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Hepatitis C virus care cascade in persons experiencing homelessness in the United States in the era of direct-acting antiviral agents: A scoping review

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Abstract

The hepatitis C virus (HCV) care cascade has been well characterized in the general United States population and other subpopulations since curative medications have been available. However, information is limited on care cascade outcomes in persons experiencing homelessness. The main objective of this study was to map the available evidence on HCV care cascade outcomes in people experiencing homelessness in the U.S. in the era of direct-acting antiviral agents (DAAs). Primary and secondary outcomes included linkage to care (evaluation by a provider that can treat HCV) and sustained virologic response (SVR) or cure. Exploratory outcomes included other cascade data, like treatment initiation, which precedes SVR. PubMed was the primary database accessed for this scoping review. We characterized the HCV care cascade in people experiencing homelessness using sources of evidence published in 2014 onwards that reported the proportions of persons who were linked to care, achieved SVR, and completed other cascade steps. We synthesized our results into a scoping review. The proportion of persons linked to care among chronically infected cohorts with unstable housing ranged from 29.3% to 88.7%. Among those chronically infected, 5%–58.8% were started on DAAs and 5%–50% achieved SVR. In conclusion, these results show that persons experiencing homelessness achieve high rates of linkage to care in non-specialist community-based settings compared to the general U.S. population pre-DAAs. However, DAA initiation was found to be a rate-limiting step along the care cascade, resulting in commensurate low rates of cure.

Keywords

cascade of care; hepatitis C; homeless persons; linkage to care; sustained virologic response

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CONFLICT OF INTEREST

No conflict of interest has been declared by the authors.

1 | INTRODUCTION

As the most common blood-borne infection in the United States, hepatitis C virus (HCV) is responsible for significant morbidity and mortality. In 2012, the rising mortality rate associated with HCV surpassed that of sixty other nationally notifiable infectious conditions combined.¹ Many with HCV are asymptomatic, allowing cirrhosis, hepatocellular carcinoma, and other sequelae to develop undetected. Of 2.4 million people in the U.S. currently infected, 50% are unaware.^{2,3} Lack of awareness in high-risk communities perpetuates transmission where the opioid epidemic and injection drug use drive incident cases.

Screening is a critical first step in addressing the burden of HCV, with individual- and population-level benefits. Screening is only beneficial as a population health tool, however, if it leads to improved health outcomes. The importance of screening is highlighted by the availability of oral direct-acting antiviral agents (DAAs), making it possible for over 95% of patients to achieve sustained virologic response (SVR) or cure. Before the advent of DAAs, interferon injections were standard of care. These were often associated with intolerable side effects and longer treatment durations, which may have been more prohibitive among individuals experiencing homelessness and those with underlying mental health conditions. In addition to high curative potential, DAAs offer short treatment courses and minimal side effects.

Advancements in diagnosis and treatment have limited impact without comparable progress in linkage to care, a critical intermediate step where focused efforts can lead to more people being cured. The HCV care cascade is a sequence of measurable indicators that patients navigate on the path to cure. Key steps include screening, diagnosis, linkage to care, treatment initiation, and SVR. These indicators also track population health level progress for groups of interest. This cascade has been well characterized in the general U.S. population pre-DAAs (Figure 1) and in subpopulations of persons who inject drugs.^{3,4} However, information is limited on cascade outcomes in persons experiencing homelessness in the DAA era, which offers opportunities to close gaps in vulnerable populations.

People experiencing homelessness have a high prevalence of HCV infection.⁵ In a national study by Strehlow et al.,⁶ risk factors for HCV infection among individuals seeking care at Health Care for the Homeless primary care clinics were injection drug use, incarceration, and tattoos. In addition to the high prevalence rate, persons experiencing homelessness encounter many barriers to treatment. Masson et al.⁷ stratified these barriers into individual, system, and social-level barriers. Identified barriers on the individual level included comorbid medical and psychiatric conditions as well as misconceptions about HCV. Stigma surrounding homelessness and limited staff advocacy for HCV services presented barriers at the social and system levels, respectively.

The objective of this study is to map the available evidence on HCV care cascade outcomes in persons experiencing homelessness in the U.S. using studies published within PubMed from 2014 onwards, signifying the start of exclusively DAA regimens. This broad objective

is best accomplished through scoping review methods. Primary and secondary outcomes include linkage to care and SVR, respectively.

2 | METHODS

2.1 | Information sources and search strategy

During April and May 2020, we accessed the Medical Subject Headings (MeSH) database within PubMed and performed multiple iterative searches. The most productive search strategies included the following MeSH and keywords of interest: hepatitis C, “cascade of care,” “linkage to care,” homeless persons, vulnerable populations, and treatment adherence and compliance. Some searches were filtered by date, yielding studies published during January 2014 or later to coincide with widespread availability of DAAs. We did not set restrictions based on study design. The most successful searches are provided in Table 1.

2.2 | Eligibility criteria and study selection

Studies were eligible for inclusion in the scoping review if they: (1) reported data on cohorts experiencing marginal housing and homelessness; (2) reported results for linkage to care, SVR, or other HCV care cascade outcomes; and (3) were published in the era of DAAs (2014 and later). We only considered studies conducted in the U.S. as factors affecting homelessness at the individual, healthcare system, and policy levels vary greatly between countries.

We excluded studies reporting primarily qualitative results and those only reporting screening outcomes (anti-HCV), as medical providers cannot make treatment decisions based on these test results alone. Anti-HCV screening identifies past or present HCV infection and is not used to diagnose active infection. An HCV RNA confirmatory test is required to establish current or chronic infection, which is present in approximately 75% of anti-HCV-positive individuals. Diagnosis of chronic HCV infection is sufficient for treatment initiation with DAAs.

For each of the searches, we reviewed the titles and abstracts of articles listed to determine eligibility for inclusion. For studies meeting the criteria above, full-text articles were examined for final inclusion.

2.3 | Data items and extraction

We defined the primary outcome, linkage to care, as healthcare provider evaluation specifically for HCV infection. The secondary outcome, SVR, is determined by HCV RNA less than or equal to 15 IU/ml 12 weeks after the end of treatment. The numbers of patients linked or cured out of all those chronically infected were reported as percentages. Other care cascade outcomes, such as DAA initiation, were similarly reported. It is important to be cognizant of the denominators used in each study, which could drastically affect the percentages for linkage to care, SVR, and other outcomes. Some studies used the preceding care cascade outcome as the denominator, causing uptake to appear higher. For the current study, chronic infection (HCV RNA positivity) was used as the common denominator to standardize outcomes.

For this scoping review, we considered any articles mentioning people experiencing marginal housing and homelessness without limiting our collective cohort by using federal or other more specific definitions. For each study, we extracted data on this population only, except when studies did not stratify accordingly.

2.4 | Evaluation of individual studies and synthesis of results

We present a table of study characteristics including location, years covered, and setting. We also provide a summary table of HCV care cascade outcomes, highlighting linkage to care and/or SVR results for each study. These results were used to construct ranges for the primary, secondary, and exploratory outcomes. The strengths and limitations of included studies were assessed.

3 | RESULTS

3.1 | Selection of studies

We identified a total of 558 articles through the literature search described above. After review, eight studies were selected for this scoping review (Figure 2). Overall, four studies reported outcomes on linkage to care and five studies reported on SVR. Notably, half of the studies were conducted in U.S. Department of Veterans Affairs (VA) populations (Table 2).

3.2 | Linkage to care

Four sources of evidence reported linkage to care outcomes in people experiencing marginal housing and homelessness. The number of chronically infected participants in each cohort ranged from 82 to 30,680 across the four studies. Percent linkage out of those chronically infected (HCV RNA-positive) ranged from 29.3% to 88.7% (Table 3).^{10–13}

3.3 | Sustained virologic response

Five sources reported SVR. The sample sizes from these studies ranged from 199 to approximately 1.4 million chronically infected participants. Percent achieving SVR out of all chronically infected ranged from 5% to 50% across studies.^{8–10,12,14}

3.4 | Other HCV care cascade outcomes

Six studies examined DAA initiation, with outcomes ranging from 5% to 58.8%.^{8–10,12–14} One study stratified RNA positivity (or chronic infection) by type of homelessness—formerly homeless, currently homeless, or at risk of homelessness (reporting concern that they would lose housing in <60 days or accessing homelessness prevention services).¹⁵ Of persons formerly homeless, 16.7% were found to be RNA-positive. Of persons currently experiencing homelessness, 12.4% were RNA-positive. Of individuals at risk for experiencing homelessness, 8.2% were RNA-positive. Collectively, 13.7% of the cohort experiencing any type of homelessness were chronically infected with HCV.

3.5 | Strengths and limitations of individual studies

3.5.1 | Beiser, 2019

Strengths: This study demonstrated the effectiveness of an urban community-based primary care programme in achieving relatively high treatment outcomes in homeless-experienced individuals in the DAA era. Several factors contributed to the observed SVR rate of 50%, higher than that of the general U.S. population at 9% pre-DAA. Factors included the following: no exclusions based on sobriety or fibrosis for referral; a dedicated HCV care team for people experiencing homelessness; adherence support tailored to their needs ranging from calls to directly-observed therapy (DOT); and a co-located 340B pharmacy. Despite the availability of these resources, however, treatment initiation was shown to be a rate-limiting step and the authors advise increasing efforts towards initial engagement. Of the 300 individuals who did start treatment, 85% achieved cure.

The authors examined multiple predictors of the treatment outcomes and found that individuals with untreated opioid use disorder or on-treatment insurance change were less likely to achieve SVR, the latter associated with missed medication doses. They conducted intention-to-treat and sensitivity analyses to assess the primary outcome of SVR.

Limitations: The study was conducted at the Boston Health Care for the Homeless Program (BHCHP); however, 114 (38%) of 300 study participants were not homeless during treatment which calls attention to the fluid state of homelessness and how these changes affect health outcomes. Patients who were homeless at the time of evaluation were less likely to start treatment.

Some states continue to impose restrictions on DAA coverage. Massachusetts, however, is “a state with universal health insurance and a Medicaid programme that has been historically generous in covering HCV treatments,” limiting generalizability to other states and settings.⁸

3.5.2 | Barocas, 2017

Strengths: This study (covering February 2014 to August 2015) preceded that of Beiser et al. (January 2014 to March 2017) and was conducted in the same setting with the same population, albeit with a smaller sample size. Nonetheless, they were able to demonstrate an SVR rate of 97% in a primary care setting where patients experiencing marginal housing and homelessness were treated.

Limitations: This was a research letter that reported outcomes with minimal information on study background. More detail can be found in the larger follow-up study by Beiser et al.⁸

The authors explain that, “patients were selected by clinicians based on an assessment of treatment readiness, which was based on adherence to appointments,” among other factors,⁹ potentially introducing selection bias. Out of 199 people experiencing marginal housing and homelessness who were considered for DAA therapy, 64 were treated and included in the analysis. The rest were either untreated or treated outside the study period. Thus, the analysis was not intention-to-treat.

The insurance climate at the time required minimum progression to Metavir stage F2 before treatment consideration, which denied DAA access to patients with earlier stages of liver disease. For patients who did meet criteria, Medicaid or Medicare provided coverage for all but one.

3.5.3 | Coyle, 2019

Strengths: With 69.4% of patients medically evaluated for HCV treatment, results demonstrate a relatively high linkage to care rate. The authors found that test and treat site patients were more likely to be linked to care than patients at all other sites combined. Although treatment uptake was low overall, it was highest at the test and treat site. The support of Linkage to Care and HCV Treatment Coordinators may have accounted for the high linkage uptake.

Limitations: This study included participants without active or past homelessness; however, 389 (44%) of 885 viremic patients had a history of homelessness and three out of five clinics served people experiencing marginal housing and homelessness. Because the study period spanned from 2012 to 2017, some patients likely received non-DAA regimens (e.g., interferon). They do note that treatment initiation and rates of SVR increased after 2014 which they attribute to DAAs.

Similar to other studies in this scoping review, the authors point to the variability of insurance regulations across states, which is a significant upstream factor that limits generalizability. They attribute the low treatment uptake partly to prior authorization issues with insurance companies.

Outcomes for 25% of patients who completed treatment could not be determined, particularly for those treated off-site. Patients may have completed treatment but did not follow up for SVR assessment. Because of this, the authors believe that SVR was likely higher than reported.

3.5.4 | Dever, 2017

Strengths: The purpose of this study was to determine patient engagement and barriers to accessing DAA treatments in a real-world setting with VA patients, where high rates of HCV infection and homelessness have been noted.^{16,17} The authors note that the VA system is dedicated to long-term care with “low financial barriers for eligible patients.” For HCV treatment specifically, they state that “Funding and access issues were eliminated as barriers in our facility beginning in February 2016 and therefore did not affect the final antiviral treatment rate.”¹¹

This study employed multiple resources in an effort to engage patients including centralized identification of viremic patients, staged outreach and group classes where patients could also undergo labs and imaging. Importantly, patients were informed of curative medications, a knowledge barrier that keeps homeless persons from seeking treatment.⁷ In logistic regression, they identified homelessness to be a statistically independent factor associated with non-engagement in HCV care.

Limitations: This study included only one VA healthcare system in San Diego and focused on viremic high fibrotic risk patients. It spanned a period (2014–2016) during which the VA directive, initially, was to reserve treatment for patients at high risk for advanced fibrosis (FIB-4 > 2.4). Many patients with HCV were thus unable to access care and treatment during the earlier part of this study.

3.5.5 | Noska, 2017

Strengths: Using a large national cohort of 242,740 veterans experiencing homelessness, a population with high rates of testing, this study estimated that 13.4% were chronically infected with HCV. They also compared care cascade outcomes in veterans experiencing homelessness versus those not and observed higher rates of diagnosis and linkage among the former. However, veterans not experiencing homelessness were more likely to have been started on treatment. Both groups saw similar rates of SVR in those who received treatment.

Limitations: This was a cross-sectional study only looking at outcomes from one year (2015). Due to the large sample size, some outcomes were derived via estimation and not the result of direct observation or measurement.

3.5.6 | Lin, 2017

Strengths: Using a sample of veterans who were previously seen in HCV clinics pre-DAA (2009–2013), the authors studied their treatment outcomes in the DAA era. They also set a time frame for patients to link to care and start treatment (within the first 16 months of DAA availability).

The authors found that untreated patients were more likely to be experiencing homelessness compared to those who received DAAs. They also characterized the cohort with respect to multiple factors, including severity of liver disease. Cirrhosis and hepatocellular carcinoma were seen in 32.5% and 3.8% of all veterans with HCV, respectively.

Limitations: This national sample was not limited to persons experiencing homelessness which limits generalizability; however, 36% (30,680 out of 84,221) of the study population included chronically infected veterans experiencing homelessness. Because of the mixed methods study design, interpretation of the results was not entirely clear. Nonetheless, the data show that 51.8% and 11.7% of those experiencing homelessness were linked to care and initiated on DAAs, respectively.

3.5.7 | Chhatwal, 2019

Strengths: This study sought to estimate the HCV care cascade in the U.S. using a validated model for the years 2011, 2018 and 2030. They compared data from the National Health and Nutrition Examination Survey (NHANES) to outcomes in homeless and other key subpopulations not included in NHANES, the latter totaling 1.44 million people infected with HCV. The authors assert that “[estimates of] HCV care cascade in different subpopulations are required to identify potential gaps in care at the subpopulation level.”¹⁴

Limitations: Although DAAs were first introduced in 2011, interferon-free all-oral regimens were not approved by the United States Food and Drug Administration (FDA) until 2014, which is the beginning of the DAA era that is the focus of this review. Thus, only 2018 outcomes were analyzed.

Because other subpopulations were included in the non-NHANES sampling frame (incarcerated, active-duty military, nursing home, and immigrant cohorts), this restricts generalizability and makes it difficult to determine how the subpopulation of people experiencing homelessness affected the low SVR rate of 5%. In addition, the care cascade outcomes were estimated and not directly measured.

3.5.8 | Byrne, 2019

Strengths: The authors of this study stratified chronic HCV infection in a large veteran cohort by type of homelessness. Although the three types do not account for the full spectrum of unstable housing experienced by the population, results provide insight into where the HCV burden is greatest and where to potentially focus efforts. They observed an increasing gradient of HCV infection. Rates were highest among individuals with an “extended history of homelessness” (16.7%) and lowest among those at risk of becoming homeless (8.2%).¹⁵

Limitations: This study covered a period from 2011 to 2016, the earlier part of which still observed interferon as a treatment modality. Thus, the analysis included some data pre-DAAs without stratification pre- and post-2014.

4 | DISCUSSION

This review highlights the effectiveness of VA and community-based programs in achieving relatively high rates of linkage to care. Clinics that function as test and treat sites with dedicated HCV care teams experienced in working with people experiencing homelessness have the potential to offer high rates of cure.

In one study, persons experiencing homelessness had high testing, diagnosis, and linkage to care rates compared to individuals with stable housing.¹² This may occur through existing linkages with other care systems such as HIV or addiction clinics.⁸ However, a major drop-off point on the care cascade for cohorts with unstable housing was at the treatment initiation step, which determines downstream effects on SVR.^{8–10,12–14} Our results show that treatment initiation outcomes mirror SVR outcomes and range from 5% to 58.8%, which is promising, in that, most homeless-experienced people who start DAAs ultimately achieve cure. In the general population pre-DAAs, linkage to care and treatment initiation rates were comparable (17% and 16%, respectively).³ However, among people experiencing homelessness in the DAA era, many who see a provider for HCV infection do not go on to start treatment as shown by the large gaps between linkage and DAA initiation (Table 3). Masson et al.⁷ attribute this to inter-related individual- and social-level factors and propose as a solution integrated models of care with interventions that improve patient knowledge of HCV and the availability of effective treatments. Severity of housing instability, discontinuous insurance coverage, and insurance coverage policies for treatment

were influential factors noted in some of the studies reviewed. For people experiencing homelessness, HCV treatment may be a lower priority compared to housing. They may also miss more medical appointments and, therefore, opportunities to renew their insurance plans.

SVR rates have generally increased over time among people experiencing homelessness with HCV. Opportunities to bypass steps of the care cascade have the potential to increase treatment uptake and cure. True test and treat sites can eliminate the need for multiple visits before treatment is started. Likewise, shelter-based clinics bring treatment to patients who access these facilities and help address financial and transportation barriers. Finally, integration of services and collaboration among homeless health care, behavioral health, and addiction and harm reduction sectors may be the most effective approach to achieving higher outcomes throughout the care cascade.⁸

The heterogeneity of the selected studies, particularly with respect to sample size variation, should be noted. The studies were also conducted in outpatient settings with variable structures, staffing, and resources. Major social support services and on-site treatment contributed to higher rates of linkage to care and SVR in some of the studies reviewed. These types of interventions may be replicable in a variety of settings.

We did not set restrictions on length of time allotted for care engagement as this scoping review sought to examine the breadth of cascade literature on cohorts with unstable housing. However, Dever et al. looked at care engagement over 12–20 months, while Lin and colleagues set a time frame of 16 months from availability of DAAs for linkage and treatment to occur.^{11,13} It is also important to note that two studies included pre-2014 data in the analyses.^{10,15}

The VA is a major provider of HCV care in the U.S. with a disproportionate number of veterans experiencing homelessness.^{16,17} Half of the studies in this review examine this robust national data set of persons experiencing homelessness with HCV infection. As such, results are based on a largely male population. Additionally, the VA has a unique healthcare delivery structure with substantial support and in-network HCV care. The barriers that patients experience at the VA can be very different than those experienced in community health centers, which may affect treatment outcomes depending on setting.

We included any studies mentioning people experiencing marginal housing and homelessness without restrictions on timing of homelessness. One study characterized housing status by three types: at risk of, current, and former homelessness.¹⁵ Some of the studies also included participants without active or past homelessness, which may have affected treatment outcomes. The spectrum of homelessness and fluidity in which persons transition into or out of homelessness significantly impacts care seeking and access.

This scoping review did not address risk or rates of reinfection, as reinfection is not an outcome on the care cascade, although reentry into the cascade is an important systems-level consideration. Similarly, the dynamics of co-infection (such as with HIV) and effect on treatment outcomes for persons experiencing homelessness were not explored. Only two studies provided insight into severity of liver disease. While Dever et al.¹¹ exclusively

studied high fibrotic risk patients, Lin et al.¹³ noted that 32.5% of their cohort had evidence of cirrhosis and 3.8% had hepatocellular carcinoma.

We only queried one database for this scoping review, but PubMed contains an extensive breath of information sources. Other databases to explore HCV or public health policy information were considered, but we ultimately deemed PubMed to have wide enough breadth for the purposes of this scoping review.

Only one investigator extracted data, but resolution of discrepancies was not called for due to the quantitative nature of the data. Expertise in HCV epidemiology was available throughout the study.

In summary, these results show that people experiencing homelessness achieve high rates of linkage to care and SVR in community-based settings where treatment and wraparound services are provided on-site to ensure that patients not only start DAAs but are offered support through the end of treatment.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Abbreviations:

BHCHP	Boston Health Care for the Homeless Program
DAAs	direct-acting antiviral agents
DOT	directly-observed therapy
FDA	United States Food and Drug Administration
HCV	hepatitis C virus
MeSH	Medical Subject Headings
NHANES	National Health and Nutrition Examination Survey
SVR	sustained virologic response
VA	U.S. Department of Veterans Affairs

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TREATMENT CASCADE FOR PEOPLE WITH CHRONIC HEPATITIS C VIRUS (HCV) INFECTION

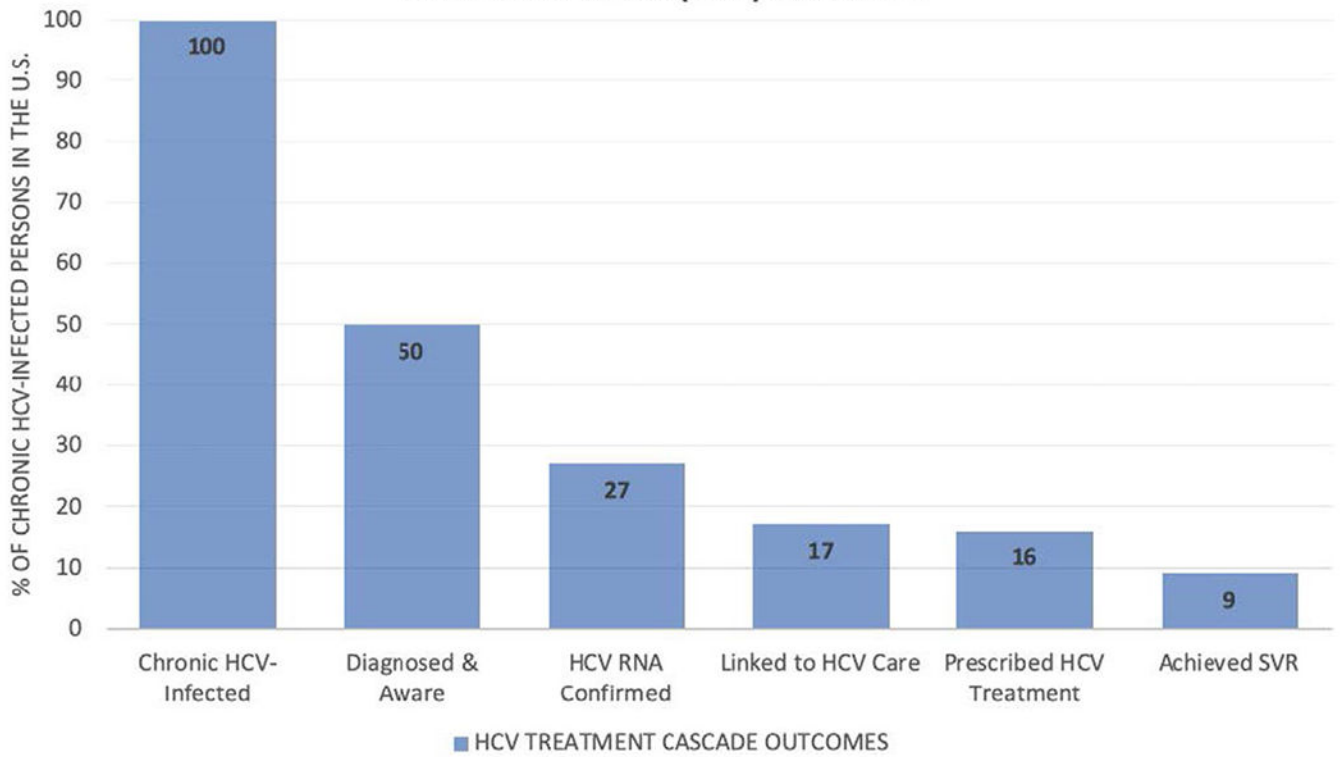


FIGURE 1. Treatment cascade for people with chronic HCV infection, adapted from a systematic review published by Yehia et al.³

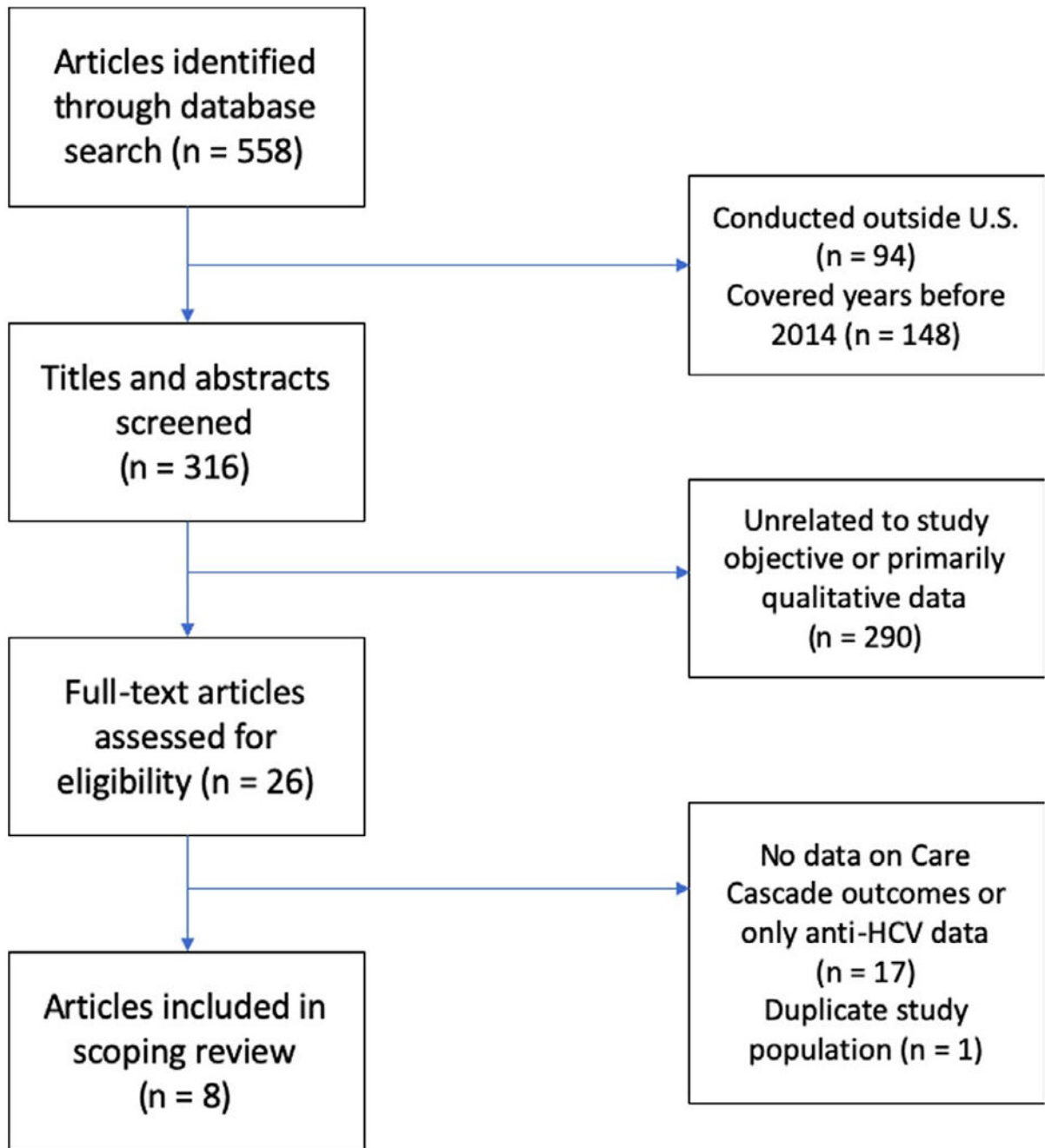


FIGURE 2.
Flow diagram from identification to inclusion

TABLE 1

Selected PubMed searches, conducted in April and May 2020

Search	Items found	References initially selected
(linkage to care) AND "Hepatitis C"[Mesh]	215	129
((cascade of care) AND "Hepatitis C"[Mesh])) NOT ((linkage to care) AND "Hepatitis C"[Mesh])	55	37
(((((("Vulnerable Populations"[Mesh]) OR "Working Poor"[Mesh]) OR "Transients and Migrants"[Mesh]) OR "Medically Uninsured"[Mesh])) AND "Hepatitis C"[Mesh])	105	40
(((((("Treatment Adherence and Compliance"[Mesh]) AND "Hepatitis C"[Mesh])) AND "United States"[Mesh])	133	62

TABLE 2

Individual study characteristics

First Author, Year (Reference No.)	Location	Years covered	Study design	Setting	On-site vs. Off-site Services	Study sample
Beiser, 2019 ⁸	Boston	2014–2017	Retrospective cohort	Community-based primary care program	On-site	510 homeless-experienced
Barocas, 2017 ⁹	Boston	2014–2015	Retrospective cohort	Community-based primary care program	On-site	199 homeless and marginally housed
Coyte, 2019 ¹⁰	Philadelphia	2012–2017	Retrospective cohort	Five federally qualified health centers	1 clinic on-site, 4 clinics off-site	14,790 HCV screened patients
Dever, 2017 ¹¹	San Diego	2014–2016	Retrospective cohort	VA HCV clinic	On-site	481 high fibrotic risk veterans
Noska, 2017 ¹²	National	2015	Cross-sectional	VHA outpatient clinics	On-site	242,740 homeless veterans
Lin, 2017 ¹³	National	2013–2015	Mixed methods	VA HCV clinics	On-site and/or off-site	84,221 previously seen in HCV clinics pre-DAAAs
Chhatwal, 2019 ¹⁴	National	2011; 2018; 2030	Modeling	Multiple (including institutionalized)	N/A	~1.4 million non-NHANES HCV persons
Byrne, 2019 ¹⁵	National	2011–2016	Retrospective cohort	128 VAMC facilities nationwide; outpatient	On-site	434,315 homeless and unstably housed veterans

Abbreviations: DAAs, direct-acting antiviral agents; HCV, hepatitis C virus; non-NHANES, groups not included in National Health and Nutrition Examination Survey; VA, U.S. Department of Veterans Affairs; VAMC, Veterans Affairs Medical Center; VHA, Veterans Health Administration.

TABLE 3

HCV care cascade outcomes in persons experiencing homelessness

Study	First Author, Journal, Year (Reference No.)	HCV care cascade outcomes
Hepatitis C treatment outcomes among homeless-experienced individuals at a community health centre in Boston	Beiser, <i>Int J Drug Policy</i> , 2019 ⁸	RNA (+) & linked: 510 DAA: 300 (58.8%) SVR: 255 (50%)
Experience and outcomes of hepatitis C treatment in a cohort of homeless and marginally housed adults	Barocas, <i>JAMA Intern Med</i> , 2017 ⁹	RNA (+) & linked: 199 DAA: 64 (32.2%) SVR: 62 (31.2%)
The hepatitis C virus care continuum: linkage to hepatitis C virus care and treatment among patients at an urban health network, Philadelphia, PA	Coyle, <i>Hepatology</i> , 2019 ¹⁰	RNA (+): 885 LTC: 614 (69.4%) DAA: 133 (15%) SVR: 71 (8%)
Engagement in care of high-risk hepatitis C patients with interferon-free direct-acting antiviral therapies	Dever, <i>Dig Dis Sci</i> , 2017 ¹¹	RNA (+): 82 LTC: 24 (29.3%)
Engagement in the hepatitis C care cascade among homeless veterans, 2015	Noska, <i>Public Health Rep</i> , 2017 ¹²	RNA (+): 29,063 LTC: 25,786 (88.7%) DAA: 7421 (25.5%) SVR: 5041 (17.3%)
Barriers to hepatitis C treatment in the era of direct-acting antiviral agents	Lin, <i>Aliment Pharmacol Ther</i> , 2017 ¹³	RNA (+): 30,680 LTC: 15,895 (51.8%) DAA: 3600 (11.7%)
The impact of direct-acting antivirals on the hepatitis C care cascade: identifying progress and gaps towards hepatitis C elimination in the United States	Chhatwal, <i>Aliment Pharmacol Ther</i> , 2019 ¹⁴	RNA (+): ~1.4 million non-NHANES DAA: ~70,000 (5%) SVR: ~70,000 (5%)
A novel measure to assess variation in hepatitis C prevalence among homeless and unstably housed veterans, 2011–2016	Byrne, <i>Public Health Rep</i> , 2019 ¹⁵	RNA (+) any homeless: 59,555 of 434,240 (13.7%) RNA (+) formerly homeless: 32,490 of 195,000 (16.7%) RNA (+) currently homeless: 22,050 of 178,056 (12.4%) RNA (+) at risk of homelessness: 5015 of 61,184 (8.2%)

Abbreviations: DAA, direct-acting antiviral agent initiation; HCV, hepatitis C virus; LTC, linkage to care; non-NHANES, groups not included in National Health and Nutrition Examination Survey; RNA (+), ribonucleic acid positive; SVR, sustained virologic response.

Primary (LTC) and secondary (SVR) outcomes are presented in bold.