

Come as You Are: Improving Care Engagement and Viral Load Suppression Among HIV Care Coordination Clients with Lower Mental Health Functioning, Unstable Housing, and Hard Drug Use

Mary K. Irvine¹ · Stephanie A. Chamberlin¹ · Rebekkah S. Robbins¹ · Sarah G. Kulkarni^{2,3} · McKaylee M. Robertson² · Denis Nash^{2,3}

Published online: 24 June 2016
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Abstract Lower mental health functioning, unstable housing, and drug use can complicate HIV clinical management. Merging programmatic and surveillance data, we examined characteristics and outcomes for HIV Care Coordination clients enrolled between December 2009 and March 2013. For clients diagnosed over 12 months before enrollment, we calculated post- versus pre-enrollment relative risks for short-term (12-month) care engagement and viral suppression. Both outcomes significantly improved in all subgroups, including those with lower mental health functioning, unstable housing, or hard drug use. Analyses further stratified within barrier-affected groups showed a tendency toward greater improvement when that barrier was reduced during the follow-up year.

Resumen Un nivel más bajo de salud mental, el alojamiento inestable y el uso de drogas pueden complicar el manejo clínico del VIH. Combinamos datos programáticos

y de vigilancia para examinar características y resultados de clientes del programa de Coordinación de Cuidado del VIH inscritos entre Diciembre del 2009 y Marzo del 2013. Para los clientes que fueron diagnosticados al menos doce meses antes de la inscripción, calculamos el riesgo relativo del compromiso con los cuidados y la supresión viral a corto plazo (12 meses) antes y después de la inscripción. Ambos resultados mejoraron significativamente en todos los subgrupos, incluyendo a los de nivel más bajo de salud mental, con alojamiento inestable o que usan drogas duras. Análisis adicionales estratificados entre los grupos afectados por obstáculos demostraron una tendencia hacia una mayor mejora cuando ese obstáculo fue reducido durante el siguiente año.

Keywords HIV surveillance · Viral load · Case management · Outcomes research · Psychosocial factors

Palabras Clave Vigilancia de VIH · Carga viral · Manejo de casos · Investigación de resultados · Factores psicosociales

Preliminary results on related subgroup analyses were presented in a poster (#305573) at the mid-November 2014 APHA conference in New Orleans, LA; a more refined, updated version was presented orally (#109) on June 29, 2015, at the conference of the International Association of Providers of AIDS Care in Miami, FL.

✉ Stephanie A. Chamberlin
stephanne.nyc@gmail.com

¹ The Bureau of HIV/AIDS Prevention and Control, New York City Department of Health and Mental Hygiene, 42-09 28th Street, Queens, New York, NY 11101-4132, USA

² Graduate School of Public Health and Health Policy, The City University of New York, 55 West 125th Street, New York 10027, NY, USA

³ Institute for Implementation Science in Population Health, The City University of New York, 55 West 125th Street, New York 10027, NY, USA

Introduction

Gaps in HIV care engagement and antiretroviral treatment (ART) adherence impede national progress toward the goal of ending the HIV epidemic. Optimal HIV care continuum outcomes have been particularly difficult to achieve for individuals experiencing psychosocial barriers such as unstable housing, lower mental health functioning, and/or drug use [1–5]. In a recent randomized controlled trial, clients with these issues showed no significant response to an enhanced-personal-contact intervention that, in contrast, demonstrated effectiveness at increasing HIV care

engagement in the broader study population [6]. As care and treatment engagement are facilitated in the general HIV population through a combination of sound, scalable interventions and simplified, well-tolerated, effective ART regimens, focused research and tailored strategies among individuals with complex psychosocial needs become increasingly important to prevent widening disparities in the HIV care continuum. In the published literature, case management stands out as an approach meriting further investigation for its potential to improve HIV care and treatment outcomes in both broader populations and specific vulnerable subgroups [1, 3–5].

We report with an update to a large-scale, multi-site observational effectiveness study of the medical case management intervention launched in late 2009 as the New York City (NYC) Ryan White Part A Care Coordination Program (CCP), for which an earlier cohort of clients showed significant outcome improvements in an intent-to-treat pre-post analysis [7]. While that prior study offered initial evidence of program benefits among individuals with known risk for and/or recent history of suboptimal HIV care outcomes, it did not examine outcomes according to drug use behaviors, mental health-related needs, or an inclusive measure of housing instability, and it represented only those enrolled in the first 16 months of program implementation ($N = 3641$). The current report utilizes standardized, CCP provider-administered assessments of drug use, mental health issues, and housing instability to stratify outcomes by baseline presence or absence of these three potential psychosocial barriers, and then by post-enrollment reduction or persistence of the potential barriers identified at baseline, among clients enrolled during the first 40 months of CCP implementation ($N = 7058$).

Methods

Intervention Model

The CCP is a Ryan White Part A-funded medical case management program that was locally (in NYC) specified as a ‘medical home’ model for building HIV care continuum engagement among individuals newly diagnosed with HIV and individuals with documented lapses in or barriers to HIV care and treatment. The CCP supportive services team shares information and responsibility for clients’ care with the primary medical care provider, working within the same hospital, clinic or community-based organization, or working across medical and social services agencies participating in a formalized partnership under a single CCP contract with the NYC health department. Program components include: (1) outreach for initial case finding and after any missed appointment; (2) case management

services, such as social services and benefits eligibility assessment and linkages; (3) multidisciplinary care team communication and decision-making via case conferences; (4) patient navigation, including appointment reminders, assistance with scheduling appointments, transportation resources, and accompaniment to primary care; (5) ART adherence support, including directly observed therapy for individuals with greatest need; and (6) a structured health promotion curriculum. The CCP offers enrollment “tracks” of differing intensity, allowing for daily (directly observed therapy), weekly, monthly, or quarterly contact with supportive services staff, according to client need. A profile of the CCP can be found on the CDC’s ‘Compendium of Evidence-based Interventions and Best Practices’ website: <http://www.cdc.gov/hiv/research/interventionresearch/compendium/irc/index.html>; and further details, including the program manual, locations, materials, and data collection forms, reside on the health department website: <http://www.nyc.gov/html/doh/html/living/hiv-care-coord.shtml>.

Data Sources and Study Population

We conducted an observational cohort study using a combination of CCP provider-reported data and longitudinal, surveillance-based laboratory data described elsewhere [7]. This intent-to-treat analysis included all clients enrolled in the CCP (at any of the 28 CCP-funded agencies) by March 31, 2013, matched to the NYC HIV Surveillance Registry (“the Registry”), and alive at least 12 months following CCP enrollment ($n = 7058$, or 96.2 %, of 7337 meeting the initial enrollment criteria). All clients in the analysis were categorized as newly diagnosed (in the 12 months prior to enrollment) or previously diagnosed (more than 12 months prior to enrollment). Only the previously diagnosed contributed complete 12-month pre-enrollment data, and thus were included in pre-post outcomes comparisons treating each client as his/her own control. This study was approved by the Institutional Review Boards of the NYC Department of Health and Mental Hygiene (DOHMH) and Hunter College, City University of New York.

Measures

Two client-level outcomes, engagement in care (EiC) and viral load suppression (VLS), were drawn from the Registry for the 12-month periods pre- and post-CCP enrollment. EiC was defined as having at least two laboratory tests dated ≥ 90 days apart, with at least one in each half of the year. VLS was defined as having a viral load (VL) ≤ 200 copies/mL at the latest test in the second half of the year [7]. Client demographic and clinical characteristics captured in

routine surveillance were also drawn from the Registry, while psychosocial characteristics and enrollment duration were drawn from programmatic reporting by CCP service providers using standard data collection forms. Unstable housing was defined to include homelessness, reliance on a temporary or transitional housing program, residence in institutional (e.g., drug treatment) housing, and temporary residence in another's housing unit; lower mental health functioning was defined as a mental component summary (MCS) score ≤ 37.0 on the 12-item Short Form Survey (SF-12, Version 2) functional health assessment [8]; and recent hard drug use was defined as a self-report of recreationally using heroin, cocaine/crack, methamphetamines, or prescription drugs during the past three months. These three barriers were assessed over time, since they are barriers that CCP services have the potential to impact within a year. Post-enrollment barrier reductions, defined as achievement of stable housing, a score increase of ≥ 3.5 points on the MCS [8], or cessation of hard drug use, were tracked using the latest program assessment during the 12-month follow-up period.

Statistical Analyses

Relative risks (RRs), derived from generalized estimating equations (GEE), were used to compare post-enrollment-year with pre-enrollment-year proportions for EiC and VLS among previously diagnosed clients. RRs were stratified by: care history, clinical factors, demographics, enrollment duration and psychosocial characteristics. For clients with unstable housing, lower mental health functioning, and hard drug use at baseline, we also examined RRs for the subgroups who had or had not experienced barrier reductions during the follow-up period, to test the hypothesis that those with barrier reductions would show greater outcomes improvement. All analyses were conducted using SAS[®] software version 9.3.

Results

Most study-eligible CCP clients were black or Hispanic (91.3 %), U.S.-born (66.4 %), male (64.1 %), and age 45 or older (51.1 %); overall, they were demographically representative of the larger HIV-positive NYC Ryan White Part A client population. In terms of medical history, most had baseline CD4 counts < 350 cells/ μL (40.9 %) or missing/unknown (26.8 %), and most were previously diagnosed with HIV (84.2 %), generally prior to 2005 (62.3 %). CCP providers reported the following (non-mutually-exclusive) reasons for client eligibility and enrollment: newly diagnosed (16.2 %), out of care (10.9 %), sporadically/irregularly in care or missing appointments

(46.6 %), non-adherent to ART (38.5 %), starting on ART or changing ART regimen (9.6 %), and ART-experienced with prior treatment failure and drug resistance or recurrent viral load rebound (7.8 %). Most clients (61.8 %) remained enrolled throughout the 12-month follow-up period, but 19.1 and 19.2 % had their enrollment closed within six months or between 6 and 12 months, respectively. At the time of CCP enrollment, 22.1 % were unstably housed, 30.0 % had lower mental health functioning, and 15.1 % reported recent hard drug use; half of CCP clients (50.4 %) exhibited at least one of these psychosocial barriers (Table 1).

Among newly diagnosed clients ($n = 1117$), 90.3 % achieved EiC and 70.1 % achieved VLS during the year following CCP enrollment. Higher proportions of stably housed (vs. unstably housed) newly diagnosed clients achieved EiC (91.4 vs. 86.1 %) and VLS (72.5 vs. 59.8 %) during the follow-up year. Post-enrollment VLS was also more common among those not reporting (vs. those reporting) recent hard drug use at baseline (71.0 vs. 59.6 %).

Among previously diagnosed clients ($n = 5941$), the proportion with EiC increased from 69.6 to 90.7 % ($\text{RR}_{\text{EiC}} = 1.30$, 95 % CI 1.28–1.33) and the proportion with VLS increased from 30.3 to 54.4 % ($\text{RR}_{\text{VLS}} = 1.80$, 95 % CI 1.73–1.87) from the pre- to the post-enrollment period. In stratified analyses, significant improvements in EiC and VLS were observed in all subgroups, including those examined in a prior analysis [7] and the additional psychosocial barrier subgroups addressed in this report (Table 1).

While all subgroups improved, some showed greater pre-post change than others (Table 1); for example, greater improvements in both outcomes were observed among clients with unstable (vs. stable) housing at baseline [$\text{RR}_{\text{EiC}} = 1.42$ (95 % CI 1.36–1.48) vs. $\text{RR}_{\text{EiC}} = 1.27$ (95 % CI 1.25–1.30); $\text{RR}_{\text{VLS}} = 2.03$ (95 % CI 1.83–2.25) vs. $\text{RR}_{\text{VLS}} = 1.74$ (95 % CI 1.67–1.82)]. VLS improvement was greater among those with (vs. those without) recent hard drug use at baseline [$\text{RR}_{\text{VLS}} = 2.17$ (95 % CI: 1.90–2.48) vs. $\text{RR}_{\text{VLS}} = 1.77$ (95 % CI 1.70–1.84)], while EiC improvement was greater among those without (vs. those with) recent hard drug use at baseline [$\text{RR}_{\text{EiC}} = 1.33$ (95 % CI 1.30–1.36) vs. $\text{RR}_{\text{EiC}} = 1.22$ (95 % CI 1.18–1.27)]. Clients enrolled throughout the 12-month follow-up period showed significantly greater EiC and VLS improvement than those with enrollment closure between 6 and 12 months or during the first six months [$\text{RR}_{\text{EiC}} = 1.37$ (95 % CI 1.34–1.40) vs. $\text{RR}_{\text{EiC}} = 1.27$ (95 % CI 1.22–1.33) or $\text{RR}_{\text{EiC}} = 1.14$ (95 % CI 1.09–1.18); $\text{RR}_{\text{VLS}} = 1.95$ (95 % CI 1.86–2.05) vs. $\text{RR}_{\text{VLS}} = 1.65$ (95 % CI 1.50–1.81) or $\text{RR}_{\text{VLS}} = 1.43$ (95 % CI 1.30–1.57)].

Table 1 Engagement in care and viral load suppression, by baseline and post-baseline psychosocial barrier status and enrollment length

CCP client characteristic	CCP all ^a		CCP newly diagnosed ^b			CCP previously diagnosed ^c			VLS ^e								
	N	%	N	EiC ^d	% Post-enrollment	N	EiC ^d	% Post-enrollment	EiC RR (95% CI)	% Pre-enrollment	VLS RR (95% CI)	N	EiC ^d	% Post-enrollment	EiC RR (95% CI)	% Pre-enrollment	VLS RR (95% CI)
Total	7058	100.0	1117	90.3	70.1	5941	69.6	90.7	1.30 (1.28, 1.33)	30.3	1.80 (1.73, 1.87)	54.4	54.4	54.4	1.80 (1.73, 1.87)	30.3	1.80 (1.73, 1.87)
Housing status at baseline																	
Unknown/missing	194	2.7	24	83.3	62.5	170	67.6	84.1	1.24 (1.11, 1.39)	24.1	2.00 (1.50, 2.66)	48.2	48.2	48.2	1.24 (1.11, 1.39)	24.1	2.00 (1.50, 2.66)
Stably housed	5304	75.1	899	91.4*	72.5*	4405	71.5	91.0	1.27 (1.25, 1.30)	33.1	1.74 (1.67, 1.82)	57.8	57.8	57.8	1.27 (1.25, 1.30)	33.1	1.74 (1.67, 1.82)
Unstably housed	1560	22.1	194	86.1*	59.8*	1366	63.8	90.6	1.42 (1.36, 1.48) [†]	21.8	2.03 (1.83, 2.25) [†]	44.3	44.3	44.3	1.42 (1.36, 1.48) [†]	21.8	2.03 (1.83, 2.25) [†]
<i>Post-baseline</i>																	
Issue reduced	247	15.8	38	97.4	73.7	209	57.9	96.2	1.66 (1.48, 1.87) [†]	18.2	3.03 (2.27, 4.03) [†]	55.0	55.0	55.0	1.66 (1.48, 1.87) [†]	18.2	3.03 (2.27, 4.03) [†]
Issue not reduced	738	47.3	93	95.7	68.8	645	66.5	94.3	1.42 (1.34, 1.50)	23.7	1.94 (1.69, 2.23)	46.0	46.0	46.0	1.42 (1.34, 1.50)	23.7	1.94 (1.69, 2.23)
Issue not re-assessed	575	36.9	63	65.1	38.1	512	62.7	83.8	1.34 (1.25, 1.43)	20.9	1.80 (1.51, 2.16)	37.7	37.7	37.7	1.34 (1.25, 1.43)	20.9	1.80 (1.51, 2.16)
Mental health functioning at baseline																	
Unknown/missing	336	4.8	54	92.6	77.8	282	72.3	92.6	1.28 (1.19, 1.38)	27.3	1.95 (1.61, 2.36)	53.2	53.2	53.2	1.28 (1.19, 1.38)	27.3	1.95 (1.61, 2.36)
MCS score >37	4605	65.3	741	90.0	69.8	3864	70.0	90.8	1.30 (1.27, 1.33)	30.6	1.80 (1.72, 1.89)	55.0	55.0	55.0	1.30 (1.27, 1.33)	30.6	1.80 (1.72, 1.89)
MCS score ≤37	2117	30.0	322	90.7	69.6	1795	68.5	90.3	1.32 (1.28, 1.36)	30.1	1.77 (1.65, 1.90)	53.2	53.2	53.2	1.32 (1.28, 1.36)	30.1	1.77 (1.65, 1.90)
<i>Post-baseline</i>																	
Issue reduced	1046	49.4	182	95.6	77.5	864	66.7	95.6	1.43 (1.37, 1.50) [†]	31.0	1.98 (1.80, 2.18)	61.3	61.3	61.3	1.43 (1.37, 1.50) [†]	31.0	1.98 (1.80, 2.18)
Issue not reduced	375	17.7	49	95.9	71.4	326	72.7	90.8	1.25 (1.16, 1.34)	31.6	1.61 (1.37, 1.90)	50.9	50.9	50.9	1.25 (1.16, 1.34)	31.6	1.61 (1.37, 1.90)
Issue not re-assessed	696	32.9	91	78.0	52.7	605	68.8	82.5	1.20 (1.13, 1.27)	27.9	1.53 (1.34, 1.75)	42.8	42.8	42.8	1.20 (1.13, 1.27)	27.9	1.53 (1.34, 1.75)
Hard drugs at baseline																	
Unknown/missing	305	4.3	35	97.1	77.1	270	78.9	91.9	1.16 (1.09, 1.24)	35.6	1.56 (1.34, 1.83)	55.6	55.6	55.6	1.16 (1.09, 1.24)	35.6	1.56 (1.34, 1.83)
No-past 3 months	5684	80.5	978	90.4	71.0*	4706	68.2	90.7	1.33 (1.30, 1.36) [†]	32.3	1.77 (1.70, 1.84)	57.1	57.1	57.1	1.33 (1.30, 1.36) [†]	32.3	1.77 (1.70, 1.84)
Yes-past 3 months	1069	15.1	104	87.5	59.6*	965	74.0	90.5	1.22 (1.18, 1.27)	18.9	2.17 (1.90, 2.48) [†]	40.9	40.9	40.9	1.22 (1.18, 1.27)	18.9	2.17 (1.90, 2.48) [†]
<i>Post-baseline</i>																	
Issue reduced	391	36.6	43	95.3	65.1	348	70.1	96.3	1.37 (1.28, 1.47) [†]	20.7	2.43 (1.98, 2.99)	50.3	50.3	50.3	1.37 (1.28, 1.47) [†]	20.7	2.43 (1.98, 2.99)
Issue not reduced	282	26.4	27	96.3	74.1	255	83.1	94.5	1.14 (1.07, 1.20)	16.1	2.15 (1.59, 2.89)	34.5	34.5	34.5	1.14 (1.07, 1.20)	16.1	2.15 (1.59, 2.89)
Issue not re-assessed	396	37.0	34	70.6	41.2	362	71.3	82.0	1.15 (1.07, 1.24)	19.1	1.91 (1.53, 2.39)	36.5	36.5	36.5	1.15 (1.07, 1.24)	19.1	1.91 (1.53, 2.39)
Baseline barrier																	
No barrier	3502	49.6	641	90.8	72.4	2861	70.8	90.9	1.28 (1.25, 1.32)	34.4	1.74 (1.66, 1.83)	59.9	59.9	59.9	1.28 (1.25, 1.32)	34.4	1.74 (1.66, 1.83)
Any barrier	3556	50.4	476	89.7	67.0	3080	68.6	90.5	1.32 (1.29, 1.35)	26.5	1.86 (1.75, 1.97)	49.3	49.3	49.3	1.32 (1.29, 1.35)	26.5	1.86 (1.75, 1.97)
<i>Post-baseline barrier</i>																	
No barrier	869	24.4	155	96.1	79.4	714	64.7	95.8	1.48 (1.40, 1.56) [†]	31.0	2.04 (1.83, 2.27)	63.0	63.0	63.0	1.48 (1.40, 1.56) [†]	31.0	2.04 (1.83, 2.27)
Any barrier	1381	38.8	179	96.6	70.4	1202	71.4	94.2	1.32 (1.27, 1.37)	26.2	1.90 (1.73, 2.08)	49.7	49.7	49.7	1.32 (1.27, 1.37)	26.2	1.90 (1.73, 2.08)
Missing information	1306	36.7	142	73.9	49.3	1164	68.0	83.5	1.23 (1.18, 1.28)	24.0	1.68 (1.51, 1.87)	40.4	40.4	40.4	1.23 (1.18, 1.28)	24.0	1.68 (1.51, 1.87)

Table 1 continued

CCP client characteristic	CCP all ^a		CCP newly diagnosed ^b			CCP previously diagnosed ^c			VLS ^e				
	N	%	N	EiC ^d	% Post-enrollment	N	EiC ^d	% Pre-enrollment	% Post-enrollment	EiC RR (95 % CI)	% Pre-enrollment	% Post-enrollment	VLS RR (95 % CI)
Enrollment length													
<6 months	1345	19.1	151	68.2	46.4	1194	70.7	80.2	40.9	1.14 (1.09, 1.18)	28.6	40.9	1.43 (1.30, 1.57)
6 months–1 year	1354	19.2	189	81.5	55.0	1165	67.6	85.9	45.5	1.27 (1.22, 1.33)	27.6	45.5	1.65 (1.50, 1.81)
>1 year	4359	61.8	777	96.8	78.4	3582	70.0	95.8	61.8	1.37 (1.34, 1.40) [†]	31.7	61.8	1.95 (1.86, 2.05) [‡]

Prepared by the Bureau of HIV/AIDS Prevention and Control with data reported to the NYC HIV Surveillance Registry as of September 30, 2014

RR relative risk, calculated using Generalized Estimating Equations (GEE). CI confidence interval, MCS mental component summary. Baseline: based on the CCP provider-conducted intake assessment at client enrollment. Post-baseline: based on the latest CCP provider-conducted reassessment in the year of follow-up

^a Clients enrolled in the NYC CCP between December 1, 2009 and March 31, 2013, matched to the NYC HIV Surveillance Registry, and living 12 months after the date of enrollment

^b Newly diagnosed: CCP clients who were diagnosed in the 12 months prior to their CCP enrollment window (defined as the 31 days leading up to and including date of enrollment)

^c Previously diagnosed: CCP clients who were diagnosed greater than 12 months prior to their CCP enrollment window (defined as the 31 days leading up to and including date of enrollment)

^d EiC, or engagement in care: ≥ 2 CD4 or viral load (VL) tests ≥ 90 days apart, with ≥ 1 test in each half of the 12-month period

^e VLS, or viral load suppression: viral load (VL) ≤ 200 copies/mL on most recent test in the second half of the 12-month period. Clients who did not have a VL test reported during the second half of the 12-month period were categorized as unsuppressed

*Using a Chi square test, at the 95 % confidence level, there was a significant difference in post-enrollment outcomes between these subgroup(s), excluding those groups with missing data on this variable

[†] At the 95 % confidence level, this subgroup's RR was significantly higher than the RR(s) of some other subgroup(s) with non-missing data on this variable

[‡] At the 90 % confidence level, but *not* the 95 % confidence level, this subgroup's RR was significantly higher than the RR(s) of some other subgroup(s) with non-missing data on this variable

Analyses further stratified within groups experiencing a given barrier at baseline showed a tendency toward greater relative outcome improvement when a reduction in that barrier was achieved during the 12 months following CCP enrollment (Table 1). For example, clients reporting cessation of hard drug use post-baseline showed significantly greater EiC improvement than those with continuing use [$RR_{EiC} = 1.37$ (95 % CI 1.28–1.47) vs. $RR_{EiC} = 1.14$ (95 % CI 1.07–1.20)]. Similarly, clients obtaining stable housing post-baseline showed significantly greater VLS improvement than those remaining in unstable housing [$RR_{VLS} = 3.03$ (95 % CI 2.27–4.03) vs. $RR_{VLS} = 1.94$ (95 % CI 1.69–2.23)]; EiC improvement was also greater among those obtaining stable housing post-baseline, though this difference was only significant at the 0.10 alpha-level. Clients with mental health functioning increases of ≥ 3.5 points from lower baseline levels showed greater EiC improvement than those without such increases [$RR_{EiC} = 1.43$ (95 % CI 1.37–1.50) vs. $RR_{EiC} = 1.25$ (95 % CI 1.16–1.34)]. Finally, clients who began with at least one of the three major barriers and ended the post-enrollment year with none of those barriers showed greater EiC improvement than those with continuing barriers [$RR_{EiC} = 1.48$ (95 % CI 1.40–1.56) vs. $RR_{EiC} = 1.32$ (95 % CI 1.27–1.37)].

Discussion

In this analysis, EiC and VLS improvements were robust across all subgroups, including those typically demonstrating poorer HIV outcomes and recently found to be unaffected by an otherwise-efficacious HIV care intervention [6]. Newly diagnosed individuals with baseline psychosocial barriers achieved roughly comparable levels of EiC and consistently higher levels of VLS relative to those of their previously diagnosed counterparts, with 60–70 % suppressed at their latest test within the 12 months following CCP enrollment. These findings extend an earlier pre-post analysis of CCP data that addressed client subgroups on multiple demographic and clinical history variables, and examined care and treatment engagement outcomes for those with the potential social/structural barriers of uninsurance or homelessness, but did not include our more inclusive measure of unstable housing or any measure for mental health functioning or drug use [7].

Unstable housing, lower mental health functioning, and hard drug use represent critical areas of unmet service need and specifically areas that the CCP is designed to address through customized care planning, referrals, and patient navigation to ensure linkage to appropriate services. Among previously diagnosed clients with housing, mental health or drug-related barriers identified at baseline, significantly

greater EiC improvements were achieved by those who stopped using hard drugs and those with clinically significant increases in mental health functioning during the follow-up year. Greater VLS improvement (significant at the 0.05 alpha-level) and greater EiC improvement (significant at the 0.10 alpha-level) occurred among clients who became stably housed during the follow-up year.

In the analyses of outcomes by baseline status on the psychosocial barriers, greater relative improvements (higher RRs) among certain subgroups reflected their lower baseline levels of EiC and VLS, *not* higher post-enrollment levels of the outcomes. However, this was not the case in the sub-analyses limited to clients who had a baseline barrier; the levels of EiC and VLS achieved among clients with post-enrollment barrier reduction were actually higher than those achieved among clients without barrier reduction, regardless of their baseline levels of EiC and VLS. While this sub-analysis was an exploratory look at potential mechanisms/pathways of CCP effectiveness, the pattern observed is consistent with the expectation of care continuum outcome improvement being facilitated by the CCP's tailoring of services to clients' psychosocial needs. Most importantly, for each of the barriers examined over time, significant EiC and VLS increases were observed for those *with* and *without* post-enrollment barrier reduction, suggesting some means of managing the demands of care and treatment engagement even while psychosocial barriers persisted.

This study is limited by its observational, single-arm pre-post design, which cannot isolate program effects from secular EiC and VLS improvements, and cannot protect against selection factors that may be associated with both CCP enrollment and likelihood of achieving EiC or VLS within the next year. Furthermore, our subgroup estimates of pre-post change in the outcomes (RRs with 95 % CIs) are crude/unadjusted, and any comparisons between subgroups on a given variable (e.g., housing stability, or reduction in an initial housing barrier) do not control for other potential differences between client groups (i.e., those with and without the barrier at baseline, or those with and without post-baseline evidence of psychosocial barrier reduction). However, the single-arm, pre-post design guards against many potential confounders by utilizing subjects as their own controls.

Missing post-baseline information on psychosocial barriers (for 33.7–37.5 % of previously diagnosed clients with a given barrier) reflects the realities of the programmatic setting and program attrition, in that missing data was significantly associated with shorter CCP enrollment duration ($p < 0.0001$, data not shown). While making the study more prone to missing data on intermediate/psychosocial outcomes, the choice to include clients regardless of enrollment duration helps minimize bias from selection factors that would influence both programmatic retention and care outcomes.

Despite 91 % of CCP clients achieving EiC in the year after enrollment, only 54 % achieved VLS in the same period; similar discrepancies in the two outcomes held across subgroups. VLS demands adherence on a daily, versus quarterly or biannual, schedule, and thus arguably a greater degree or consistency of self-management than that required to maintain the expected frequency of primary care visits. Further research is needed to examine longer-term outcomes among those who enroll in the CCP, particularly given that the program undertakes to increase HIV care and treatment engagement among individuals who are likely to experience other needs (e.g., for housing) as more pressing than HIV-related health. Progress on these kinds of needs may take many months to achieve and then to translate to VLS.

Reporting of HIV care intervention outcomes in relation to care history and other participant characteristics is rare [9] and critical for informing the tailoring of interventions. This study extends earlier work examining the effects of case management interventions on healthcare utilization [1] and treatment uptake or adherence [4, 5, 10] among vulnerable subgroups, by demonstrating post-intervention improvement in those subgroups on both care engagement and viral load suppression. Finally, this study helps advance the knowledge base regarding “what works best for whom and when,” and specifically assesses relationships between the intermediate targets of case management interventions (e.g., psychosocial barriers) and case management clients’ relative improvements on HIV outcomes [11]. The specification of mechanisms of effect is a critical step to support replicability, and indicate the extent of generalizability of results, for an intervention that has shown initial evidence of effectiveness [12]. Our findings suggest a connection between support to address psychosocial barriers and greater improvement on indicators along the HIV care continuum. Further research is needed to understand the mechanisms behind barrier reduction in the first year of intervention, the timing of barrier reduction in relation to improvements on care continuum outcomes, and the means by which HIV Care Coordination services may be facilitating outcome improvements even for those clients whose psychosocial barriers persist.

Conclusion

Our findings lend further evidence to the role of Care Coordination in increasing health and survival opportunities among those at highest risk for suboptimal HIV health outcomes, while simultaneously advancing the public health goal of treatment as prevention. Data are still needed on longer-term viral suppression and care engagement

patterns among persons enrolling in HIV Care Coordination.

Acknowledgments The authors are indebted to Care Coordination Program providers and clients, for their invaluable and ongoing contributions to real-world program implementation and evaluation. We also thank Kent Sepkowitz, Levi Waldron, Katherine Penrose, Julie Myers, Sarah Braunstein, Bisrat Abraham, Graham Harriman, and Beau Mitts for their review of drafts and involvement in the larger intervention effectiveness study, CHORDS (Costs, Health Outcomes, and Real-world Determinants of Success in HIV Care Coordination).

Funding This work was supported by the National Institutes of Health [Grant number R01 MH101028].

Author Contribution Drs. Irvine and Nash conceptualized the study, along with Ms. Chamberlin. Dr. Irvine drafted the manuscript. Ms. Chamberlin, Ms. Robbins, and Ms. Robertson prepared datasets and conducted and confirmed analyses. Ms. Kulkarni assisted with preparation of the manuscript for publication. All authors participated in the interpretation of results, critically reviewed and edited the manuscript, and approved the final draft.

Compliance with Ethical Standards

Conflict of Interest The author declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of study formal consent is not required.

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