setting [1–5]. This is due to, in part, the complexity of antiretroviral therapy (ART) as well as practitioner lack of knowledge or familiarity regarding these therapies [6]. Medication error rates related to ART and/or opportunistic infection (OI) medications have been reported in 27% to 72% of hospitalized persons with HIV [1–5, 7–9]. In addition, a majority of these medication errors are not corrected before hospital discharge, which can lead to unnecessary toxicities, antiretroviral (ARV) drug-resistance, and treatment failure, which may lead to an increased rate of transmission of HIV in the community [3, 10].

Assistance with transitions of care (TOC) between the inpatient and outpatient settings is vital for persons with HIV because this population has up to 50% increased risk of readmission within 30 days compared with patients without HIV [11]. Persons with HIV may have difficulty navigating the healthcare system due to mental health barriers, stigma, lack of transportation, unstable housing, substance abuse, and challenges accessing ART [10]. These barriers impede linkage to care and are associated with poor virologic and immunologic outcomes as well as the emergence of ARV drug resistance [12–16].

The Infectious Diseases Society of America, HIV Medicine Association, and American Academy of HIV Medicine have called for the implementation of ARV stewardship programs into health systems to enhance patient safety [17]. Antiretroviral stewardship is defined as "coordinated interventions designed to improve continuity of care for patients receiving ARVs through the utilization of evidence-based ARV practices including medication reconciliation, dosing, mitigation of drug interactions, and prevention of viral resistance." Antiretroviral stewardship programs have demonstrated value through reductions in

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medication-related errors as well as an increase in resolution of these errors before discharge for persons with HIV [7, 17–22]. Despite these interventions, data are lacking on the impact of a combined ARV stewardship and TOC program on all-cause readmission rates, access to medications, and linkage to care rates in persons with HIV.

The University of Illinois (UI) Health system serves approximately 1100 patients with HIV per year in outpatient HIV clinics throughout the city of Chicago. In addition, University of Illinois Hospital (UIH) admits approximately 400 persons with HIV per year. Historically, medication error rates related to ART or OI medications occurred 38% of the time in patients with HIV admitted to UIH [1]. In response to these high medication error rates at UIH, a pharmacist-driven ARV stewardship and TOC program was developed and implemented to improve inpatient care for persons with HIV. The purpose of this study was to evaluate the impact of a pharmacist-driven ARV stewardship and TOC program on medication error rates, access to discharge medications, all-cause readmission rates, and linkage to care rates in persons with HIV.

METHODS

Study Design

A retrospective, quasi-experimental analysis was conducted to compare outcomes in persons with HIV admitted to UIH for a 6-month period (July 1, 2017 to December 31, 2017) before and a 6-month period (July 1, 2018 to December 31, 2018) after the implementation of a pharmacist-driven ARV stewardship and TOC program. The ARV stewardship and TOC program was implemented at UIH in March 2018 as a quality improvement project aimed to enhance care for patients with HIV hospitalized at UIH. Analysis included persons with HIV who followed up, or planned to follow up, at any one of the UI outpatient clinics for HIV care. The index hospitalization, defined as the first hospitalization within the study period, was used to assess study outcomes. The Institutional Review Board at the University of Illinois at Chicago approved the conduct of this study. All research was conducted within the guidelines of ethical principles and local legislation.

Study Population

Only persons ≥18 years with HIV who followed up with, or who were newly diagnosed or lost to care and planned to follow up with, UI outpatient clinics for HIV care were included in the study. Patients admitted to UIH during the preimplementation phase (July 1, 2017 to December 31, 2017) and/or the postimplementation phase (July 1, 2018 to December 31, 2018) were included. Patients who were incarcerated, pregnant, or taking ARV medications for indications other than HIV, such as hepatitis B or pre-exposure or postexposure prophylaxis, were excluded.

Intervention

On March 5, 2018, the pharmacist-driven ARV stewardship and TOC program began and was led by the PGY-2 HIV pharmacy resident (the HIV PharmD) under the supervision of 5 HIV/Infectious Diseases (ID)-trained clinical pharmacists. The HIV PharmD was notified via an alert in Cerner (Cerner PowerChart [2011], Cerner Corporations), Monday through Friday, between 7:00 AM and 5:00 PM, once an ARV was ordered during the inpatient stay. If the patient was ART naive or not actively taking ART (with a history of taking ART), the HIV PharmD was paged by either the ID consult team or the primary medical team. The intervention consisted of 2 components: ARV stewardship and TOC. All interventions were documented in the medical record by the HIV PharmD. If a patient was reviewed and no intervention was required, the HIV PharmD documented the chart review on a separate deidentified document. Documentation included reason for admission, past medical history, date of last outpatient clinic visit for HIV care, ART, OI medication(s), pertinent laboratory tests (including CD4 count, HIV ribonucleic acid, liver function tests, basic chemistry, toxoplasmosis immunoglobulin G, hepatitis serology, etc), concomitant medications, history of ARV resistance, insurance status, patients' pharmacy information, date of next follow-up visit for outpatient HIV care, and the intervention made by the HIV PharmD during the admission, if any. Incident reports for medication errors and prescribing errors were submitted to UIH's internal medication safety committee to review for process improvement.

Antiretroviral Stewardship

The ARV stewardship component involved the HIV PharmD reviewing the electronic medical record (EMR) for each patient daily (Monday through Friday), ensuring that ART and/or OI medications were ordered and administered during the inpatient setting. If there were errors to ART and/or OI medication orders (ie, inpatient therapy ordered incorrectly compared with outpatient therapy), the HIV PharmD assisted with correcting these. In addition, HIV PharmD assisted with modifications to ART and/or OI medications warranted by changes in renal and hepatic function, drug interactions, and/or changes in oral access [23, 24]. The HIV PharmD assisted with rapid initiation of ART, defined as ART initiation within 7 days of diagnosis, in newly diagnosed patients as well as reviewed accuracy of dosing of antimicrobials in patients presenting with concomitant OIs [25]. The HIV PharmD collaborated with the ID consult team, the primary care team during hospitalization, and outpatient providers to perform these interventions.

Transitions of Care

The TOC component involved the HIV PharmD ensuring that patients had access to medications at time of hospital discharge. The HIV PharmD worked with UI outpatient pharmacy, which

serves both the hospital and outpatient clinics, to get medications delivered to the bedside before hospital discharge. If patients chose to, or were required to, fill at an outside pharmacy, the HIV PharmD coordinated with these pharmacies to ensure that all medications were accessible at time of discharge. The HIV PharmD also worked with the primary care team during hospitalization to complete prior authorizations, patient assistance program applications, and enroll patients into the AIDS Drug Assistance Program (ADAP), when necessary due to lack of insurance coverage. Within 7 days postdischarge, the HIV PharmD contacted high-risk patients via telephone to evaluate understanding of and adherence to complete medication list. High-risk patients were defined by the HIV PharmD as those who (1) had any 30-day readmission within the previous year, (2) had changes to outpatient ART regimen or OI medications while inpatient, and/or (3) were diagnosed during hospital admission or re-engaging into HIV care. The HIV PharmD ensured that clinic follow up was scheduled before inpatient discharge for persons with HIV planning to continue HIV care with UI outpatient clinics. If the patient missed their postdischarge clinic follow up, the HIV PharmD contacted them by phone to reschedule. If the patient was unable to be reached by the HIV PharmD, HIV outreach workers were contacted to assist with linkage to care.

Outcome Measures

Primary outcomes included medication error rates related to ART and OI medications during index admission, follow-up rates at UI outpatient clinics, and 30-day all-cause readmission rates. Medication errors were defined as inaccurate use of ART or OI medications that reached the patient while admitted to UIH. Examples of medication errors included incorrect therapy (eg, wrong drug or drug formulation), incomplete therapy (eg, at least 1 ARV was omitted), omitted therapy (eg, failed to start ART or OI medication within 24 hours, if clinically indicated), duplicate ART (eg, 2 ARV within the same class used inaccurately) wrong dose (eg, raltegravir 400 mg daily), and drug-drug and drug-food interactions related to ART and/or OI medications. Linkage to care was defined as follow up at a UI outpatient clinic for HIV care within 6 months of discharge. The 6-month time frame was based on the Illinois ADAP requirement for patients to be evaluated at least once every 6 months [26]. All-cause readmission rate was defined as admission to UIH, excluding emergency room visits or planned admissions (eg, chemotherapy or scheduled surgery), within 30 days of discharge.

Secondary outcomes included 90-day all-cause readmission rates, intercepted prescribing errors, and access to medications at discharge of index hospitalization. An intercepted prescribing error was defined as inaccurate use of ART or OI medication that was intercepted by HIV PharmD before reaching the patient while admitted to UIH.

Statistical Analysis

The χ^2 or Fisher's exact test was used to compare categorical variables. The Mann-Whitney *U* test was used to analyze nonparametric continuous variables (there were no parametric continuous variables identified). Descriptive statistics were used for baseline demographics and study outcomes. All analyses were conducted using GraphPad Prism, version 8 (GraphPad Software, San Diego, CA).

RESULTS

Patient Characteristics

After excluding duplicate patients due to readmissions and patients who did not follow up at UI outpatient clinics, a total of 128 patients were included in the study: 60 in the preimplementation phase and 68 in the postimplementation phase (Figure 1). The majority of patients were black (80% in pre- and 82% in postimplementation phase), males (53% in pre- and 71% in postimplementation phase), and had a median age of 47 years (interquartile range [IQR], 35–59) in pre- and 49 years (IQR, 37–57) in postimplementation phase (Table 1). The preimplementation phase had significantly more females than the postimplementation phase (47% vs 29%, $P = .04$). Approximately 40% of admissions in the preimplementation phase and 51% of admissions in the postimplementation phase had an ID team consultation. Only 35% of patients in the preimplementation phase and 46% of patients in the postimplementation phase were on a single-tablet regimen (STR) at the time of admission.

Antiretroviral regimens at time of hospital admission are listed in Table 2. There were significantly more patients on 2 nucleoside/nucleotide reverse-transcriptase inhibitors (NRTIs) plus an integrase strand transfer inhibitor (INSTI) in the postimplementation phase (37% vs 57%, $P = .02$). Thirty-five percent of patients were on nontraditional, mixed regimens (ie, not on 2 NRTIs + a third agent) at time of admission, which were determined to be due to either ARV resistance, history of intolerance to specific drug classes, or patients on 2-drug regimens.

Medication Errors

Medication errors related to ART and OI medications pre- and postimplementation of the ARV stewardship and TOC program are summarized in Table 3. The medication error rates related to ART and OI medications decreased from 17% (10 of 60) to 6% (4 of 68) (relative risk [RR], 0.35; 95% confidence interval [CI], 0.12–1; $P = .051$) after implementation of the program. The errors in the preimplementation phase included omitted OI therapy (4 of 10 or 40%), omitted ARV therapy (3 of 10 or 30%), drug-drug interactions (2 of 10 or 20%), and incorrect therapy (1 of 10 or 10%). The errors in the postimplementation phase included wrong dose of ART (1 of 4

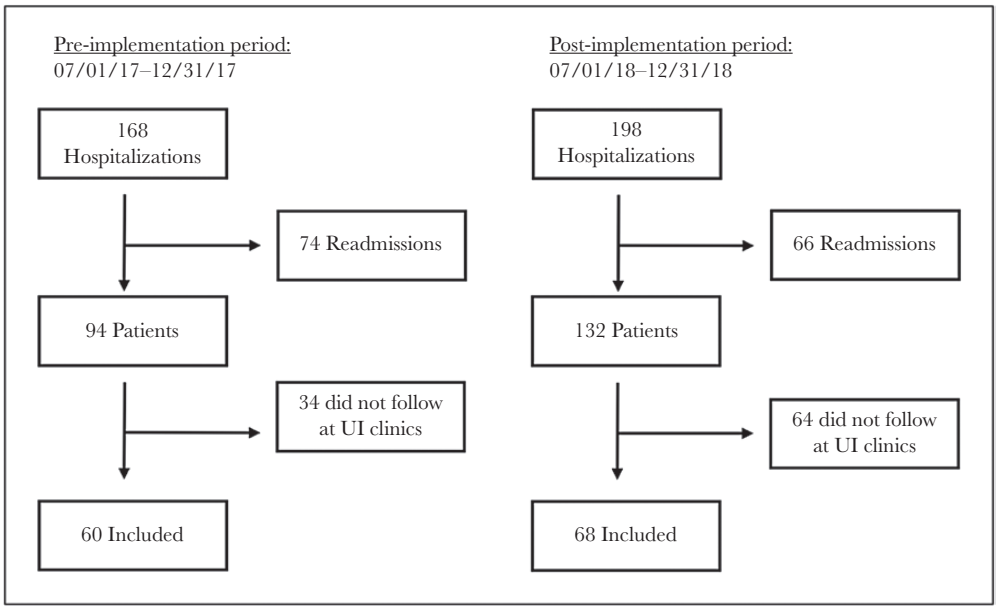

Figure 1. Patient disposition. UI, University of Illinois.

or 25%), wrong dose of OI prophylaxis (1 of 4 or 25%), incorrect therapy (1 of 4 or 25%), and drug-drug interactions (1 of 4 or 25%). Error resolution rates before discharge increased from 0% (0 of 10) in the preimplementation phase to 100% (4 of 4) in the postimplementation phase (P = .001). Two of the errors in the postimplementation phase (wrong dose of OI prophylaxis and drug-drug interaction) were made outpatient at a previous clinic visit and 2 were made inpatient (wrong dose of ART and incorrect therapy) during a time when the HIV PharmD was not actively reviewing patients (ie, during the weekend); all errors were corrected within 24 hours of initial inpatient administration. Of the total patients who experienced medication errors in both study arms, 21% (3 of 14) were on STRs at time of admission. The ID team was consulted for 50% (7 of 14) of the patients who experienced medication errors.

All-Cause Readmission Rates

Thirty-day all-cause readmission rates decreased significantly from 27% (16 of 60) to 12% (8 of 68) (RR, 0.44; 95% CI, 0.21–0.93; P = .03) after the implementation of the ARV stewardship and TOC program (Table 3). The primary admission diagnosis was the same as discharge diagnosis for the index admission in 69% (11 of 16) of readmissions in the preimplementation phase and 62% (5 of 8) of readmissions in the postimplementation phase (P = .59). In addition, HIV-related readmission rates decreased from 13% (2 of 16) to 0% (0 of 8) after the implementation of the program (P = .54). Ninety-day all-cause readmission rates also decreased from 24% (10 of 60) to 13% (8 of 68) (RR, 0.55; 95% CI, 0.24–1.24; P = 0.15) after the implementation of the program.

Intercepted Prescribing Errors

The HIV PharmD intercepted prescribing errors in 22% (15 of 68) of patients in the postimplementation phase. The types of prescribing errors included incorrect therapy (5 of 15 or 33%), incomplete therapy (4 of 15 or 27%), omitted OI therapy (2 of 15 or 13%), omitted ARV therapy (1 of 15 or 7%), wrong dose of ART (1 of 15 or 7%), duplicate ART (1 of 15 or 7%), and drug-drug interactions (1 of 15 or 7%). All of these orders were previously verified before they were intercepted by the HIV PharmD. Prescribing errors were documented by the HIV PharmD during the postimplementation phase. During retrospective chart review, it was not possible to evaluate whether an order was intercepted by a pharmacist in the preimplementation phase due to lack of documentation. Therefore, prescribing errors were only reported for the preimplementation portion of the study.

Medication Access at Hospital Discharge

During the postimplementation phase, the HIV PharmD ensured access to medications for 45% (30 of 67) of persons with HIV at time of discharge from UIH. Three of these patients were rapid start initiations and another was restarted on ART after being lost to follow up. The 37 patients for whom the HIV PharmD did not intervene reported already having an ART supply at home, did not have any medication changes during the inpatient stay, or the primary care team did not need additional assistance with discharge medications.

Linkage to Care

Linkage to care rates increased significantly from 78% (46 of 59) to 92% (61 of 66) after the implementation of the ARV stewardship and TOC program (RR, 1.19; 95% CI, 1.03–1.42; P = .02) (Table 3). The HIV PharmD coordinated clinic follow

Table 1. Demographics and Baseline Characteristics[a]

Parameter	Preimplementation (n = 60)	Postimplementation (n = 68)	*P* Value[b]
Age, years	47 (35–59)	49 (37–57)	*P* = .79
Female[c]	28 (47)	20 (29)	*P* = .04
Race			
Black	48 (80)	56 (82)	*P* = .73
White	1 (2)	5 (7)	*P* = .21
Hispanic	11 (18)	5 (7)	*P* = .06
Other	-	2 (3)	*P* = .50
CD4 count, cells/mm^3	366 (174–603)	346 (163–666)	*P* = .78
HIV RNA, copies/mL	0 (0–4039)	19 (0–11 351)	*P* = .24
HIV diagnosis on admission	3 (5)	3 (4)	*P* = .88
Primary Insurance			
Medicaid	24 (40)	39 (57)	*P* = .050
Medicare	20 (33)	17 (25)	*P* = .30
Private	11 (18)	9 (13)	*P* = .43
Uninsured	5 (8)	3 (4)	*P* = .47
Past Medical History			
Psychiatric Condition	20 (33)	29 (43)	*P* = .28
HTN	18 (30)	24 (35)	*P* = .52
Malignancy	12 (20)	20 (29)	*P* = .22
DM	12 (20)	8 (12)	*P* = .20
CKD	11 (18)	17 (25)	*P* = .36
COPD/ Asthma	8 (13)	12 (18)	*P* = .50
HF	4 (7)	5 (7)	*P* > .99
Transplant Recipient	3 (5)	1 (1)	*P* = .34
CD4 count <200 cells/ mm^3	17 (28)	22 (32)	*P* = .62
HIV RNA <20 copies/mL	37 (62)	35 (51)	*P* = .33
Current regimen STR	21 (35)	31 (46)	*P* = .22
ID consulted	24 (40)	35 (51)	*P* = .19
Transferred during stay	5 (8)	10 (15)	*P* = .26

Abbreviations: CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; HF, heart failure; HIV, human immunodeficiency virus; HTN, hypertension; ID, infectious diseases; OI, opportunistic infection; RNA, ribonucleic acid; STR, single-tablet regimen.

[a]Data are median (interquartile range) or n (%).

[b]Mann-Whitney, χ^2, or Fisher's exact test.

[c]Transgender patients were included and categorized based on gender they identified with at time of hospitalization.

up for 17% (11 of 66) of patients in the postimplementation phase, none of whom had appointments scheduled at time of hospital admission. Eighty-two percent (9 of 11) of these patients made it to their follow-up appointment within 6 months of discharge.

Table 2. Antiretroviral Therapy at Time of Admission[a]

Antiretroviral Therapy	Preimplementation (n = 60)	Postimplementation (n = 68)	*P* Value[b]
Mixed regimen	23 (38)	21 (31)	*P* = .46
2 NRTIs + INSTI	22 (37)	39 (57)	*P* = .02
2 NRTIs + NNRTI	6 (10)	2 (3)	*P* = .15
2 NRTIs + PI	4 (7)	2 (3)	*P* = .42
No ART on admission	5 (8)	4 (6)	*P* = .73

Abbreviations: ART, antiretroviral therapy; INSTI, integrase strand transfer inhibitor; NNRTI, nonnucleoside reverse-transcriptase inhibitor; NRTI, nucleoside reverse-transcriptase inhibitor; PI, protease inhibitor.

[a]Data are n (%).

[b]χ^2 or Fisher's exact test.

DISCUSSION

To the authors' knowledge, this is the first study to evaluate the impact of a combined ARV stewardship and TOC program on all-cause readmission rates, medication access at time of hospital discharge, and linkage to care rates for persons with HIV. This program was associated with significant reductions in 30-day all-cause readmission rates and significantly increased likelihood of linkage to HIV care. The HIV PharmD assisted with these improvements by ensuring patients had access to medications, follow up scheduled before discharge, and providing another point of contact within the healthcare system through follow-up phone calls after discharge.

This study reinforces the impact an HIV-trained clinical pharmacist can have on reducing inpatient medication error rates related to ART and OI medications. Previous studies have demonstrated the impact of pharmacist-led interventions on reductions in ART errors [2, 17–20, 27]. The value of a dedicated, multidisciplinary, ARV stewardship team has also proven benefit in reduction of inpatient ART medication error rates [7, 9, 17]. Although many studies evaluate the impact of ARV stewardship interventions on inpatient medication errors, this is the first study to evaluate the impact of combined TOC and ARV stewardship interventions on patient outcomes. Our approach is unique because outcomes included the impact of ARV stewardship and TOC interventions on linkage to care rates and readmission rates. Previous data highlight the importance of retaining persons with HIV into care to improve adherence to ART, maintain virologic suppression, reduce transmission of HIV in the community, and improve overall survival rates [28–31]. In addition, pharmacist-led TOC interventions have shown cost savings through a reduction in readmissions, although cost savings data specific to patients with HIV is still lacking [32, 33]. Unlike previous publications, the authors of this study also included all inpatient medication errors in the final analysis, even if they were made when the HIV PharmD was not actively reviewing patients [9]. Finally, this is the first study to evaluate the impact of an ARV stewardship program on

Table 3. Study Outcomes[a]

Outcome	Preimplementation (n = 60)	Postimplementation (n = 68)	RR (95% CI)	*P* Value[b]
Primary Outcomes				
Medication error rates	10 (17)	4 (6)	0.35 (0.12–1)	*P* = .051
Linkage to care rates[c]	46/59 (78)	61/66 (92)	1.19 (1.03–1.42)	*P* = .02
30-day all-cause readmission rates	16 (27)	8 (12)	0.44 (0.21–0.93)	*P* = .03
Secondary Outcomes				
90-day all-cause readmission rates	10 (24)	8 (13)	0.55 (0.24–1.24)	*P* = .15

Abbreviations: CI, confidence interval; RR, relative risk.

[a]Data are n (%).

[b]χ^2 or Fisher's exact test.

[c]Excluded patients who missed follow up due to readmissions or death.

intercepted prescribing errors, which likely would have led to medication errors had the ARV stewardship program not been in place.

We found that there was a numerical reduction in medication error rates related to both ART and OI medications after the implementation of an ARV stewardship and TOC program, decreasing from 17% to 6%. Although this was not statistically significant, the reduction in unnecessary harm was considered clinically significant by the authors (P = .051). The incidence of medication error rates related to ART and OI medications were much lower in the present study compared with what was previously reported at our institution (132 of 344 or 38%) [1]. This may be due to inpatient formulary changes beginning in January 2017 that included more STRs, an increase in clinical pharmacists of various specialties at UIH, a significant increase in percentage of patients on INSTI-based regimens, and/or limiting our study population to only those who followed up at UI for outpatient HIV care, who typically have physician notes and prescriptions available in the EMR for reference during admission when starting ART and/or OI medications. Our program was associated with a significant increase in resolution of medication errors made during inpatient stay (0% vs 100%, P = .001). In addition, in the postimplementation phase, the HIV PharmD intercepted prescribing errors in 22% (15 of 68) of persons with HIV admitted to UIH.

Strengths of this study include the unique study population of mostly Medicaid, Medicare, and uninsured black persons with HIV living in an urban area, who are vulnerable to be lost to follow-up and lack attainment of virologic suppression [34]. Insurance or lack thereof can make it difficult for patients to transition between inpatient and outpatient settings due to medication costs. Although Department of Health and Human Services guidelines recommend the use of 2 NRTIs plus an INSTI as initial therapy in most patients with HIV, approximately one third of our study population was on mixed, nontraditional regimens due to resistance, history of intolerance, or 2-drug regimens [10].

Limitations of our study include the retrospective design, resulting for some confounders and biases, such as interventions made by someone other than the HIV PharmD and leading to improved outcomes. In addition, readmission data did not include emergency room visits or admissions to outside hospitals. Our study was a quality improvement initiative to evaluative feasibility of an ARV stewardship and TOC program at UIH. Due to time constraints and study outcomes, data collection was limited to a short time frame and small population of persons with HIV. For example, the authors excluded all persons with HIV admitted to UIH who did not follow up with an outpatient UI clinic. The ARV stewardship and TOC program was not conducted on Saturdays and Sundays or after hours on weekdays (5:00 PM–7:00 AM), which was an additional limitation leading to medication errors being missed, yet subsequently resolved, by the HIV PharmD. Because medication errors made when the ARV stewardship and TOC program was not conducted (ie, on the weekend) were still included in the final analysis, the reduction in medication error rates may not have appeared as significant in this present study. Medication errors and intercepted prescribing errors were also not scored using a standardized scale, making it more difficult to generalize data. In addition, the HIV PharmD only documented within the chart if interventions were made on a patient, and they did not notify the primary care team when only a chart review was performed. In addition, Cerner alerts to HIV PharmD were triggered once ARV medications were started inpatient, which may have led to some patients being overlooked if ART was never started inpatient. Perhaps modifying the Cerner alert to include a diagnosis code could have improved the quality of our program. In addition, only index hospital admissions were analyzed to better identify postdischarge study outcomes, but this may have limited or biased data on medication error rates and/or interventions required by HIV PharmD during subsequent readmissions. Finally, the feasibility of utilizing this specific ARV stewardship and TOC program as a model for other institutions may be difficult due to the amount of labor and resources required from the HIV PharmD. In this present study, the HIV PharmD performed duties typically considered outside the scope of pharmacy (eg, insurance enrollment, ADAP

enrollment, and linkage to care interventions) in addition to clinical pharmacist interventions.

This is the first study to demonstrate the impact of a combined, pharmacist-driven, ARV stewardship and TOC program on outcomes in persons with HIV. We were able to demonstrate a statistically significant improvement in 30-day all-cause readmission rates and linkage to care rates for patients following up at UI outpatient clinics. Although not statistically significant, this program was also associated with a reduction in medication error rates related to ART and OI medications for inpatient persons with HIV admitted to our hospital. We hope our program outcomes can support other institutions that are interested in implementing a similar program to improve care in persons with HIV.

CONCLUSIONS

A pharmacist-led ARV stewardship and TOC program improved overall care of persons with HIV through reduction in medication error rates, reduction in all-cause readmission rates, and an improvement in linkage to care rates.

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Potential conflicts of interest. All authors: no reported conflicts of interest. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest.

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