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ORIGINAL RESEARCH

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Predictors of linkage to hepatitis C virus care among people living with HIV with hepatitis C infection and the impact of loss to HIV follow-up

Abby A. Lau[1,2] | Joslyn K. Strebe[2] | Teena V. Sura[3] | Laura A. Hansen[1] | Mamta K. Jain[1,2]

[1]Department of Internal Medicine, Division of Infectious Diseases and Geographic Medicine, UT Southwestern Medical Center, Dallas, Texas, USA

[2]Parkland Health and Hospital System, Dallas, Texas, USA

[3]Population and Data Science, UT Southwestern Medical Center, Dallas, Texas, USA

Correspondence

Abby A. Lau, Department of Internal Medicine, Division of Infectious Diseases and Geographic Medicine, UT Southwestern Medical Center, Dallas, TX, USA.
Email: abby.lau@utsouthwestern.edu

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Abstract

Objective: Half of the people living with HIV (PLWH) with hepatitis C virus (HCV) remain untreated for HCV. We examined predictors of HCV linkage to care among PLWH and the impact of HIV lost to care.

Design and methods: We conducted a retrospective review of PLWH/HCV from our HIV clinics between 2014 and 2017, and examined predictors of HCV linkage to care. We used the Kaplan–Meier method to estimate the probability of HIV retention and HCV linkage over time.

Results: Of 615 PLWH/HCV, 34% linked to HCV care and 21% were cured. Higher odds of linkage to HCV care were among blacks (adjusted odds ratio [aOR]: 2.95, 95% confidence interval [CI]: 1.59, 5.47), prior injection drug users (IDUs; aOR: 2.89, 95% CI: 1.39, 6.01), Medicare (aOR: 3.09, 95% CI: 1.56, 6.11), and cirrhotics (aOR: 2.80, 95% CI: 1.52, 5.14). Reduced odds for linkage were in active IDU (aOR: 0.16, 95% CI: 0.05, 0.45) and those seen by an advanced practice provider (aOR: 0.53, 95% CI: 0.30, 0.92). The main reason for failure to link to HCV care was lost to HIV care. At 3 years, the overall probability of being retained in HIV care was 53%; among those who had an HCV evaluation visit, it was 75% vs. 41% with no HCV evaluation visit. Accounting for loss to follow-up, PLWH/HCV had a 65% probability of having an HCV evaluation at 3 years.

KEYWORDS

cascade of care, hepatitis C virus (HCV), HIV, linkage to care, lost to follow-up

1 | INTRODUCTION

In this current era of available direct-acting antivirals (DAAs) for hepatitis C virus (HCV), treatment is simple, side effects are uncommon, and success rates are high.[1] Furthermore, the American Association for the Study of Liver Disease and the Infectious Disease Society of America guidelines place particular importance on treating people living with HIV (PLWH) with HCV coinfection, as this population has higher rates of progression to cirrhosis, decompensation, and liver-related mortality.[2] Although some studies showed that PLWH (compared with their non-HIV counterparts) are more likely to be initiated on HCV treatment initiation,[3–5] half of PLWH with HCV still remain untreated.[6]

There are several studies[4,7–12] looking at disparities in DAA treatment initiation in different demographic groups. These studies suggested that non-Hispanic white patients, patients who identify as men who have sex with men, patients with greater degrees of liver fibrosis, PLWH with CD4 > 200 cells/μl HIV viral load suppression, and those who were engaged in HCV care were more likely to initiate DAA treatment compared with their counterparts.[4,7,8] In contrast, patients with injection drug use (IDU), heavy alcohol use, had multiple clinic missed visits, younger age, Black or Hispanic patients, uninsured, homeless, low-income patients, women, and incarcerated patients were less likely to initiate DAA treatment.[7,9–12]

In the current DAA era, a number of HCV elimination programs showed that once a patient initiates HCV treatment, most will complete treatment and achieve sustained virologic response (SVR).[6] However, several steps need to be completed before treatment initiation; depending on the setting, this can include obtaining a subspecialty referral for HCV treatment evaluation, completing the evaluation visit, receiving a prescription for a DAA, and obtaining insurance approval before treatment can be initiated.[13] Of note, in some health care systems, many of these steps are consolidated or are not needed (i.e., settings in which primary care providers provide HCV treatment[14,15] or treatment is provided to uninsured patients through patient assistance programs, obviating the need for referral to subspecialists or obtaining medical approvals through insurance companies). Nevertheless, many of these steps require both health system and patient initiatives to complete each step. A number of studies showed that linkage to care (i.e., completion of an HCV evaluation visit) is a crucial barrier to completing the HCV care cascade.[13,16–24] Less is known about what the predictors are for completing this crucial early step in the care cascade.[25]

Based on the findings of these studies, we sought to examine what demographic or clinical factors in our patient population were predictive of completing an HCV evaluation visit, to understand how to increase our population's completion of this care cascade step. By understanding the population at risk and the barriers associated with failure to progress along the HCV care cascade, we can better target our interventions to improve treatment and cure, and move toward HCV viral elimination goals by 2030. [26]

2 | METHODS

2.1 | Design and setting

Parkland Health & Hospital System (PHHS) is a publicly funded healthcare system, which includes outpatient specialty clinics. Within this system, over 6000 PLWH receive primary care and HIV care in 3 different locations in the metroplex. HCV care is provided through a dedicated hepatitis C program housed in the Liver Clinic on the main campus. During this time frame, to receive HCV treatment, PLWH with HCV needed to be referred for evaluation and treatment at the HCV specialty clinic. However, starting in January 2018, we initiated a new program in which HIV providers began evaluating and treatment of HCV in the HIV clinic setting. We conducted a retrospective electronic health record review of PLWH with HCV within PHHS between January 1, 2014 and December 31, 2017. As this was a retrospective study with deidentified data, a waiver of consent was approved by the UT Southwestern Institutional Review Board.

2.2 | Data source and variables

Included in the study are all PLWH having an encounter with an HIV provider between January 1, 2014 and December 31, 2017, and a diagnosis of hepatitis C (ICD 10 code of B18.2 or B19.20) or HCV RNA detected on laboratory testing. Excluded patients were HCV antibody (Ab) negative or HCV RNA undetectable (either due to prior treatment or spontaneous clearance before January 1, 2014).

For PLWH who met the inclusion criteria, we extracted data on demographics (age, gender, race and ethnicity, insurance), comorbid social conditions (based on documentation of alcohol use, drug use, mental health status, and homelessness through manual chart review of all HIV patients), HIV characteristics (HIV risk factors, CD4 count, and HIV viral load at the first HIV visit during the study period), the patients' primary care provider (either an MD, a provider with a Doctor of Medicine degree vs an Advanced Practice Provider [APP], a provider with a Physician Assistant degree or Family Nurse Practitioner degree), the presence of cirrhosis (based on clinic notes), and prior history of treatment for HCV. We abstracted data on HCV care cascade outcomes (completion of an HCV evaluation visit, receipt of HCV prescription, and achievement of SVR 12). We stratified patients based on whether a patient had completed an HCV evaluation visit, as this was our surrogate marker for the "linkage to care" step in the HCV care cascade. Completion of an HCV evaluation was defined as having a completed HCV template note from an HCV provider in the electronic medical record that indicated that the patient was seen and evaluated on a specified date. The outcome of the visit (i.e., receipt of a prescription for treatment, completion of further workup, and so on) was not needed. Before an evaluation visit, other steps had to occur, which were not captured; this included placing a referral to the HCV clinic and scheduling an appointment. We evaluated patients for rates of loss to HIV follow-up, which was defined as not having completed an HIV follow-up visit in our electronic health record system at PHHS within 365 days from the date of the last HIV visit. (At the time of our study, our electronic health record system did not have the ability to access outside institutions' medical records to capture whether patients who were lost to follow-up were being seen at outside institutions). A patient was censored at the time of loss to follow-up. All patient data were censored on December 31, 2017. Thus, a patient who had a clinic visit on March 5, 2017, was not considered lost to follow-up on December 31, 2017, as 365 days did not elapse from the last HIV visit.

Additionally, we performed a chart review on all patients who were not linked to HCV care and did not initiate DAA treatment to qualitatively assess potential barriers to why patients were not referred. Chart notes from primary care providers were reviewed to examine whether explicit reasons were notated in the chart as to why

a referral was not placed; the reasons for lack of referral were then grouped into different barrier categories (categories included "non-adherence to medication-including HIV medication," "drug use," "patient refuses treatment," and so on). Of note, many providers cited more than one reason for not referring a patient for an HCV evaluation visit. In many cases, the primary care providers did not explicitly indicate that they chose not to refer a patient for an HCV evaluation visit; rather, the chart review shows that the patient was simply lost to HIV follow-up care. This group of patients was categorized as "lost to follow-up."

The primary outcome of this study is to examine predictors of completing an HCV evaluation visit, which was used as a surrogate marker for completing the "linkage to care" step in the HCV care cascade; in many HCV care cascades, this has been a key drop-off step in cascade. The secondary outcomes of this study are to understand the barriers to completing an HCV evaluation visit.

2.3 | Statistical analysis

We examined the primary outcome of predictors for completing an HCV evaluation visit and the secondary outcome of receiving HCV treatment using descriptive statistics. Additional secondary analysis included examining the probability of engagement in HIV care and obtaining HCV evaluation at 3 years. Covariates included demographics, comorbid social conditions, CD4 count, and HIV characteristics. Multivariate logistic regression was also performed to estimate the odds of completing an HCV evaluation visit and receiving HCV treatment. Regression coefficients were considered significant at a $p < 0.05$. A person was considered to have completed an HCV visit if it occurred after an initial HIV encounter during the study period. Kaplan–Meier method was used to determine the probability of loss to HIV follow-up. A patient could contribute variable person-days to the cohort. They were considered engaged in care unless censored for loss to follow-up or end of the study. Those considered lost to follow-up were censored at 365 days. A stratified analysis based on completing an HCV evaluation visit was performed. In addition, the probability of obtaining an HCV evaluation after censoring for loss to HIV care was performed. SAS 9.4 was used to conduct the analysis.

3 | RESULTS

Baseline characteristics of the 615 PLWH who met inclusion criteria are presented in Table 1. Overall, most patients were male, half were Black and about one-third each was uninsured, had Medicaid, or had Medicare. Approximately one-half had a psychiatric illness, 50% were either active or had a history of IDU, one-third had a history of homelessness, and one out of five were cirrhotic. Two-thirds of patients had a CD4 count < 200 cells/μl and 17% had an undetectable HIV viral load.

Among this population, one-third ($n = 208$) completed an HCV evaluation visit, one-fourth ($n = 139$) started HCV treatment, and 21% ($n = 127$) ultimately achieved an SVR 12 (Figure 1). The rates of SVR 12 for those starting treatment is >90%.

In multivariable logistic regression, Blacks had close to a threefold increased odds compared with non-Hispanic Whites for completing an HCV evaluation visit; similarly, having IDU as a risk factor for HIV infection and having Medicare insurance increased the odds of completing an HCV evaluation visit (Table 2). Patients with cirrhosis also had close to a threefold increased odds of completing an HCV evaluation visit. In contrast, patients with active IDU had a decreased odds of completing an HCV evaluation compared with patients with no history of IDU. In addition, patients with an APP as a primary care provider had lower odds of completing an HCV evaluation compared with patients who had an MD as a primary care provider. For those who did not complete an HCV evaluation visit, the barrier that was most commonly cited by providers was loss to follow-up (58%); other barriers are noted in Table S1.

The median time in the cohort was 707 person-days (SD 486.5). We found the probability of being engaged in HIV care was 53% for PLWH with HCV at 3 years (Figure 2A). However, those who had an HCV evaluation completed had a 75% probability of being engaged in HIV care at 3 years. Those who did not have an HCV evaluation had a 41% probability of being engaged in HIV care (Figure 2B). As those who were lost to HIV care did not have the opportunity to have an HCV evaluation, we examined the probability of having an HCV evaluation by censoring those who were lost to HIV care. We found among those who were engaged in HIV care, the probability of having an HCV evaluation at 3 years was 65% (Figure 2C).

4 | DISCUSSION

In this study, we found that failure to link to HCV care was the most significant barrier to achieving HCV cure in PLWH with HCV. Almost two-thirds of our patient population failed to complete an HCV evaluation visit. Patients who were more likely to complete an HCV evaluation visit were Black, had prior IDU, were Medicare-insured, and had cirrhosis; those with active IDU or had a primary HIV provider, who was an APP, had decreased odds of completing HCV evaluation. Among those who failed to link to HCV care, we found a higher probability of loss to HIV care compared with those who were successful in linkage to HCV care. As a group, loss to HIV follow-up was high, with only a 53% probability of the cohort being engaged in HIV care at 3 years. Data from other studies show similarly low rates of 3-year retention in HIV care, ranging from 25–30%[27] to 38.2%.[28]

Our study mirrors many of the trends in the literature on HCV care cascades with a significant drop-off noted at the linkage to care step and a smaller drop-off in treatment initiation.[18,20–24,29]

Studies that have looked at underlying reasons why PLWH fails to link to HCV care have also found that loss to follow-up is the most common reason.[24,30] We found a higher probability of retention in HIV care among those who had an HCV evaluation compared with those who did not. However, this may reflect those who are more motivated to obtain HCV treatment and HIV

TABLE 1 Demographic and clinical characteristics of PLWH/HCV between 2014 and 2017, by HCV evaluation status

Characteristics	Overall (*N* = 615)	Evaluation visit not done (*N* = 403)	Evaluation visit done (*N* = 208)	*p**
Gender				0.95
Male	469 (76.26)	307 (76.18)	158 (75.96)	
Female	146 (23.74)	96 (23.82)	50 (24.04)	
Age				0.0004
10–39 Years	96 (15.61)	79 (19.60)	17 (8.17)	
40–49 Years	184 (29.92)	124 (30.77)	59 (28.37)	
50–59 Years	263 (42.76)	161 (39.95)	99 (47.61)	
≥60 Years	72 (11.71)	39 (9.68)	33 (15.87)	
Ethnicity				0.83
Hispanic or Latino	72 (11.71)	49 (12.16)	23 (11.06)	
Non-Hispanic or Latino	541 (87.97)	353 (87.59)	184 (88.46)	
Unknown	2 (0.33)	1 (0.25)	1 (0.48)	
Race				0.02
American Indian/Alaskan Native	2 (0.33)	1 (0.25)	1 (0.48)	
Asian	7 (1.14)	2 (0.50)	5 (2.41)	
Black	338 (54.96)	209 (51.86)	128 (61.54)	
White	260 (42.28)	185 (45.91)	72 (34.62)	
Unknown	8 (1.31)	6 (1.49)	2 (0.96)	
Language				0.16
English	588 (95.61)	389 (96.53)	195 (93.75)	
Spanish	19 (3.09)	11 (2.73)	8 (3.85)	
Other	8 (1.31)	3 (0.74)	5 (2.41)	
HIV acquisition risk factor				0.69
MSM	146 (23.93)	91 (22.75)	52 (25.24)	
IDU	294 (48.20)	198 (49.50)	95 (46.12)	
Heterosexual	170 (27.87)	111 (65.29)	59 (34.71)	
PCP training				0.54
MD/DO	351 (65.24)	213 (63.77)	135 (67.51)	
NP	127 (23.61)	84 (25.15)	42 (21.00)	
PA	60 (11.15)	37 (11.08)	23 (11.51)	
Insurance				<0.0001
Charity	98 (15.93)	61 (15.14)	37 (17.79)	
Commercial	28 (4.55)	14 (3.47)	13 (6.25)	
Medicaid	213 (34.63)	154 (38.21)	57 (27.41)	
Medicare	181 (29.43)	95 (23.57)	85 (40.87)	
Self-pay	94 (15.28)	78 (19.35)	16 (7.69)	
Unknown	1 (0.16)	1 (0.25)	0	
Homeless				<0.0001
No	411 (66. 83)	245 (60. 79)	162 (77.88)	
Yes	204 (33.17)	158 (39.21)	46 (22.12)	

TABLE 1 (Continued)

Characteristics	Overall (*N* = 615)	Evaluation visit not done (*N* = 403)	Evaluation visit done (*N* = 208)	*p**
HIV viral load				<0.0001
Not detected	102 (16.59)	50 (12.41)	52 (25.00)	
Detected	513 (83.41)	353 (87.59)	156 (75.00)	
Cirrhosis				<0.0001
No	373 (60.65)	232 (57.57)	139 (66.83)	
Definite	81 (13.17)	27 (6.70)	52 (25.00)	
Likely	34 (5.53)	21 (5.21)	13 (6.25)	
Unknown	127 (20.65)	123 (30.52)	4 (1.92)	
Decompensated cirrhosis				0.01
No	578 (94.29)	380 (94.29)	196 (94.23)	
Yes	19 (3.11)	7 (1.74)	12 (5.77)	
Unknown	16 (2.61)	16 (3.97)	0	
Mental health				0.08
No	320 (52.03)	199 (49.38)	118 (56.73)	
Yes	295 (47.97)	204 (50.62)	90 (43.27)	
Alcohol				0.09
Active use	265 (43.09)	185 (45.91)	77 (37.02)	
History of heavy use	192 (31.22)	121 (30.02)	71 (34.13)	
None	158 (25.69)	97 (24.07)	60 (28.85)	
IV drugs				<0.0001
Active use	99 (16.10)	83 (20.60)	16 (7.69)	
History of use	339 (55.12)	218 (54.09)	120 (57.69)	
None	172 (27.97)	97 (24.07)	72 (34.62)	
Unknown	5 (0.81)	5 (1.24)	0	
CD4 cells/microliter				0.0006
>200	115 (18.8)	93 (23.1)	22 (10.6)	
≤200	403 (65.9)	248 (61.5)	155 (74.5)	
Missed HIV appointment for prior year				0.13
0	343 (55.77)	219 (54.34)	121 (58.17)	
1	131 (21.30)	81 (20.10)	49 (23.56)	
2	75 (12.20)	51 (12.66)	24 (11.54)	
3	37 (6.02)	31 (7.69)	6 (2.88)	
≥4	13 (2.11)	21 (5.21)	8 (3.85)	

Abbreviations: DO, doctor of osteopathic medicine; HCV, hepatitis C virus; IDU, injection drug user; MD, doctor of medicine; MSM, men who have sex with men; NP, nurse practitioner; PA, physician assistant; PCP, primary care provider; PLWH/HCV, people living with HIV with hepatitis C coinfection.
*χ^2 or Fisher's exact test.

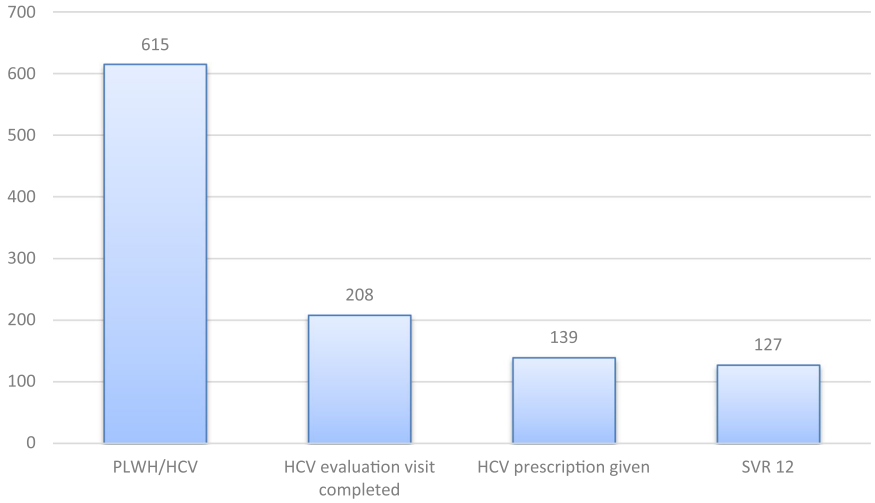

FIGURE 1 Cascade of HCV care among PLWH/HCV within the Parkland Health and Hospital System between 2014 and 2017. Abbreviations: HCV, hepatitis C virus; PLWH/HCV, people living with HIV with hepatitis C virus co-infection; SVR 12, sustained virologic response at 12 weeks.

TABLE 2 Univariate and multivariable logistic regression analysis of variables associated with hepatitis C evaluation visit

	Univariate logistic regression			Multivariable logistic regression		
Variable	**Crude OR**	**95% CI**	***p***	**Adjusted OR**	**95% CI**	***p***
Sex						
Male	Ref		0.95	Ref		0.66
Female	1.01	(0.68–1.49)		0.87	(0.46–1.65)	
Age						
10–39 Years	Ref		0.0007	Ref		0.28
40–49 Years	2.21	(1.20–4.05)		2.15	(0.86–5.37)	
50–59 Years	2.85	(1.59–5.10)		1.34	(0.55–3.27)	
≥60 Years	3.93	(1.95–7.91)		1.28	(0.42–3.89)	
Ethnicity						
Hispanic or Latino	Ref		0.83	Ref		0.44
Non-Hispanic or Latino	0.90	(0.53–1.52)		1.48	(0.53–4.11)	
Race			0.03			0.004
Asian	6.42	(1.21–33.86)		12.35	(0.55–277.4)	
Black	1.57	(1.10–2.23)		2.95	(1.59–5.47)	
White	Ref			Ref		
Unknown	0.85	(0.16–4.34)		0.64	(0.06–6.65)	
Language						
English	Ref		0.19	Ref		0.77
Spanish	1.45	(0.57–3.66)		1.13	(0.19–6.47)	
Other	3.32	(0.78–14.03)		0.38	(0.02–5.73)	
HIV risk factor			0.69			0.01
MSM	1.07	(0.67–1.71)		1.29	(0.61–2.69)	
IDU	0.90	(0.60–1.34)		2.89	(1.39–6.01)	
Heterosexual	Ref			Ref		

TABLE 2 (Continued)

Variable	Univariate logistic regression			Multivariable logistic regression		
	Crude OR	95% CI	*p*	Adjusted OR	95% CI	*p*
PCP training						
MD/DO	Ref		0.38	Ref		0.02
NP/PA	0.84	(0.58–1.22)		0.53	(0.30–0.92)	
Insurance			<0.0001			0.01
Charity	1.02	(0.66–1.58)		1.69	(0.83–3.44)	
Commercial	2.50	(1.11–5.66)		1.60	(0.50–5.13)	
Medicaid	Ref			Ref		
Medicare	2.41	(1.58–3.68)		3.09	(1.56–6.11)	
HIV viral load						0.07
Not detectable	Ref		<0.0001	Ref		
Detectable	0.39	(0.26–0.57)		0.57	(0.32–1.06)	
Homeless						
No	Ref		<0.0001	Ref		0.63
Yes	0.44	(0.30–0.64)		0.86	(0.47–1.56)	
Cirrhosis						
No	Ref		0.0002	Ref		0.0009
Yes	2.26	(1.47–3.46)		2.80	(1.52–5.14)	
Mental health						
No	Ref		0.08	Ref		0.39
Yes	0.60	(0.42–0.86)		0.78	(0.45–1.36)	
Alcohol			0.09			0.30
Active	0.65	(0.43–1.001)		0.61	(0.32–1.15)	
History of use	0.92	(0.60–1.43)		0.68	(0.35–1.29)	
None	Ref			Ref		
IV drugs			<0.0001			0.003
Active use	0.26	(0.14–0.48)		0.16	(0.05–0.45)	
History use	0.74	(0.50–1.08)		0.52	(0.25–1.06)	
None	Ref			Ref		
Missed HIV appointment for prior year						
0	Ref		0.14	Ref		0.37
1–3	0.87	(0.61–1.24)		0.86	(0.51–1.45)	
≥4	0.69	(0.29–1.60)		0.46	(0.15–1.40)	
CD4 cells	1.001	(1.00–1.002)		1.01	(1.00–1.002)	0.09

Abbreviations: CI, confidence interval; DO, doctor of osteopathic medicine; HIV, human immunodeficiency virus; IDU, injection drug user; IV, intravenous; MD, doctor of medicine; MSM, men who have sex with men; NP, nurse practitioner; OR, odds ratio; PA, physician assistant.

care. Once PLWH were linked to HCV care, 73% ultimately got treated, suggesting that the linkage to care step was the main barrier to cure.

Although it may seem obvious that patients who are lost to HIV care would not be able to be referred for an HCV evaluation visit, we found that even after accounting for loss to HIV follow-up, about one-third of PLWH with HCV did not have an HCV evaluation after 3 years of follow-up. Ours is the first study that looked specifically at loss to HIV follow-up and its quantitative and temporal association with linkage to HCV care.

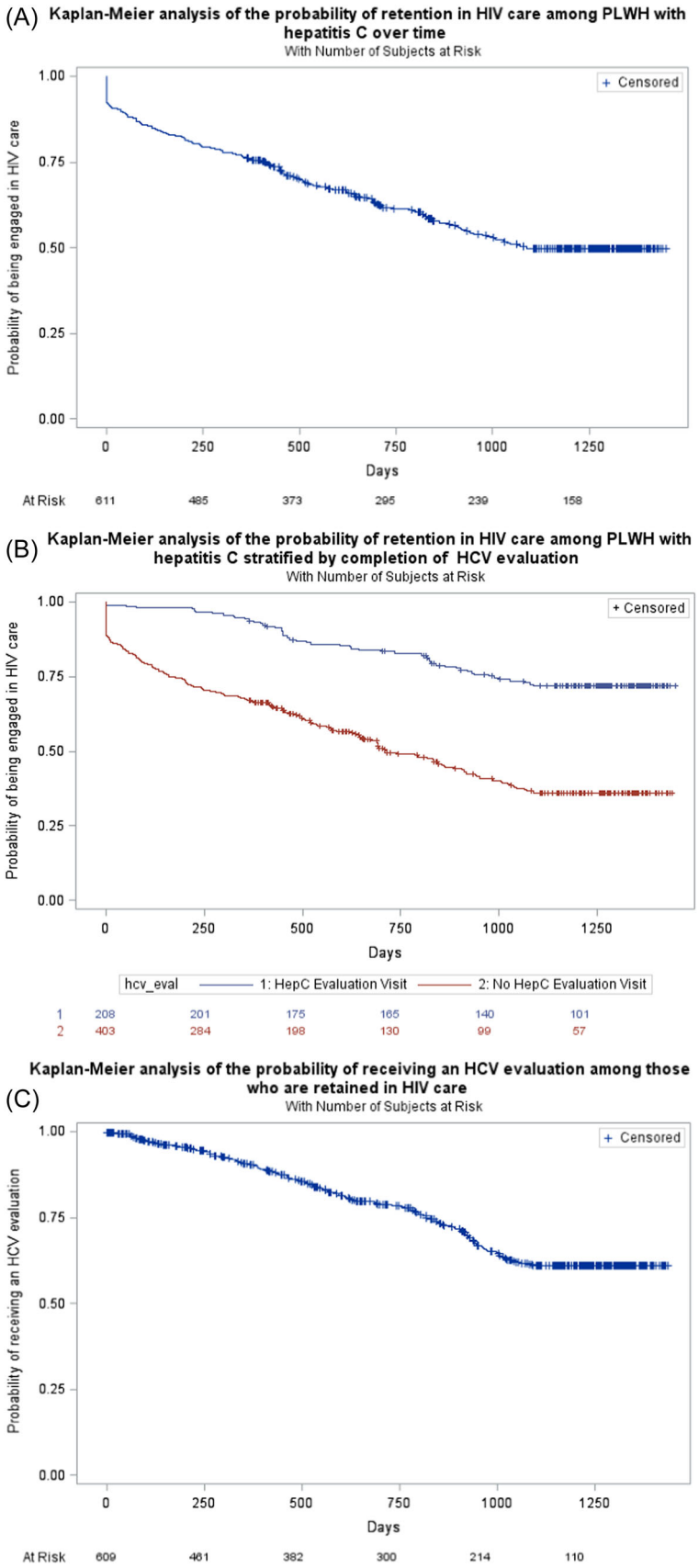

FIGURE 2 (A) Kaplan–Meier analysis of the probability of retention in HIV care among people living with HIV with hepatitis C virus co-infection (PLWH/HCV) over time. (B) Kaplan–Meier analysis of the probability of retention in HIV care among PLWH/HCV stratified by completion of HCV evaluation. (C) Kaplan–Meier analysis of the probability of receiving an HCV evaluation among those who are retained in HIV care.

Of note, these associations do not necessarily imply causality. However, early linkage to HCV treatment may increase the odds of completing an HCV evaluation and subsequent cure. In addition, early referral and treatment for HCV may be an important strategy to engage patients and also eradicate HCV in this population. Strategies to streamline and expedite initiation of therapy will be important, whether through colocation of HIV/HCV clinic,[24,25] streamlining treatment algorithms to reduce the time from evaluation to treatment,[31] and utilizing patient navigators to help limit no-shows.[29,30] Furthermore, it will be important to evaluate how providers prioritize treatment in their patients. Although patients with advanced fibrosis and who have minimal comorbid social conditions are often prioritized by providers for treatment, patients with minimal fibrosis and uncontrolled HIV, active IDU, or other comorbid conditions are often continually deferred for HCV treatment evaluation and initiation until these conditions change. Given the high rates of loss to follow-up, it is then not unsurprising that these patients often do not get treated at all.

In many ways, this provider framework for prioritizing treatment is analogous to our earlier conceptualizations of antiretroviral therapy (ART) initiation in PLWH. Just as the benefits and success of early ART in PLWH—irrespective of CD4 count, active IDU or significant comorbid conditions—has been well demonstrated, early HCV treatment to prevent the development of cirrhosis and decompensation needs to be the standard practice for all HCV patients, even in the presence of comorbid conditions. Many studies have documented successful HCV treatment among IDU in the context of utilizing directly observed therapy,[32] opioid agonist therapy,[33,34] incentives, frequent visits,[35] and increased adherence support.[36] In fact, a study by Roux et al.[37] showed that coinfected patients who received treatment for HCV were actually more likely to be adherent to ART posttreatment.

Interestingly, in this study, having an APP as a primary care provider reduced the odds of completing an HCV treatment evaluation. We suspect this may be related to decreased knowledge about HCV treatment among APPs resulting in both a decreased referral rate and education to patients, to improve successful linkage to care. In one study,[38] the authors noted that specialty physicians and providers in practice for 5 years or more had the highest HCV knowledge scores.[38] Programs focusing on providing HCV education may improve knowledge but further studies are needed to see if that leads to increased linkage to HCV care.

In previous studies, PLWH who are successfully engaged in HIV care were more likely to initiate HCV therapy.[10,23,38,39] Although our study did not show that having a detectable viral load decreased the odds of completing an HCV evaluation visit, there was a trend in that direction. It is unclear whether markers of HIV nonadherence led to providers not referring PLWH for HCV treatment evaluation or whether it was related to patients prone to nonadherence not completing these referrals, or both. Although our study was not designed to answer this question, on chart review, a significant number of providers did note HIV nonadherence as a reason for not referring or delaying referral for treatment.

Similar to other studies that found that having certain types of insurance[13,24,40–43] and having advanced fibrosis[4,8,9] were associated with obtaining HCV treatments, our study also found these variables to be predictors of linkage to care as well. These findings are unsurprising given the known restrictions of coverage for patients on Texas Medicaid (specifically for patients who have low fibrosis scores or have active substance use).

The strengths of this study include a relatively large and diverse patient population that we were able to track data for 3 years of follow-up. However, there are several limitations to this study. This was a retrospective study conducted at a single-site safety-net hospital system in a population with significant comorbid social conditions, which may not be generalizable to other patient populations. We did not have data on the proportion of PLWH with HCV, who actually received a referral; this data would have helped better understand the provider's contribution to linkage to care. Although much of the data was able to be easily extracted from the electronic medical system, trying to understand why patients did not complete an HCV evaluation visit was based on the review of providers' charting and was limited by documentation that was not always complete.

Our study shows that linkage to HCV care remains one of the main barriers to HCV cure, particularly among PLWH who do not have cirrhosis, are non-Medicare insured, have active IDU, and have a primary care provider who is an APP. To achieve HCV cure for all, the focus should be on improving linkage to care in these key populations. Furthermore, delays in HCV linkage to care are associated with decreased retention in HIV care and decreased probability of future HCV linkage to care. Our data suggest that early linkage to HCV care may be vital to achieving HCV cure, given the high risk of loss to follow-up with each subsequent year.

AUTHOR CONTRIBUTIONS

Abby A. Lau: conceptualization; investigation; writing–original draft; writing–review and editing. **Joslyn K. Strebe**: conceptualization; data curation; investigation. **Teena V. Sura**: data curation; formal analysis; methodology; software. **Laura A. Hansen**: investigation; project administration. **Mamta K. Jain**: conceptualization; data curation; formal analysis; funding acquisition; methodology; resources; supervision; writing–review and editing.

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CONFLICT OF INTEREST

Mamta K. Jain has received funding for consulting from Gilead Sciences and research funding from Janssen, Merck, and GSK/ViiV.

DATA AVAILABILITY STATEMENT

Data available on request from the authors.

TRANSPARENCY STATEMENT

Abby A. Lau affirms that this manuscript is an honest, accurate and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and if relevant, registered) have been explained.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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