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Illness Perceptions, Medication Beliefs, and Adherence to Antiretrovirals and Medications for Comorbidities in Adults with HIV Infection and Hypertension or Chronic Kidney Disease

Jeffrey J. Weiss¹, Ioannis Konstantinidis¹, Anna Boueilh², Daniel S. Fierer¹, Donald Gardenier¹, Mark G. Barber³, Tony Kang⁴, Anna Kress⁵, Katherine Ericson⁶, Marlene C. Lira⁷, Marina P. Yostos⁸, Hillary R. Bogner, MD⁹, Juan P. Wisnivesky¹, and Christina M. Wyatt¹

¹Department of Medicine, Icahn School of Medicine at Mount Sinai ²Department of Nephrology-Transplantation-Dialysis, Pellegrin Hospital, Bordeaux, France ³University of Connecticut School of Medicine ⁴Sidney Kimmel Medical College at Thomas Jefferson University ⁵Columbia University College of Physicians and Surgeons ⁶SUNY Downstate College of Medicine ⁷Clinical Addiction Research and Education (CARE) Unit, General Internal Medicine, Medicine, Boston Medical Center ⁸Royal College of Surgeons in Ireland ⁹Perelman School of Medicine

Abstract

Background—Mortality in patients with HIV infection is increasingly due to comorbid medical conditions. Research on how adherence to medications for comorbidities relates to antiretroviral (ARV) medication adherence and how interrelations between illness perceptions and medication beliefs about HIV and comorbidities affect medication adherence is needed to inform adherence interventions.

Methods—HIV-infected adults with hypertension (n=151) or chronic kidney disease (CKD; n=41) were recruited from ambulatory practices at an academic medical center. Illness perceptions and medication beliefs about HIV and hypertension or CKD were assessed and adherence to one ARV medication and one medication for either hypertension or CKD was electronically monitored for ten weeks.

Results—Rates of taking, dosing, and timing adherence to ARV medication did not differ from adherence to medication for hypertension or CKD, with the exception that patients were more adherent to the timing of their ARV (78%) than to the timing of their anti-hypertensive (68%;p=0.01]. Patients viewed HIV as better understood, more chronic, having more negative consequences, and eliciting more emotions, compared to hypertension. Patients viewed ARVs as more necessary than medication for hypertension or CKD. Having a realistic view of the efficacy

Corresponding Author: Jeffrey J. Weiss, PhD, MS, Icahn School of Medicine at Mount Sinai, One Gustave L. Levy Place, Box 1087, New York, New York 10029. Tel. +1-212-824-7575; Fax +1-212-824-2317; Jeffrey.Weiss@mountsinai.org.

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of ARVs ($r=-0.20$; $p<0.05$) and a high level of perceived HIV understanding ($r=0.21$; $p<0.05$) correlated with better ARV adherence.

Conclusions—HIV patients showed similar rates of adherence to ARVs as to medications for comorbidities, despite perceiving HIV as more threatening and ARVs as more important. This can be used in adapting existing interventions for ARV adherence to encompass adherence to medications for comorbid conditions.

Keywords

medication adherence; antiretrovirals; illness perceptions; medication beliefs; hypertension; chronic kidney disease

INTRODUCTION

Due to the advent of highly effective antiretroviral (ARV) therapy, HIV has been transformed into a chronic and manageable illness. Consequently, morbidity and mortality among persons living with HIV are increasingly due to the many co-occurring medical conditions and non-infectious complications.¹ However, most prior studies of adherence in persons with HIV have focused on ARV adherence and have not investigated adherence to treatment for comorbid chronic medical conditions.

Hypertension (HTN) is among the three most prevalent medical comorbidities in HIV-infected individuals, with prevalence rates of 20-43%.²⁻⁸ Hypertension increases the risk for cardiovascular, cerebrovascular, and kidney disease. In a sample of over 33,000 HIV-infected veterans, HTN was the only medical comorbidity associated with higher CD4 lymphocyte count (CD4), leading the authors to hypothesize that long term ARV therapy may promote HTN.³ This effect of ARVs on blood pressure may be mediated through an increase in BMI.⁹

Chronic kidney disease (CKD) is another important comorbidity, which may be secondary to HIV infection, HIV treatment, or traditional CKD risk factors including HTN.¹⁰ The estimated prevalence of CKD among HIV-infected persons varies substantially among studies, depending on region, population, study design, and the definition of CKD used.¹⁰ In the HIV clinical setting in which the current study was conducted, the prevalence of CKD was previously reported to be between 11-15%.^{5,11} CKD is associated with poorer health outcomes in those with HIV infection, including increased rates of heart failure, cardiovascular disease, end-stage renal disease, and mortality.^{12,13}

HIV-infected patients have been shown to have suboptimal levels of awareness of their diagnosed comorbid medical conditions including hypertension and CKD.^{5,6} Hypertension and CKD are commonly treated with medications, and patient adherence to the prescribed medication strongly predicts disease control in both conditions.^{14,15}

Turner and colleagues found that primary care providers were less likely to intensify treatment for uncontrolled hypertension in patients with a greater number of comorbid medical conditions,¹⁶ demonstrating that increasing medical comorbidities are not only a challenge for patient but also for medical providers. Medication adherence research across

multiple conditions has established that medication adherence is a rational behavior based on patient beliefs about their illness and prognosis.¹⁷ Consequently, patients taking medications for comorbid chronic illnesses may be differentially adherent to medications because they hold discordant beliefs about medications and the illnesses they treat. In contrast to this, in a sample of 361 urban HIV-infected patients, Monroe and colleagues found that poor HIV control correlated with poor control of hypertension and diabetes, possibly reflecting poor adherence across medication classes.¹⁸

To date, four studies have reported quantitative data on patient adherence to ARVs and concomitant medications for the treatment of chronic comorbid conditions. Wagner and colleagues¹⁹ reported that in a cohort of HIV-infected individuals suffering from mental illness, self-reported adherence to psychiatric medication was moderately correlated with self-reported and electronically monitored ARV adherence. Fumaz and colleagues²⁰ reported differences in the levels of self-reported adherence to ARVs and medication for Hepatitis C virus (HCV) co-infection during a 48 week course of HCV treatment, with higher adherence to HCV medications. Batchelder, Gonzalez and Berg²¹ examined self-reported medication adherence and illness beliefs in patients with comorbid HIV and type 2 diabetes using the same theoretical framework as that used in the current study. They found that adherence was related to patient beliefs, and that adherence was higher to ARVs than to diabetes medications. Langness and colleagues used pharmacy refill data to examine adherence rates for ARV and either anti-hypertensive or psychiatric medication in a large sample of 865 persons with HIV infection.²² They found that adherence to ARVs was better than adherence to both anti-hypertensive and psychiatric medication.

Given the paucity of research in this area, we examined the relationships of patient illness perceptions and medication beliefs with electronically monitored adherence to ARVs and medications for comorbid HTN or CKD.

METHODS

Participants

HIV-infected adults with HTN and/or CKD were recruited from ambulatory practices affiliated with a single academic medical center in New York City. All study and consent procedures were reviewed and approved by the Institutional Review board at Icahn School of Medicine at Mount Sinai, and all study participants provided written informed consent. Subjects were evaluated at study baseline, at which time they were given the electronic monitoring devices. Subjects were seen for one follow-up interview ten weeks later.

Two cohorts of participants were enrolled consecutively. All participants were age 21 years or older and were currently prescribed ARV therapy and at least one medication for the management of HTN or CKD, with no anticipated changes in therapy within the three months after enrollment. Because of the adherence burden associated with short-term HCV therapy, patients currently receiving or expected to begin treatment for HCV co-infection within the following three months were excluded. For similar reasons, patients currently on dialysis were excluded from the HIV and HTN cohort. Because the standardized study instruments were administered by two separate teams of trained research staff, study

eligibility was restricted to English-speaking (both cohorts) or Spanish-speaking individuals (HIV and HTN cohort only). Participants with concerns about electronic monitoring of adherence were excluded from the HIV and HTN study.

HIV and HTN Cohort—Participants with HIV and HTN were recruited from three clinical practices providing HIV primary care to >2500 patients (see Figure 1a). Data were collected between February 2011 and November 2012. HTN was defined as a documented diagnosis of HTN in the electronic medical record. Eligible participants were currently prescribed at least one antihypertensive medication.

HIV and CKD Cohort—Participants were recruited from three clinical practices, including one of the HIV primary care practices described above, a nephrology clinic, and an outpatient hemodialysis unit (see Figure 1b). Data were collected between September 2013 and August 2014. CKD was defined as estimated glomerular filtration rate [eGFR] < 60mL/min/1.73m² (as calculated by the Modification of Diet in Renal Disease equation) or the presence of albuminuria or proteinuria (defined as urine albumin-to-creatinine ratio 30 mg/g or greater or urine protein-to-creatinine ratio 200 mg/g or greater), persisting for >3 months, or end-stage renal disease (ESRD) on dialysis. Eligible participants were currently prescribed medications to delay CKD progression or manage CKD complications. Patients with concerns about electronic monitoring of adherence were eligible to participate in the baseline interview. This change in eligibility criteria reflects lessons learned during the HIV and HTN study and was aimed at maximizing.

Measures

Illness Perceptions and Medication Beliefs—The guiding theoretical framework for this study is Leventhal's Common Sense Model, which posits that patients' management of chronic illness is directly related to how they perceive aspects of the illness, both from a cognitive and emotional perspective.²³⁻²⁵ Horne has expanded upon this disease management model to include the patient's view of medications used to treat the illness.²⁵

At baseline, participants in each cohort completed the Illness Perception Questionnaire-Revised (IPQ-R) and the Beliefs about Medicines Questionnaire (BMQ) for HIV and either HTN or CKD. Both tools have been validated in multiple chronic illness populations and have shown good validity and reliability.^{25,26} The IPQ-R measures illness perceptions along discrete domains: (1) "Control/cure" involves the perception that either treatment or one's own behavior can influence the course of the illness; (2) "Timeline" is the perceived course of the illness (chronic or cyclical); (3) "Consequences" reflect the perceived outcome of having the illness; (4) "Identity" refers to the labeling of an illness in terms of symptoms the patient believes are caused by this illness or by its treatment; (5) "Emotional Representations" are the patient's affective responses to the illness; and (6) "Illness Coherence" is the degree to which the patient believes that he or she understands the illness. The BMQ was used to assess patients' beliefs about medications along two domains 1) "Necessity" (patient beliefs about the need for medications) and 2) "Concerns" (patient concerns about the potential adverse effects of medications). Participants were asked these questions specifically about ARV medications and about medications used to treat HTN or

CKD. To avoid bias, we alternated the order of question administration of the IPQ-R and BMQ for HIV and HTN or CKD.

Questions in the IPQ-R and BMQ are scored on a 5-point Likert scale with higher scores reflecting greater degree of agreement or stronger beliefs. Scores for each domain are calculated as the mean of the scores for questions relevant to that domain. Additionally, a necessity-concern differential is calculated from the BMQ results by subtracting the concerns score from the necessity score.

Medication Adherence—Medication adherence was measured using the Medication Event Monitoring System (MEMS™ AARDEX Group Ltd) caps over a ten-week period. A single medication in each category (ARV and HTN or CKD) was selected for electronic monitoring. In the HIV and HTN cohort, the highest dosing frequency possible was chosen so that the dosing frequency for both the ARV and HTN medication were the same. If not possible to match the ARV and HTN dosing frequency (for example if there was a twice daily ARV and only a once daily HTN medication), then the highest frequency for each one was used. When there were multiple ARV or HTN medications at a given dosing frequency, the medication to be monitored was chosen by a random number generator. In contrast, in the HIV and CKD cohort, the CKD medication to be monitored was chosen according to the following prioritization 1) Medications targeting underlying causes of CKD; 2) Medications targeting complications of CKD; 3) Angiotensin converting enzyme (ACE) inhibitor or angiotensin receptor blocker (ARB); 4) Anti-diabetic medications; 5) Other antihypertensive medications. An ARV medication that had the same dosing frequency as the chosen CKD medication was then selected. The same procedures as described above were used to handle multiple medication choices and to match dosing frequencies.

MEMS™ caps employ a pressure-activated microprocessor in the cap of the medication bottle that records the date, time, and duration of the bottle's opening. Although there is no 'gold-standard' for assessing adherence, MEMS™ caps have emerged as the most valid and sensitive measure and have been cross-validated in multiple studies comparing self-report, assay pill count, and collateral report.^{27,28} Metrics for summarizing MEMS™ adherence data include "Taking Adherence" [(number of device activations during a certain period divided by number of tablets prescribed during the same period) × 100], interpreted as the percentage of pills taken as prescribed over a specified time period; "Dosing Adherence" [(number of days with the correct number of device activations based on the prescribed regimen divided by the number of days during the same period) × 100], which reflects the percentage of days on which doses are taken correctly; and "Timing Adherence" [(number of device activations at 24±6 h for once-daily, 12±3 h for twice-daily, 8±2 for thrice-daily, or 6±1.5 h for four-times-daily medication regimens during a certain period divided by the number of days during the same period) × 100], reflecting the percentage of doses taken at the correct inter-dose intervals. "Therapeutic Coverage" was defined as the percentage of time the patient has drug coverage based on the dose events recorded and the time window set based on dosing frequency for drug duration of action. PowerView software (Version 3.5.2; AARDEX, Inc.) was used to retrieve data from MEMS™ caps and to calculate these metrics. The MEMS™ adherence data were censored in line with recommended guidelines.²⁹

While virologic suppression is possible with less than 95% adherence to ARV therapy, adherence below that level has been associated with increased viral replication, development of drug-resistance, and adverse medical outcomes.^{30,31} Thus, consistent with prior research, a minimum of 95% adherence remains the clinical goal for HIV therapy.³² Taking medication correctly at least 80% of the time has been the most commonly used definition of medication adherence in the general chronic disease management adherence literature.³³ Thus, participants were categorized as adherent to HIV and HTN or CKD medications based on the 95% and 80% taking adherence thresholds, respectively.

Illness Control—The relationship between electronically monitored adherence and illness control was examined in the HIV and HTN cohort. HIV virologic control was defined as having two consecutive measurements of HIV viral load <48 copies/ml. Blood pressure control was defined as having blood pressure at the baseline interview of <140 mmHg systolic and <90 mmHg diastolic (based on the average of two measurements).

Statistical Analysis

Demographic data are presented as proportions and means [standard deviations (SD)], while data on illness perceptions and medications beliefs are presented as medians [interquartile ranges (IQR)]. Taking adherence was analyzed as both a dichotomous and a continuous variable. Categorical variables (sex, race, virologic control, blood pressure control, GFR category) were examined using chi-squared tests and continuous variables (age, CD4, eGFR) were examined using t-tests and ANOVA to compare subgroups within each study cohort. The associations between adherence for HIV and HTN or CKD; between illness perceptions and medications beliefs for each condition; and between adherence measures and illness perceptions and medications beliefs for each condition, were measured by Spearman's correlation coefficient. The differences between these variables were tested with the Wilcoxon signed rank sum. The associations between taking adherence and illness control were tested with the Mann-Whitney test. All data analyses were conducted using SPSS version 21. A p-value <0.05 was considered statistically significant.

RESULTS

Baseline Demographic Characteristics

Participant enrollment in the two cohorts is presented in Figures 1a and 1b. Demographic and clinical characteristics for cohort participants who completed the baseline interview are presented in Table 1. Participants in both cohorts had mean age of 54 (9) years, were mostly male (57% and 59%), and were predominantly black or Hispanic (90% and 92%). In the HIV and HTN cohort, 68% of participants had virologic control and 63% had blood pressure control at baseline; whereas in the HIV and CKD cohort, 88% of participants had HIV virologic control but only 46% had blood pressure control at baseline. Participants in both cohorts had mean CD4 close to 600 cells/mm³.

Participants who completed both the baseline and follow-up study visits in the HIV and HTN cohort (n=102) were significantly more likely to have HIV virologic control at baseline as compared to participants who did not complete both study visits (n=47; 93.1% vs. 78.7%,

p=0.023; see Supplemental Table 1), but the groups did not differ on other baseline demographic or clinical characteristics. In the HIV and CKD cohort, there were no significant differences in baseline characteristics among participants who completed both study visits in the MEMS™ group (n=20), participants who were enrolled in the non-MEMS™ group and who completed the baseline interview (n=15), and participants who did not adhere fully to the study protocol (n=6; see Supplemental Table 2).

Illness Perceptions and Medications Beliefs: HIV and HTN Cohort

Participants in the HIV and HTN cohort attributed greater chronicity to their HIV illness ($z=-4.7$; $p<0.01$) and considered HTN to have a more cyclical nature ($z=-3.6$; $p<0.01$). HIV evoked stronger emotional responses ($z=-5.1$; $p<0.01$), was perceived to be better understood ($z=-4.1$; $p<0.01$), and was viewed as having greater negative consequences than HTN ($z=-6.3$; $p<0.01$). Participants attributed more symptoms to their HIV illness and its medications than to HTN ($z=-5.2$; $p<0.01$) and its medications ($z=-5.7$; $p<0.01$); they were more concerned about the potential adverse effects of HIV medications than of HTN medications ($z=-4.1$; $p<0.01$), but also expressed a stronger belief in the necessity of HIV medications than of HTN medications ($z=-7.2$; $p<0.01$). There were no differences in participants' perceptions of having personal control over HIV and HTN, or of the illnesses being controllable by treatment (Table 2).

Illness Perceptions and Medications Beliefs: HIV and CKD Cohort

Participants attributed more symptoms to their HIV medications than to their CKD medications ($z=-3.0$; $p<0.01$) and expressed stronger belief in the necessity of medications for HIV than for CKD ($z=-2.6$; $p<0.01$). Illness perceptions and medication beliefs did not differ significantly for other domains in the HIV and CKD cohort (Table 2).

Electronically Monitored Adherence

Of the 102 participants in the HIV and HTN cohort with electronic monitoring data, 92 were monitored for a once daily ARV medication and 10 for a twice daily ARV medication; 96 were monitored for once daily anti-hypertensive medication and 6 for twice daily anti-hypertensive medication. Based on the established thresholds for taking adherence of 95% and 80% for HIV and HTN medications, respectively, 61% of HIV and HTN cohort participants were adherent to HIV medications and 80% were adherent to HTN medications ($p=0.22$); for comparison, 82% of participants met the 80% threshold for HIV medications and 57% met the 95% threshold for HTN medications. While this difference was not statistically significant, the 19% difference in meeting the adherence cutoff for HTN medications as compared to HIV medications may be considered by some to be clinically significant.

Among the 20 participants in the HIV and CKD cohort who completed the MEMS™ portion of the study, eighteen had once daily and two had twice daily ARV medication monitored. Eighteen participants had once daily CKD medication monitored, one twice daily, and one three times daily. In 17 of the 20 participants, the CKD medication selected for electronic monitoring was an ACE inhibitor, angiotensin receptor blocker, or other antihypertensive agent. Based on conventional thresholds used in the literature, taking adherence of ARV and

CKD medication did not differ significantly, with 65% and 80% of participants adherent to HIV (95% threshold) and CKD (80% threshold) medications, respectively ($p=0.23$). For comparison, 75% of participants reported at least 80% adherence to HIV medications and 60% reported 95% adherence to CKD medications.

Participants in the HIV and HTN cohort had greater timing adherence for HIV than HTN medications (78.3% vs. 68.1%, $p=0.01$; Table 3). There were no statistically significant differences for dosing adherence or therapeutic coverage in either cohort, and no difference in timing adherence in the HIV and CKD cohort (Table 3). All 4 adherence metrics were strongly correlated between ARVs and medications for HTN or CKD (all correlation coefficients >0.8 , all $p<0.01$; Table 3).

Relationship between Electronically Monitored Adherence and Illness Perceptions/ Medications Beliefs

In the HIV and HTN cohort, perceiving HIV as less controllable by treatment and having a better perceived understanding of HIV were correlated with better taking adherence to HIV medications ($r=-0.198$, $p=0.046$ and $r=0.207$, $p=0.036$, respectively). No significant correlations were found between the other illness perception domains or participants' beliefs about HIV medications and their adherence to HIV medications, or between participants' perceptions of HTN and HTN medications and adherence to HTN medications (all p values >0.05). In the HIV and CKD cohort, there was no apparent relationship between participants' illness perceptions/ medication beliefs and adherence to medications for HIV or CKD (all p values >0.05). The high levels of adherence in these samples may have limited the identification of relationships between illness perceptions/medication beliefs and adherence that may be identified in sample with more variability in adherence levels.

Relationship between HIV and HTN illness control at follow-up

The relationship between HIV and HTN illness control was evaluated at ten-week follow-up. Virologic control was achieved by 88% (90/102) of participants and blood pressure was controlled in 60% (61/102) of participants. Blood pressure control and HIV control at follow-up were not correlated [$\chi^2(1, N=104)=0.597, p=0.76$].

Discussion

Using electronic monitoring of medication adherence for a ten week period, we did not find significant differences in participants' adherence to their HIV medications and to their medications for a comorbid condition, with the exception that ARV timing adherence was significantly higher than antihypertensive timing adherence. Participants' adherence to their HIV medication was highly correlated to their adherence to their medication for comorbid HTN or CKD for all adherence metrics assessed.

Overall, participants in this study demonstrated very high levels of adherence, with median dosing adherence levels to HIV, HTN and CKD medications all being above 90%. Participants in the HIV and HTN cohort who did not complete study visits were more likely to have detectable HIV viral load at baseline (greater than 48 copies/ml), suggesting that the requirements of study participation may have biased the sample with medication adherence

data towards a more adherent patient population (see Supplemental Table 1). As a result of this bias in the sample who completed the study, the longitudinal findings of this study may not be generalizable to those who have poor adherence.

The results of the four other studies that have examined ARV adherence and adherence to another comorbid condition,¹⁹⁻²² have been inconsistent, with two studies finding higher rates of adherence to ARVs than to medications for a comorbid condition,^{21,22} one finding similar rates,¹⁹ and one finding lower rates of adherence to ARVs.²⁰ The current study reports on a sample with higher ARV adherence rates than these prior studies, and the findings can be interpreted to indicate that in a sample of highly adherent HIV-positive patients, the adherence behavior mastered for HIV may be transferred to self-management of other comorbid conditions, while the impact of illness perceptions and medication beliefs may be less relevant to determining adherence in this population.

The finding that perceiving HIV as less controllable by treatment is correlated with better ARV adherence appears counterintuitive. One of the four questions making up the IPQ-R treatment control scale is “My treatment will be effective in curing my HIV infection.” Those who strongly endorsed this item and had the highest levels of perceived HIV treatment control may have an overly optimistic, unrealistic view of the power of HIV medications to control the illness, and less appreciation of the importance of their own behavior. This suggests that HIV adherence education should continue to emphasize the ability of HIV medications to successfully suppress the HIV virus (as oppose to cure HIV) and the essential role for the patient in optimally adhering to medication. Our findings also suggest that patients have successfully integrated the importance of timing adherence specifically in relation to their HIV medications.

Participants hold very different views of HIV than of HTN and similarly of ARVs than of anti-hypertensives; we observed significant differences in all domains of illness perceptions and medication beliefs measured, with the exception of treatment control and personal control. While these findings were not as clearly demonstrated in the HIV and CKD sample, this may have been due to the relatively small sample size in this cohort and the fact that the cohort included a broad spectrum of CKD severity. Larger studies are needed to evaluate differential illness perceptions and medication adherence in patients with more advanced CKD.

Conclusions

Whereas HIV illness control is very tightly related to ARV adherence, illness control in hypertension and in CKD is more likely to be influenced by additional behavioral (e.g., diet and physical activity) and medical factors, making it challenging for providers to know how much to attribute to poor medication adherence when faced with poor control of HTN or CKD in their HIV patients. The similar rates of adherence to ARVs and adherence to comorbid conditions found in this study suggest that the determinants of adherence to each class of medications do not differ widely within patients. It appears that the strategies HIV patients develop to adhere to their ARVs are in turn applied to medications for their comorbid medical conditions. It seems likely that HIV providers can use the patient’s ARV

adherence as a surrogate marker of adherence to their HTN or CKD medications in patients with high levels of adherence.

This is the largest study to date examining medication adherence to ARVs and to medications for a comorbid medical condition in patients with HIV infection using electronic adherence monitoring. Future research in this area may be most informative by focusing on the patients who are nonadherent to their ARVs and/or to medications for their comorbid medical conditions. This is an inherently challenging population to retain in research studies and innovative strategies will be needed in order to successfully do so.³⁵

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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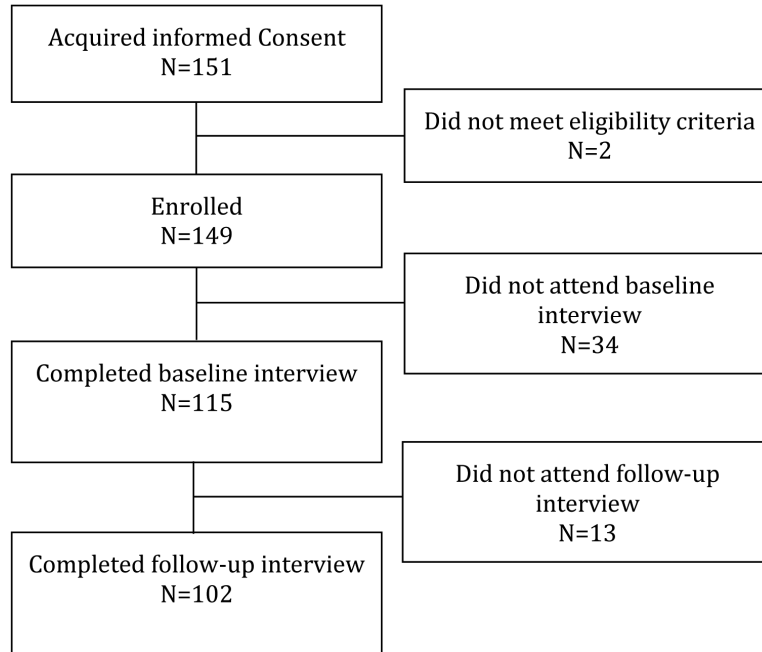
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1a. HIV and HTN Cohort



1b. HIV and CKD Cohort

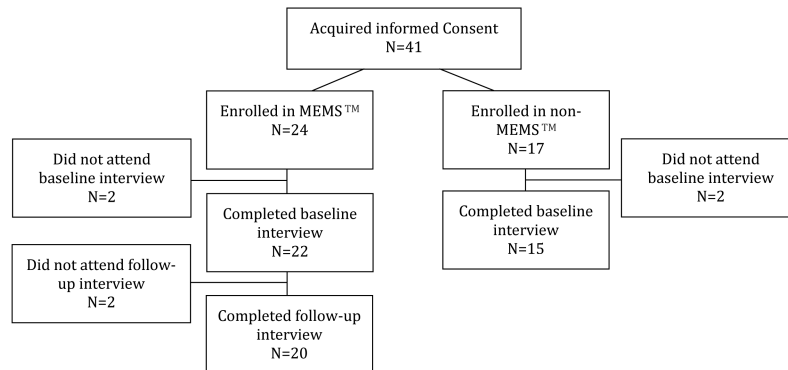


Figure 1.
Flowchart for Study Participation

Table 1

Baseline Demographic and Clinical Characteristics

	HIV and HTN Cohort (n=115)	HIV and CKD Cohort (n=37)
Age – mean years (SD)	53.5 (8.5)	54.4 (9.2)
Sex - male	68 (59.1%)	21 (56.8%)
Race –		
black / not Hispanic	66 (57.4%)	25 (67.6%)
Hispanic	37 (32.2%)	9 (24.3%)
white	12 (10.4%)	1 (2.7%)
Asian	0	1 (2.7%)
Other	0	1 (2.7%)
HIV viral load undetectable (<48 copies/ml)	78 (67.8%)	28 (87.5%)*
CD4+ cells/mm ³ - mean (SD)	602.3 (277.8)	588.6 (263.4)
Well-controlled blood pressure	72 (62.6%)	17 (45.9%)
eGFR		
60 mL/min/1.73m ²	83 (72.2%)	3 (8.1%)
30-59 mL/min/1.73m ²	28 (24.3%)	21 (56.8%)
15-29 mL/min/1.73m ²	4 (3.5%)	4 (10.8%)
<15 mL/min/1.73m ² or dialysis	Not eligible	9 (24.3%)

HTN = hypertension

CKD = chronic kidney disease

GFR= glomerular filtration rate

* Data missing on 5 subjects with end-stage renal disease

Table 2

Illness Perceptions and Medication Beliefs

Scale	HIV and HTN Cohort (n=115)					HIV and CKD Cohort (n=37)					
	HIV_M (IQR)	HTN_M (IQR)	Correlation Coefficient	p-value	Z score	p-value	Correlation Coefficient	CKD_M (IQR)	HIV_M (IQR)	Z score	p-value
Treatment Control	3.8 (0.5)	4.0 (0.5)	0.26	0.01	-2.6	0.10	0.21	3.5 (0.8)	3.5 (0.8)	-0.63	0.53
Personal Control	4.0 (0.7)	4.0 (1.0)	0.53	0.000	-0.06	0.94	0.12	3.8 (0.7)	4.0 (0.7)	-1.90	0.057
Timeline – Chronic	3.3 (1.3)	2.7 (1.3)	0.36	0.000	-4.7	<0.01	0.015	2.7 (1.3)	3.2 (1.3)	-0.44	0.66
Timeline – Cyclical	3.0 (1.5)	3.5 (1.5)	0.35	0.000	-3.6	<0.01	0.013	3.0 (1.4)	3.0 (1.4)	-0.08	0.94
Consequences	3.3 (1.0)	2.8 (0.8)	0.31	0.001	-6.3	<0.01	0.019	3.0 (0.9)	3.3 (0.9)	-1.62	0.11
Illness Identity	2.0 (6.0)	0.0 (2.0)	0.50	0.000	-5.2	<0.01	0.000	0.5 (3.0)	0.5 (3.0)	-1.10	0.27
Medication Identity	1.0 (4.0)	0.0 (0.0)	0.42	0.000	-5.7	<0.01	0.000	0.0 (0.0)	1.0 (3.8)	-3.00	<0.01
Emotional Representations	2.8 (1.4)	2.0 (0.8)	0.37	0.000	-5.1	<0.01	0.008	2.5 (1.0)	2.4 (1.6)	-1.03	0.30
Illness Coherence	4.0 (0.5)	4.0 (1.0)	0.47	0.000	-4.1	<0.01	0.27	3.8 (1.5)	4.0 (1.3)	-1.63	0.10
Medication Necessity	4.0 (0.8)	3.6 (0.9)	0.46	0.000	-7.2	<0.01	0.07	3.9 (0.6)	4.0 (0.8)	-2.62	<0.01
Medication Concerns	2.4 (0.7)	2.2 (0.5)	0.63	0.000	-4.1	<0.01	0.17	2.4 (0.6)	2.6 (0.7)	-1.82	0.069
Necessity-Concerns Differential	1.7 (1.0)	1.3 (1.0)	0.57	0.000	-4.5	<0.01	0.038	1.3 (0.7)	1.4 (1.1)	-0.66	0.51

IQR = Interquartile Range; HTN = hypertension; CKD = chronic kidney disease

Table 3

Electronically Monitored Adherence Data

Adherence Measure, Median (IQR)	HIV and HTN Cohort (n=102)					HIV and CKD Cohort (n=20)						
	HIV med	HTN med	Correlation Coefficient	p-value	Z score	p-value	HIV med	CKD med	Correlation Coefficient	p-value	Z score	p-value
Taking Adherence	97.1 (11.8)	97.1 (15.7)	0.80	<0.01	-1.2	0.22	97.9 (17.3)	96.4 (8.6)	0.90	<0.01	-1.2	0.23
Dosing Adherence	92.9 (19.0)	92.9 (20.0)	0.81	<0.01	-1.5	0.15	92.9 (32.2)	92.9 (26.1)	0.88	<0.01	-0.1	0.94
Timing Adherence	78.3 (40.7)	68.1 (40.7)	0.84	<0.01	-2.6	0.01	87.7 (33.3)	86.3 (50.9)	0.83	<0.01	-0.1	0.91
Therapeutic Coverage	97.2 (9.7)	95.8 (11.9)	0.82	<0.01	-1.3	0.18	98.0 (9.0)	97.4 (6.0)	0.85	<0.01	-1.0	0.30

IQR = Interquartile Range; HTN = hypertension; CKD = chronic kidney disease