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MAJOR ARTICLE

# Continuum of Care for Hepatitis C Virus Among Patients Diagnosed in the Emergency Department Setting

**Erik S. Anderson,[1,2,3] James W. Galbraith,[4] Laura J. Deering,[1] Sarah K. Pfeil,[1] Tamara Todorovic,[1] Joel B. Rodgers,[4] Jordan M. Forsythe,[4] Ricardo Franco,[5] Henry Wang,[4] N. Ewen Wang,[2] and Douglas A. E. White[1]**

[1]Department of Emergency Medicine, Alameda Health System, Highland Hospital, Oakland, and [2]Department of Emergency Medicine, Stanford University, Palo Alto, California; [3]Northern Navajo Medical Center, Shiprock, New Mexico; and Departments of [4]Emergency Medicine and [5]Internal Medicine, Division of Infectious Diseases, University of Alabama at Birmingham

***Background.*** Urban emergency departments (EDs) seem to be able to detect new hepatitis C virus (HCV) infections at a high rate, but it is unknown the extent to which individuals screened in the ED can progress to treatment and cure. We evaluate the HCV Continuum of Care for patients identified with HCV in 2 urban EDs, and consider the results in the context of outcomes from ambulatory screening venues where 2%–10% of chronically infected patients are treated.

***Methods.*** This is a multicenter, retrospective cohort study of 2 ED HCV screening programs. Patients who screened HCV antibody reactive between 1 May and 31 October 2014 were followed for up to 18 months. The main outcome was the absolute number and proportion of eligible patients who completed each stage of the HCV Continuum of Care.

***Results.*** A total of 3704 ED patients were estimated to have undiagnosed HCV infection, and screening identified 532 (14.4%) HCV antibody–reactive patients. Of the 532 HCV antibody–reactive patients, 435 completed viral load testing (82%), of whom 301 (69%) were chronically infected. Of the 301 chronically infected patients, 158 had follow-up arranged (52%), of whom 97 attended their appointment (61%). Of these 97, 24 began treatment (25%), and 19 of these 24 achieved sustained virological response (79%).

***Conclusions.*** Urban EDs serve patients with poor access to preventive care services who have a high prevalence of HCV infection. Because ED patients identified with HCV infection can progress to treatment and cure with rates comparable to ambulatory care settings, implementation of ED HCV screening should be expanded.

**Keywords.** hepatitis c virus; screening; emergency department; linkage to care; continuum of care.

Hepatitis C virus (HCV) infection affects 3–4 million persons in the United States and accounts for more deaths annually than human immunodeficiency virus (HIV), tuberculosis, and 58 other nationally reportable infectious conditions combined [1, 2]. Furthermore, it is estimated that nearly half of individuals with HCV infection are unaware of their diagnosis [3].

Both the Centers for Disease Control and Prevention (CDC) and the US Preventive Services Task Force have recently expanded their HCV screening guidelines to include screening for all baby boomers (born between 1945 and 1965) at least once, in addition to high-risk patient populations such as persons with a history of injection drug use [4, 5]. Recent data show that urban emergency departments (EDs) may play an important role as safety net providers for HCV screening [6, 7]. ED-based HCV screening programs have reported an alarmingly high overall prevalence of HCV antibody reactivity, approaching 10% among all persons tested [8–10]. This disease burden far exceeds national estimates for baby boomers in the general population (3–4%), as well other healthcare settings in which it has been measured [4, 11–14]. Although the detection of undiagnosed HCV infection itself likely has some inherent benefit (through harm reduction measures or the modification of comorbidities that accelerate cirrhosis), the impact and importance of screening are greatly reduced if it does not lead to treatment and cure. While urban EDs seem to be able to detect new HCV infections at a high rate, the extent to which individuals screened for HCV in the ED can progress to cure is unknown.

It may be reasonable to conjecture that patients screened in the ED for HCV would face significant patient- and system-level barriers to treatment. Urban ED patients have been shown to have lower median incomes, less-adequate insurance coverage, and higher rates of substance use disorders and homelessness compared with patients in the ambulatory care setting [15–19]. Additionally, EDs are often poorly integrated into the greater healthcare system and emergency providers do not have ongoing doctor–patient relationships, making linkage to subspecialty care particularly difficult. These concerns about the ability to connect patients to HCV treatment may be the

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Correspondence: E. S. Anderson, Northern Navajo Medical Center, PO Box 160 Shiprock, NM 87420 (esoremanderson@gmail.com).

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rationale behind the decision by the Centers for Medicare and Medicaid Services to exclude EDs, and other secondary screening venues, from reimbursement for HCV screening [20].

Despite these concerns, there may be tremendous public health benefit for HCV screening in the ED setting. Many patients utilize the ED as a safety net for preventive care services and may not be diagnosed in other healthcare environments [18, 21]. Emergency departments also have higher rates of patients who use injection drugs, and screening and treatment for this population carries substantial potential to curb incident HCV infections [22, 23]. Currently there are few EDs engaged in HCV screening, and a perceived or actual lack of treatment capacity likely acts as a disincentive to the widespread adoption of screening programs. The demonstration of rates of treatment for patients identified in the ED may encourage a more widespread adoption of HCV screening in the emergency care setting.

The HCV Continuum of Care is a population health model that describes successive stages as patient progress from disease identification to cure [24–27]. It can be used to describe the public health burden of HCV and identify gaps in care and foci for improvement. Hepatitis C virus screening programs in ambulatory care settings have demonstrated significant barriers to completing the Continuum of Care, with only 2%–10% of chronically infected patients successfully treated with antiviral medications [13, 14, 28, 29]. In this study we apply the HCV Continuum of Care model to a retrospective cohort of patients diagnosed from 2 ED HCV screening programs, and consider the results in the context of outcomes from screening programs in other settings.

## MATERIALS AND METHODS

### Design and Setting

This is a multicenter, retrospective cohort study of 2 ED HCV screening programs. The 2 EDs are located in urban areas in geographically distinct regions of the country: Highland Hospital (HH) in Oakland, California, and the University of Alabama at Birmingham (UAB). This project received institutional review board approval from the participating institutions with a waiver of written informed consent.

### Study Sites

Highland Hospital is a public, urban ED, and is located in a state that expanded Medicaid to low-income adults [30]. Patients at HH can also be enrolled in a county health plan that provides limited coverage for specialty services, including HCV treatment, if provided within the county health system. Highland Hospital has 250 inpatient beds, an annual ED census of 90 000 visits, and an HCV clinic run by gastroenterology specialists. The community in Oakland, California, has had an increase in opioid overdoses and injection drug use in recent years, though on a lesser level than rural areas throughout California or compared to Alabama as a whole [31, 32]. Oakland also has several syringe exchange programs, and there are significant resources in the community for harm reduction measures for the prevention of HIV and HCV. At the time of this study, however, HH had not made significant investments in increasing treatment capacity for HCV infection.

The UAB is an urban, academic ED, and is located in a state that did not expand Medicaid to low-income adults [30]. The UAB hospital has 1000 inpatient beds, an annual ED census of 75 000 visits, and an HCV clinic run by infectious disease and gastroenterology specialists. Birmingham and its surrounding more rural counties have been hit particularly hard by the opioid epidemic, and there are no syringe exchange programs in the state of Alabama [31, 33]. At the time of this study, the UAB HCV clinic run by infectious disease specialists added additional clinic days to accommodate HCV-infected patients identified in the ED.

### Screening and Linkage Protocols

Both ED screening programs utilized a triage-based screening strategy targeting baby boomers (born between 1945 and 1965) and patients with a current or past injection drug use history. The specifics of each hospital's HCV screening program can be found elsewhere [8, 9]. The characteristics of the linkage to care protocols can be found in Table 1.

### Participants and Exposures

All patients presenting to the ED were included in this study, with a focus on those patients who were tested for and diagnosed with HCV and were not already engaged in HCV-specific care. The study period took place from 1 May through 31 October

**Table 1. Details and Responsibilities for Stages of the of the Hepatitis C Virus Continuum of Care for Patients Screened in the Highland Hospital and University of Alabama at Birmingham Emergency Departments**

| Stage | Highland Hospital | University of Alabama at Birmingham |
|---|---|---|
| HCV screen | Screened at triage; baby boomer and past or current IDU eligible | Screened at triage; baby boomer and past or current IDU eligible |
| Order HCV viral load | Performed by EP on initial ED visit when possible, otherwise LTCC | Performed by ED laboratory on initial ED visit, otherwise LTCC |
| Arrange follow-up with HCV treating provider | Arranged by EP for HCV antibody–reactive patients on index visit if possible, otherwise by LTCC if chronically infected | Arranged by LTCC only if chronically infected |
| Retain in care and treatment | HCV clinic | HCV clinic |

Abbreviations: ED, emergency department; EP, emergency physician; HCV, hepatitis C virus; IDU, injection drug use; LTCC, linkage to care coordinator.

2014. The follow-up period for all stages in the Continuum of Care was collected until 31 October 2015. All patients who had treatment initiation prior to 31 October 2015 were followed to assess for sustained virologic response (SVR) at a minimum of 12 weeks.

### Main Outcomes and Measures

The estimation for the total number of ED patients who are HCV antibody reactive and undiagnosed is based on each institution's unpublished data from pilot nontargeted HCV screening programs in the ED. The estimated prevalence of patients who are HCV antibody reactive and undiagnosed in the ED at HH is 5.7% and at UAB is 7.7%. The results of the HCV antibody and viral load tests were captured from the laboratory electronic health record. Time to viral load completion was divided into whether it was ordered and the blood was drawn before or after 24 hours. This 24-hour time cutoff was used as a surrogate marker for whether or not viral load testing was drawn while the patient was still in the ED. The results of follow-up appointment scheduling, adherence, and treatment initiation were prospectively collected by the linkage to care coordinator at each hospital, and cross checked at the end of the study period by medical records review by 2 study investigators at each site to ensure accuracy (E. S. A., J. W. G., L. J. D., J. F.).

Demographic information and insurance status at the initial ED visit was downloaded from the electronic health record at each institution. We defined SVR as an undetectable viral load drawn at a minimum of 12 weeks after treatment was finished, defined in the literature as treatment success [34]. Using a standardized medical records review process, 2 investigators (E. S. A., J. W. G.) assessed the reasons for treatment failure. The data at HH was stored in a spreadsheet (Microsoft Excel 2010, Microsoft, Redmond, Washington) in a secure, encrypted, research computer, and then transferred to a secure online software Research Data Capture (RedCAP) hosted by Stanford University for data analysis [35]. All patient data from UAB were collected and stored using RedCAP.

### Data Analysis

The primary outcome was the absolute number and proportion of patients eligible for each step of the Continuum of Care who completed it. Secondary outcomes were the time to completion of viral load, follow-up, and treatment. Descriptive analysis was performed for all variables, and patients rather than visits were the unit of analysis. All statistical analyses were performed using Stata version 13 software (StataCorp LP, College Station, Texas).

## RESULTS

During the 6-month study period, 55 335 unique patients presented to the 2 EDs. The characteristics of the HCV antibody–reactive cohort at each institution can be found in Table 2. The full results and characteristics of patients in the Continuum of Care can be found in Table 3. Figure 1 shows the Continuum of Care for each institution individually and combined.

**Table 2. Characteristics of Hepatitis C Virus Antibody–Reactive Patients Identified at the Highland Hospital and University of Alabama Birmingham Emergency Departments**

| | Highland Hospital | University of Alabama at Birmingham | |
|---|---|---|---|
| Total HCV Antibody Reactive | (n = 226) | (n = 306) | *P* Value |
| Age, y, mean (SD) | 52.6 (10.7) | 54.0 (11.7) | .05 |
| Birth cohort | | | |
| Born after 1965 | 59 (26) | 79 (26) | .79 |
| Born 1945–1965[a] | 164 (73) | 221 (72) | .80 |
| Born before 1945 | 3 (1) | 6 (2) | .36 |
| Reason for test | | | |
| Current or prior IDU | 30 (13) | 19 (6) | .01 |
| Birth cohort | 116 (51) | 193 (63) | .01 |
| Both | 48 (21) | 28 (9) | <.001 |
| Unknown | 32 (14) | 66 (22) | .02 |
| Sex | | | |
| Male | 146 (65) | 195 (64) | .81 |
| Female | 80 (35) | 110 (36) | |
| Race/ethnicity | | | |
| Black | 140 (62) | 140 (46) | <.001 |
| Hispanic | 24 (11) | 1 (0) | <.001 |
| Asian | 5 (2) | 0 (0) | .01 |
| White | 51 (23) | 163 (53) | <.001 |
| Other/unknown | 6 (3) | 2 (1) | .09 |
| Insurance | | | |
| Medicare | 29 (13) | 71 (23) | .01 |
| Medicaid | 183 (81) | 95 (31) | <.001 |
| Private | 3 (1) | 28 (9) | <.001 |
| Uninsured/self-pay | 2 (1) | 68 (22) | <.001 |
| Other/unknown | 9 (4) | 5 (2) | .17 |

Abbreviations: HCV, hepatitis C virus; IDU, injection drug use; SD, standard deviation.

[a]Baby boomers identified as being at higher risk of HCV infection by the US Preventive Services Task Force and the Centers for Disease Control and Prevention [4, 5].

We estimated 3704 patients (6.7% of the unique patient census) to be undiagnosed HCV antibody reactive, of which 532 (14.4%; 95% confidence interval [CI], 13.2%–15.5%) were identified through screening. Of the 532 HCV antibody–reactive patients, 435 completed viral load testing (81.8%; 95% CI, 78.2%–85.0%). There were 226 HCV antibody–reactive patients identified from the HH ED, of which 185 (81.9%) had viral load testing performed. There were 306 HCV antibody–reactive patients identified from the UAB ED, of which 250 (81.7%) had viral load testing performed.

Of the 301 chronically infected patients, 97 (32.2%; 95% CI, 27%–38.0%) attended their follow-up appointment. There were 129 chronically infected patients identified from the HH ED, of which 44 (34.1%) attended their follow-up appointment. There were 172 chronically infected patients identified from the UAB ED, of which 53 (30.8%) attended their follow-up appointment.

**Table 3. Characteristics of Patients Screened in the Emergency Department at Each Stage of the Hepatitis C Virus Continuum of Care[a]**

| | Part 1: Detection | | | Part 2: Linkage to Care | | | | |
|---|---|---|---|---|---|---|---|---|
| | Undiagnosed HCV-Ab Reactive (n = 3704[b] [100%]) | Undiagnosed and Tested HCV-Ab Reactive[c] (n = 532 [14%]) | HCV-Ab Reactive and Viral Load Testing Completed (n = 435 [82%]) | Chronically Infected[d] (n = 301 [100%]) | Follow-up Arranged[e] (n = 158 [52%]) | Follow-up Attended[f] (n = 97 [61%]) | Treatment Initiated (n = 24 [25%]) | SVR[g] (n = 19 [79%]) |
| Age, y, mean (SD) | … | 53.4 (11.3) | 53.4 (11.3) | 53.3 (11.4) | 55.1 (10.0) | 55.9 (10.2) | 58.9 (7.6) | 59.3 (8.2) |
| Birth cohort | | | | | | | | |
| Born after 1965 | … | 138 (26) | 109 (25) | 79 (26) | 28 (18) | 15 (15) | 2 (8) | 2 (11) |
| Born 1945–1965 | … | 385 (72) | 319 (72) | 219 (73) | 130 (82) | 82 (85) | 22 (88) | 17 (89) |
| Born before 1945 | … | 9 (2) | 7 (2) | 3 (1) | 0 | 0 | 0 | 0 |
| Reason for test | | | | | | | | |
| Current or prior IDU | … | 49 (9) | 42 (10) | 31 (10) | 17 (11) | 10 (10) | 2 (8) | 2 (11) |
| Birth cohort[h] | | 309 (58) | 250 (57) | 169 (56) | 96 (61) | 64 (66) | 17 (71) | 14 (74) |
| Both | … | 77 (14) | 69 (16) | 50 (17) | 34 (22) | 18 (19) | 5 (21) | 3 (16) |
| Unknown | … | 98 (18) | 74 (17) | 51 (17) | 11 (7) | 5 (5) | 0 | 0 |
| Sex | | | | | | | | |
| Male | … | 341 (64) | 277 (64) | 213 (71) | 107 (68) | 64 (67) | 11 (46) | 8 (42) |
| Female | … | 190 (36) | 157 (36) | 96 (32) | 59 (37) | 32 (33) | 13 (54) | 11 (58) |
| Race/ethnicity | | | | | | | | |
| Black | … | 280 (53) | 234 (54) | 179 (59) | 107 (68) | 69 (71) | 15 (63) | 11 (58) |
| Hispanic | … | 25 (5) | 21 (5) | 10 (3) | 6 (4) | 3 (3) | 1 (4) | 1 (5) |
| Asian | … | 5 (1) | 4 (1) | 2 (1) | 2 (1) | 2 (2) | 1 (4) | 0 |
| White | … | 214 (40) | 169 (39) | 106 (35) | 41 (26) | 22 (23) | 6 (25) | 6 (32) |
| Other/unknown | … | 8 (2) | 6 (1) | 4 (1) | 3 (2) | 1 (1) | 1 (4) | 1 (5) |
| Insurance | | | | | | | | |
| Medicaid[i] | … | 278 (52) | 234 (54) | 165 (55) | 108 (68) | 63 (65) | 14 (58) | 10 (53) |
| Medicare | … | 100 (19) | 76 (17) | 50 (17) | 26 (16) | 16 (16) | 6 (25) | 5 (26) |
| Private | … | 31 (6) | 26 (6) | 13 (4) | 8 (5) | 5 (5) | 1 (4) | 1 (5) |
| Uninsured/self-pay | … | 70 (13) | 54 (12) | 40 (13) | 5 (3) | 5 (5) | 1 (4) | 1 (5) |
| Other/unknown | … | 53 (10) | 45 (10) | 33 (11) | 11 (7) | 8 (8) | 2 (8) | 2 (11) |

Abbreviations: Ab, antibody; HCV, hepatitis C virus; IDU, injection drug use; SD, standard deviation; SVR, sustained virologic response.

[a]Proportions in column headings indicate proportion of patients who progress to the next stage based on the number of patients eligible to complete that stage; proportions in each row represent the proportion of patients in each category of the total patients in that stage.

[b]Estimate based on pilot nontargeted screening data at each institution.

[c]Undiagnosed and not already engaged in HCV care.

[d]Elevated viral load; the beginning of part 2: linkage to care.

[e]A follow-up appointment was made with an HCV treating provider.

[f]Patient succesfully attended their arranged follow-up appointment.

[g]SVR was defined as undetectable viral load 12 weeks after treatment.

[h]Born between 1945 and 1965.

[i]Including state-sponsored county health plans.

Of the 97 patients who presented for treatment, 19 (19.6%; 95% CI, 12.2%–28.9%) were treated and achieved an SVR. Forty-four patients from the HH ED presented for HCV treatment, of whom 6 (13.6%) were treated and achieved an SVR. There were 53 patients identified from UAB ED who presented for HCV treatment, of which 13 (24.5%) were treated and achieved an SVR.

Of the 421 patients for whom the date of viral load testing was known, 317 (75.3%; 95% CI, 70.9%–79.3%) had testing performed within 24 hours of the reactive HCV antibody test. Of the patients who had viral load testing completed after 24 hours, the median time to viral load testing was 103.5 days (interquartile range [IQR], 15–206.5 days). The overall median time to successful follow-up was 145.5 days (IQR, 66–311 days). The median time from screening to treatment initiation was 271 days (IQR, 226–337 days), and all patients received novel oral direct-acting antiviral (DAA) medications. Five patients who began treatment did not achieve an SVR: 2 HH patients finished a course of treatment but did not achieve SVR; 1 HH patient and 1 UAB patient did not finish treatment due to a substance use disorder; and 1 HH patient was lost to follow-up after moving out of state.

## DISCUSSION

In this study we apply the HCV Continuum of Care to 2 ED HCV screening programs in geographically distinct areas of the

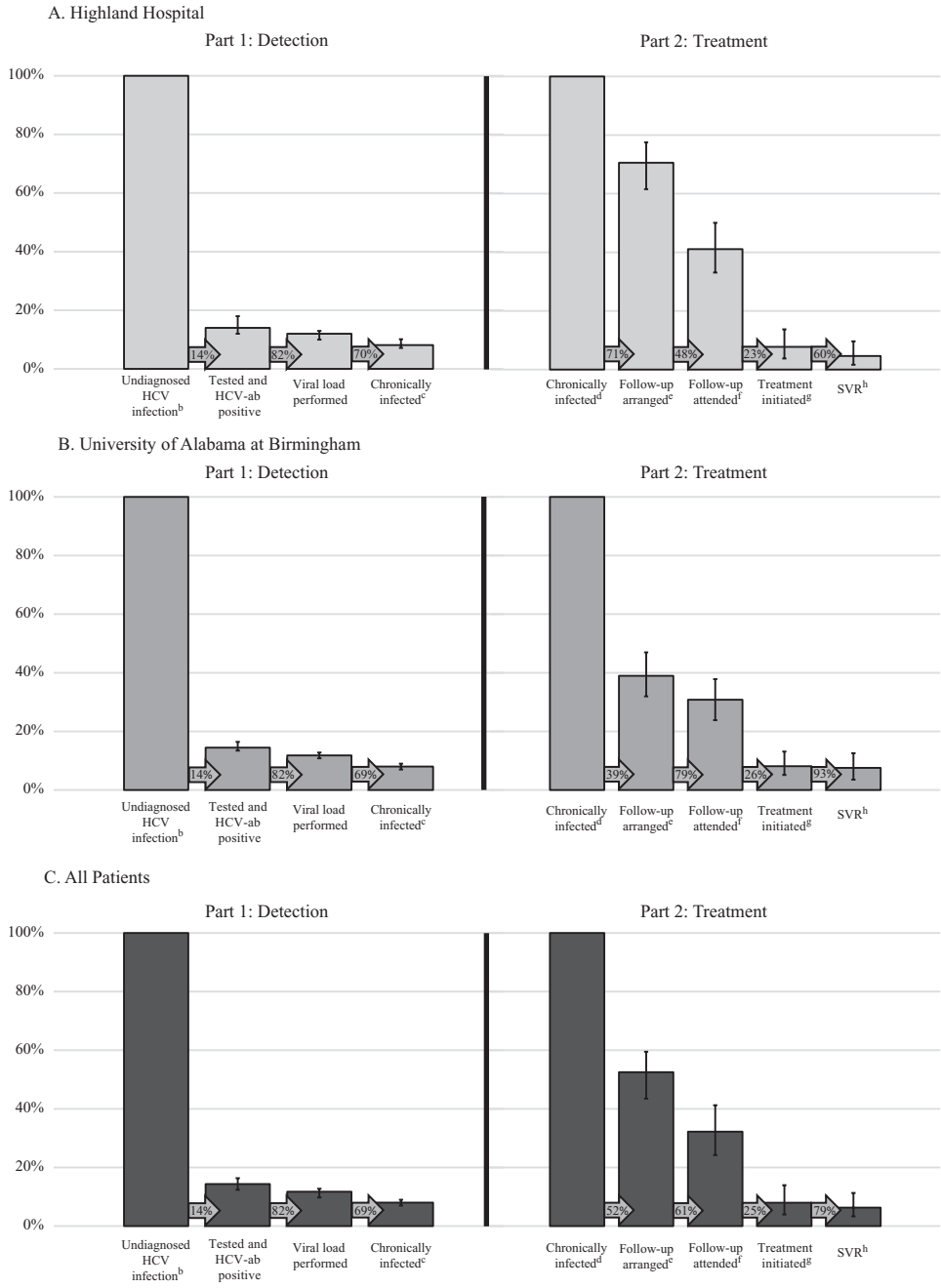


**Figure 1.** The hepatitis C virus (HCV) Continuum of Care for patients identified in the emergency department. [a]Column height proportions are based on the initial stage in each part of the Continuum of Care. Proportion of patients progressing to the next stage among eligible patients are shown within the arrows. Error bars represent 95% confidence intervals. [b]Estimated total undiagnosed HCV antibody (HCV-ab) reactive. [c]Detectable viral load of those who had viral load performed. [d]Total chronically infected. [e]Follow-up appointment arranged with HCV treating provider. [f]Attended at least 1 follow-up appointment with HCV treating provider. [g]Began treatment with direct-acting antiviral medications. [h]Sustained virologic response (SVR) at least 12 weeks after treatment completed.

country in the era of all-oral DAA treatments. Overall, the HCV Continuum of Care showed significant attrition as patients identified with HCV in the ED progressed from screening to cure. Importantly, the rates of treatment among chronically infected patients screened in the ED (8%) are comparable to the rates of treatment for patients identified in other health settings (2%–10%) [13, 14, 28, 29].

The drop-offs seen in the initial detection stages of the HCV Continuum of Care may be the most amenable to innovations in ED processes and protocol modifications. For example, if patients were not able to complete viral load testing during their ED visit, it generally took 100 days to get testing completed. This represents a significant barrier for patient linkage, and was resource intensive for staff. A solution to this barrier could be the implementation

of routine viral RNA testing policies for HCV antibody–reactive patients [36] or the development automated reflex testing procedures on preexisting reactive antibody samples [37].

Arranging and successfully attending follow-up appointments represent stages that can be improved through a multidisciplinary approach. These were also the only stages where we found significantly differing results between institutions: Patients at HH were more likely to have follow-up arranged, but less likely to attend their follow-up appointments. This may be due to differing approaches to these early stages in the Continuum of Care. Providers in the ED at HH were able to directly book HCV clinic appointments for HCV antibody–reactive patients if they were still in the ED, and the linkage to care coordinator arranged follow-up for patients when this was not possible. At UAB, the linkage coordinator was responsible for establishing contact with all HCV antibody–reactive patients by phone, conducting brief education and counseling, and arranging follow-up only after they were confirmed to be chronically infected. The UAB approach of contacting patients prior to arranging follow-up may better utilize limited specialty clinic access by ensuring higher rates of follow-up attendance. Expanding treatment capacity outside of specialty clinics and into primary care settings may also help improve access to curative treatments, as the median time to follow-up with treating providers at both institutions was close to 5 months.

The steepest drop between stages was from follow-up attendance to treatment, which mirrors the state of the HCV continuum nationally. While the ED does not provide treatment for HCV, the health system's capacity to provide it directly affects the impact and efficacy of ED screening activities. We found that only 8% of chronically infected patients in our study began treatment with DAAs, and this is similar to rates of treatment for patients identified in other healthcare settings [13, 14, 28, 29]. Several recent studies have utilized an HCV care continuum to evaluate screening programs in various ambulatory care settings, including the Kaiser Permanente system, an opioid detoxification program, a network of urban community-based primary care clinics, and a postincarceration clinic [13, 14, 28, 29]. Each study found significant attrition at most stages of care, and of the studies reporting treatment outcomes, between 2% and 10% of chronically infected patients were treated. It is possible that the low treatment rates found in the ED and other settings are simply reflective of the low treatment capacity throughout the healthcare system. As treatment capacity increases, it may also be possible that EDs will remain affected by barriers to care that are lifted elsewhere.

The HCV epidemic is currently 4 times the size of the HIV epidemic, but receives <3% of funding compared to HIV [38]. Without policy changes aimed at increasing screening and linkage to care for HCV, annual mortality from HCV is expected to reach 35 000 by 2030 [39]—a number similar to the current annual mortality from motor vehicle accidents [40]. In addressing this public health epidemic, expanding policy support and funding for screening outside of the primary care setting is critical.

With >115 million annual visits, EDs are uniquely positioned to raise national HCV awareness, especially among the most vulnerable and disproportionately affected patients who are often without access to preventive services [18, 21]. Using the HCV Continuum of Care model, we demonstrate that not only is the ED a high-yield venue for identifying previously unrecognized HCV infection, but linkage to care outcomes are comparable to other outpatient settings. With this in mind, ED HCV screening ought to be supported in healthcare financing models to a similar extent that other healthcare settings are.

There are several important limitations to our findings. This is a relatively small study, especially in the latter stages of the Continuum of Care, and we do not have data for risk factors (specifically injection drug use) and reason for testing for many patients. While we present data from institutions in geographically distinct regions, they are both urban academic centers, which limits the generalizability of our findings. The fact that both institutions are training centers in urban areas may lead to higher rates of treatment as they likely have a higher treatment capacity than many community hospitals, though these institutions also serve a disadvantaged patient population that may bias our results in the opposite direction. Furthermore, the specifics of both ED screening programs, as well as the local and state healthcare environments, may not be generalizable. The linkage coordinators were responsible for all patients lost to follow-up, and it is possible that some patients that we were unable to contact received HCV care elsewhere. We place our findings in the context of HCV screening in other settings, but further research ought to directly compare HCV screening programs between EDs, and also between EDs and other health settings.

## CONCLUSIONS

Emergency department patients have a high prevalence of undiagnosed HCV infection, and while there are challenges in linkage to care and treatment, our results demonstrate treatment outcomes that mirror those in other venues that perform HCV screening. Especially as EDs often act as safety net healthcare providers for patients without access to primary care, ED HCV screening programs ought to be expanded.

### Notes

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ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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