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Peer support in small towns: A decentralized mobile Hepatitis C virus clinic for people who inject drugs

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Abstract

Background & Aims: New models of HCV care are needed to reach people who inject drugs (PWID). The primary aim was to evaluate HCV treatment uptake among HCV RNA positive individuals identified by point-of-care (POC) testing and liver disease assessment in a peer-driven decentralized mobile clinic.

Methods: This prospective study included consecutive patients assessed in a mobile clinic visiting 32 small towns in Southern Norway from November 2019 to November 2020. The clinic was staffed by a bus driver and a social educator offering POC HCV RNA testing (GeneXpert®), liver disease staging (FibroScan® 402) and peer support. Viremic individuals were offered prompt pan-genotypic treatment prescribed by local hospital-employed specialists following a brief telephone assessment.

Results: Among 296 tested individuals, 102 (34%) were HCV RNA positive (median age 51 years, 77% male, 24% advanced liver fibrosis/cirrhosis). All participants had a history of injecting drug use, 71% reported past 3 months injecting, and 37% received opioid agonist treatment. Treatment uptake within 6 months following enrolment was achieved in 88%. Treatment uptake was negatively associated with recent injecting (aHR 0.60; 95% CI 0.36–0.98), harmful alcohol consumption (aHR 0.44; 95% CI 0.20–0.99), and advanced liver fibrosis/cirrhosis (aHR 0.44; 95% CI 0.25–0.80). HCV RNA prevalence increased with age (OR 1.81 per 10-year increase; 95% 1.41–2.32), ranging from 3% among those <30 years to 55% among those ≥60 years.

Conclusions: A peer-driven mobile HCV clinic is an effective and feasible model of care that should be considered for broader implementation to reach PWID outside the urban centres.

KEYWORDS
hepatitis C virus, peer support, people who inject drugs, point of care, treatment

Abbreviations: HCV, hepatitis C virus; PWID, people who inject drugs; DAA, direct-acting antiviral; SVR, sustained virological response; POC, point of care; OAT, opioid agonist treatment; IQR, interquartile range; HR, hazard ratio; CI, confidence interval; OR, odds ratio.

1 | INTRODUCTION

Hepatitis C virus (HCV) infection is a leading cause of liver cirrhosis and hepatocellular carcinoma.[1,2] Among 58 million people living with chronic HCV infection globally,[3] approximately 6 million have injected drugs in the past year.[4] Two-thirds of the HCV disease burden in Western Europe is attributable to injecting drug use,[5] and most new cases occur among people who inject drugs (PWID).[6] Almost half of all HCV infections among PWID are assumed to be undiagnosed.[7] Thus, PWID are a priority population for improving testing, linkage to care and treatment in order to reach the WHO goal of eliminating HCV as a global public health threat within 2030.[8]

Highly efficient and tolerable direct-acting antiviral (DAA) HCV treatment leads to a sustained virological response (SVR) in more than 95% after 8–12 weeks of oral treatment.[9,10] DAA treatment is equally safe and effective among PWID, including marginalized individuals with recent injecting drug use.[11,12] Utilizing treatment to prevent onwards HCV transmission relies on engaging more PWID in care using innovative testing strategies and efficient linkage to care.[13,14]

PWID are often marginalized with considerable barriers to HCV care at patient, provider and system levels, including low health literacy.[15] In most countries, including Norway, HCV treatment has relied on specialist infrastructure and has primarily been provided by hospital outpatient clinics or low-threshold clinics located in urban centres.[16] Thus, an increasing number of PWID living in rural areas may face geographical distance and transport costs that combined with isolation and stigma may represent significant barriers to HCV screening and treatment.[17,18] There are observational data and qualitative evidence showing that peer support is valuable in removing such barriers.[19–22] Also, a recent randomized controlled trial (RCT) showed that peer support could improve engagement with healthcare services for patients with HCV infection.[23]

Rapid point-of-care (POC) tests enable easy access to HCV testing for individuals with less frequent contact with healthcare professionals. Although POC testing has been shown to increase testing and linkage to care,[24] most tests detect HCV antibodies and require additional HCV RNA testing to identify viraemia, increasing the risk of delay or a dropout from the HCV care cascade.[25,26] Thus, POC HCV RNA testing should be more feasible, as it provides reliable results within 1 h and enables testing and treatment initiation during one visit.[27–30]

Promising outcomes have been reported following POC testing in community-based services, including needle and syringe programs, pop-up clinics, mobile harm reduction units and community pharmacies.[31–37] Although there are examples of successful mobile HCV clinics,[32,35,37] they have been conducted in typical urban settings, and few have combined POC testing with peer support. To our knowledge, this is the first study reporting on the effectiveness of a peer-driven mobile HCV clinic providing services in small towns, integrating POC HCV RNA testing, liver disease staging and treatment initiation in a one-step process facilitated by peer support.

Lay summary

A peer-driven mobile clinic visited small towns in rural Norway and offered point-of-care hepatitis C testing and liver disease assessment for people who inject drugs. One-third of all tested individuals had hepatitis C infection, and almost 90% of those received treatment within 6 months. The model of care was feasible and should be considered for broader implementation to achieve the elimination of hepatitis C.

The primary aim of this study was to evaluate HCV treatment uptake and associated factors among HCV RNA positive PWID following POC testing and liver disease assessment in a peer-driven decentralized mobile HCV clinic. The secondary aims were to describe the cascade of care in the same population and to assess HCV RNA prevalence among tested individuals.

2 | MATERIALS AND METHODS

2.1 | Study setting

In 2018, the Norwegian government aimed to eliminate HCV infection, targeting a 90% decrease in prevalence and major reductions in HCV-related mortality within 2023.[38] The majority of HCV infections in Norway have occurred among PWID and by the end of 2018, it was estimated that approximately 6100 PWID were living with chronic HCV infection.[39]

As a response to the national elimination plan, the Norwegian peer support organization for opioid agonist treatment (OAT) recipients (ProLAR Nett) conceptualized a peer-driven mobile outreach HCV clinic. The clinic aimed to reach PWID living in small towns outside the urban centres in Norway and provide POC HCV testing, liver disease staging and HCV treatment in a one-step process via telemedicine, facilitated by peer support as needed.

2.2 | Model of care and peer involvement

The project was characterized by thorough peer involvement at all levels without top-down decisions. *The Hepatitis Bus* was named and conceptualized by ProLAR Nett (RB). The study protocol was developed in collaboration between ProLAR Nett (RB) and clinical researchers at the Norwegian centre for elimination of hepatitis C (HM, OD, AKF and KBK). The bus was staffed with a driver with user experience (ED or RB) and a social educator (ME), all employed as peer workers by ProLAR Nett. Prior to the implementation of the project, the bus personnel received education and practical training on POC testing and liver disease staging from the researchers (HM, OD and RB).

The tour schedule for the bus and local logistics were organized by a consultant at the Norwegian Directorate of Health (MB). As a part of this process, healthcare providers and social workers at the local municipalities were encouraged to prepare for the upcoming visit a few weeks in advance in order to facilitate the recruitment of PWID. Local hospital departments were encouraged to contribute to a streamlined model of care with immediate DAA prescription following telephone inquiry. A promotional film about the project, made in collaboration between proLAR Nett and the film company Snøball Film, was published on YouTube in December 2019.[40] ProLAR Nett received a grant from the Norwegian Directorate of Health to fund the bus.

Between November 2019 and November 2020, *the Hepatitis Bus* visited 32 small towns in Southern Norway. During the Covid-19 lockdown in Norway between March and May 2020, the mobile clinic was paused. The bus stayed 1–3 days at each site and provided its services with a drop-in approach. The bus was operative for 14 days followed by 14 days of rest. The model of care was entirely peer-driven with all POC assessments, baseline data collection and communication with local hospital-employed prescribers being performed by the bus staff. The bus personnel provided peer support on a discretionary basis, facilitating treatment initiation and promoting treatment adherence in cooperation with local social workers. In addition, they educated patients and local personnel on harm reduction, HCV transmission risk, testing and treatment.

2.3 | Study participants

This prospective observational study included consecutive patients aged above 18 years who were tested for HCV infection in the mobile clinic between 5 November 2019 and 13 November 2020. All participants provided written informed consent. The study protocol was an extension of an ongoing low-threshold HCV clinic approved by The Regional Committee for Medical Research Ethics (2014/2247). The study was done according to the Declaration of Helsinki and International Conference on Harmonization Good Clinical Practice guidelines.

2.4 | Assessments

Assessments at enrolment included POC HCV testing, transient elastography and a questionnaire collecting information on sociodemographics (age, gender, housing status, source of income), clinical data (medical history, medications, HCV treatment history) and alcohol and drug use (alcohol consumption, OAT and injecting drug use). Stable housing was defined as living in an owned or a rented house or a flat. Harmful alcohol consumption was defined as ≥10 units/week for women or ≥14 units/week for men.

POC HCV RNA testing was performed by one of the bus staff on capillary blood using GeneXpert® HCV RNA Viral Load (Cepheid, California, USA). In individuals with a perceived low risk of HCV infection (i.e. those without a history of injecting drug use and those who reported nasal or oral administration of drugs only), initial POC anti-HCV testing was performed on saliva using OraQuick® Rapid HCV Antibody Test (OraSure, USA). This individual risk assessment was done at the discretion of bus personnel. The stage of liver disease among viremic individuals was assessed by the social educator using transient elastography with FibroScan® 402 (Echosens, Paris, France). The cut-offs for detection of advanced liver fibrosis and liver cirrhosis were 9.5 kPa and 12.5 kPa respectively.[41]

2.5 | Hepatitis C virus treatment

All HCV RNA positive individuals were offered immediate pangenotypic DAA treatment and follow-up in accordance with Norwegian recommendations for simplified HCV care.[42] DAA treatment was prescribed by local hospital-employed specialists following a brief telephone assessment. For this assessment, the bus personnel reported key clinical data (age, gender, liver stiffness, clinical status, treatment experience, comorbidity and co-medication), ensuring safe and streamlined HCV care. Individuals with suspected liver cirrhosis based on liver stiffness measurements were scheduled for outpatient specialist assessment including post-treatment hepatocellular carcinoma surveillance. For these individuals, the decision whether to start immediate treatment or await specialist consultation was made by the hospital-employed specialist.

Personnel at local municipalities assisted, in collaboration with the bus personnel, study participants with dispensing DAA treatment from the local pharmacy and scheduled on-treatment follow-ups on an individual basis. Some participants were expected to administer the course of treatment without assistance, while some required closer follow-up.

2.6 | Data collection

Baseline data were registered by the bus staff at the time of enrolment. Data on the outcomes were extracted retrospectively by the researchers 6 months after enrolment of the final study participant (data lock) by reviewing the prescription module in the 'core medical record' of the hospital's electronic patient files. This module captures data on all drug prescriptions nationwide within the last 3 years.

2.7 | Outcomes

The primary outcome was HCV treatment uptake within 6 months. The primary outcome was accomplished if the participant had been dispensed the first 4-week package of the prescribed DAAs within 6 months after enrolment. Thus, the primary outcome was not accomplished even if treatment had been initiated by the time of data

lock, but more than 6 months following enrolment. This time frame was chosen to strengthen the likelihood of a causal effect between the assessment and peer support provided by the bus personnel and the accomplishment of the outcome.

The first secondary outcome was the cascade of care, defined as prescription, initiation and completion of DAA treatment, respectively, by the time of data lock. Treatment completion was defined as dispensing of the final 4-week package of the prescribed DAAs, that is the second package in individuals receiving 8 weeks regimens (sofosbuvir/ledipasvir or glecaprevir/pibrentasvir) and the third package in individuals receiving 12 weeks regimens (sofosbuvir/velpatasvir).

The final secondary outcome was detectable HCV RNA by POC testing. Individuals with a negative POC anti-HCV test were assumed to be HCV RNA negative. Individuals who were lost to follow-up following a positive anti-HCV test were excluded from this analysis.

2.8 | Statistical analysis

Categorical data were summarized and reported as N (%), continuous data as median (interquartile range [IQR]). Analyses of the primary outcome and the cascade of care were performed among all HCV RNA positive participants. Proportions with detectable HCV RNA (viremic prevalence) were reported among all participants with a valid POC test result.

Time from enrolment to treatment uptake was estimated using Kaplan–Meier failure analysis. Cox regression analysis, reporting hazard ratios (HR) and 95% confidence intervals (CI) were used to identify factors associated with the primary outcome. Logistic regression analysis, reporting odds ratios (OR) and 95% CI, was used to identify factors associated with detectable HCV RNA.

Hypothesized factors included age, gender, housing status, source of income, OAT, recent injection drug use, somatic comorbidities, harmful alcohol consumption and stage of liver disease. Factors significant at the 0.1 level in the unadjusted analysis, including age and gender, were considered for inclusion in the adjusted analysis. The covariates in the adjusted Cox model were tested for collinearity using variance–covariance matrices and tested for the proportional hazard's assumption using Schoenfeld residuals and log–log transformation of the failure function. All analyses were performed using Stata version 16.1 (College Station, TX, USA).

3 | RESULTS

3.1 | Participant characteristics

A total of 305 individuals received POC HCV testing, of whom an initial anti-HCV test was performed in 60 participants. Among 296 individuals with a valid test result, excluding two individuals who were lost to follow-up after a positive anti-HCV test and seven individuals with an invalid HCV RNA result, 102 HCV RNA positive participants were included in the main analyses (Figure 1).

Characteristics of enrolment for HCV RNA positive individuals are shown in Table 1. The median age was 51 years, 77% were male, 6% had unstable housing, 11% reported harmful alcohol consumption and 24% had advanced liver fibrosis or liver cirrhosis. All participants had a history of injecting drug use, 71% reported recent injecting (predominantly amphetamines) and 37% received OAT. Previous HCV treatment experience was reported by 7%.

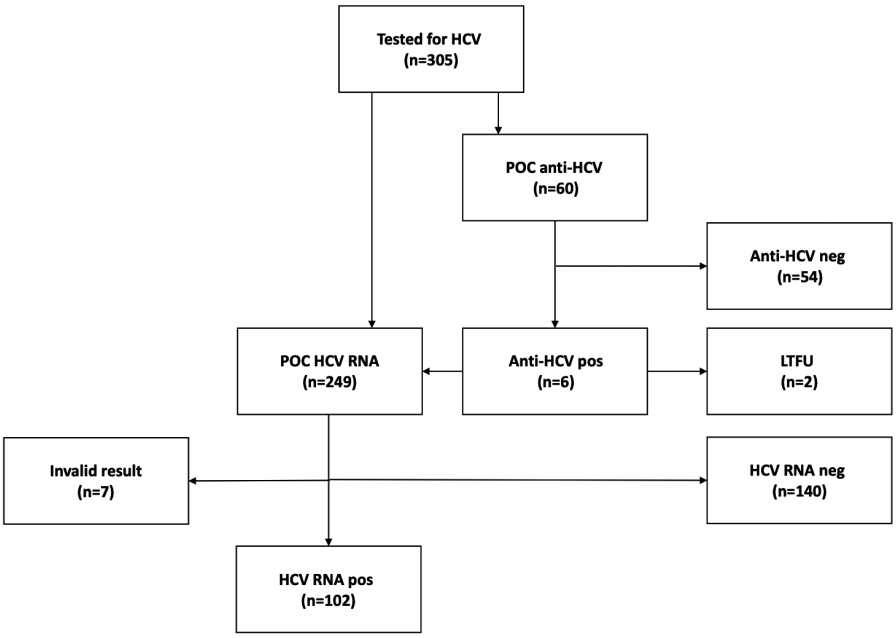

FIGURE 1 Flow chart of the study population

TABLE 1 Characteristics of for HCV RNA positive study participants

Variable	Overall (n = 102)
Median age (IQR)	51 (42–56)
Age groups	
<30	1 (1)
30–39	18 (18)
40–49	29 (28)
50–59	43 (42)
60–70	11 (11)
Gender	
Male	78 (77)
Female	24 (23)
Housing status[c]	
Owned accommodation	32 (32)
Municipal housing	61 (62)
Prison	4 (4)
Homeless	2 (2)
Source of income[d]	
Welfare pension	83 (87)
Social benefits	8 (8)
Other	5 (5
History of injecting drug use[e]	98 (100)
Median age at first injecting (IQR)[f]	18 (15–23)
Recent (past 3 months) injecting drug use[d]	68 (71)
Drug most frequently injected[a]	
Heroin	31 (46)
Amphetamines	37 (54)
Current opioid agonist treatment[c]	37 (37)
Opioid agonist treatment drug[b]	
Methadone	15 (41)
Buprenorphine	9 (24)
Buprenorphine-naloxone	7 (19)
Other	6 (16)
HCV treatment experienced[e]	7 (7)
Somatic comorbidities	17 (17)
Harmful alcohol consumption[e]	11 (11)
Stage of liver disease[g]	
F1 (<7 kPa)	45 (40)
F2 (7–9.5 kPa)	23 (26)
F3 (9.5–12.5 kPa)	9 (10)
F4 (>12.5 kPa)	13 (14)
Median liver stiffness, kPa (IQR; range)	7.0 (5.5–9.4; 3.2–55)

Note: Data are presented as n (%) unless otherwise indicated.

[a]Among 68 participants with recent injecting drug use.

[b]Among 37 participants with current opioid agonist therapy.

[c]Missing data for 3 participants.

[d]Missing data for 6 participants.

[e]Missing data for 4 participants.

[f]Missing data for 5 participants.

[g]Missing data for 12 participants.

3.2 | Treatment uptake

The primary outcome (treatment uptake within 6 months after enrolment) was accomplished in 90 of 102 (88%) participants. The median time from enrolment to treatment uptake was 13 days (IQR 6–67 days), with 57 of 102 (56%) initiating treatment within 1 month, 81 of 102 (79%) initiating it within 3 months and 94 of 102 (92%) initiating by the time of data lock (Figure 2). The median time from enrolment to DAA prescription was 5 days (IQR 2–60 days), and the median time from prescription to treatment was 4 days (IQR 2–8 days).

The cascade of care by the time of data lock is shown in Figure 3. Among 102 HCV RNA positive participants, prescription, initiation and completion of DAA treatment were observed in 95 (93%), 94 (92%) and 85 (83%) individuals respectively. Of note, treatment completion was observed in 85 of 94 (90%) participants who initiated treatment. DAA treatment, predominantly pan-genotypic regimens, was prescribed by 27 different specialists and included sofosbuvir/velpatasvir (87%), sofosbuvir/ledipasvir (8%), glecaprevir/pibrentasvir (2%) and grazoprevir/elbasvir (2%).

3.3 | Factors associated with treatment uptake

Kaplan–Meier analysis of time from enrolment to treatment uptake demonstrated a lower probability of treatment among individuals with recent injecting drug use, harmful alcohol consumption and advanced liver fibrosis/cirrhosis (Figure 4).

Cox regression analysis of factors associated with the primary outcome is presented in Table 2. In adjusted analysis, the hazard of treatment uptake was reduced by 40% in individuals with recent injecting drug use (aHR 0.60; 95% CI 0.36–0.98), by 56% in individuals with harmful alcohol consumption (aHR 0.44; 95% CI 0.20–0.99) and by 56% in individuals with advanced liver fibrosis/cirrhosis (aHR 0.44; 95% CI 0.25–0.80). Time to treatment uptake was not associated with age, gender, housing status, source of income or OAT.

3.4 | Hepatitis C virus RNA prevalence

Among 296 individuals with a valid test result, a total of 102 were HCV RNA positive for an overall viremic prevalence of 34%. Detectable HCV RNA was associated with increasing age (OR 1.81 per 10-year increase; 95% 1.41–2.32), ranging from 3% among those <30 years to 55% among those ≥60 years (Figure 5). Detectable HCV RNA was not associated with gender, housing status, source of income, OAT, recent injecting drug use, most frequently injected drug or harmful alcohol consumption. There were considerable regional differences in HCV RNA prevalence, ranging from 20% to 100%.

Among 102 HCV RNA positive individuals, 23 (23%) had not previously been notified to the Norwegian Surveillance System for Communicable Diseases.

4 | DISCUSSION

This observational study reported 88% HCV treatment uptake among HCV RNA positive PWID identified by POC testing and liver disease assessment in a peer-driven decentralized mobile clinic. Time to treatment was negatively associated with recent injecting drug use, harmful alcohol consumption and advanced liver fibrosis/cirrhosis. HCV RNA prevalence among tested individuals increased with age, ranging from 3% among those <30 years to 55% among those ≥60 years. Despite being conducted during the Covid-19 pandemic, the study demonstrates an effective and feasible model of care that should be considered for broader implementation in order to reach PWID living outside the urban centres.

Treatment uptake was higher than reported from cohorts of PWID assessed with conventional diagnostic approaches and also higher than reported in studies employing POC testing.[43–46] Yet, there was a subsequent drop in the cascade of care with treatment being completed in 90% of those who initiated. This finding is not surprising and consistent with the broader HCV literature among PWID where rates of loss to follow-up or DAA treatment discontinuation have been reported in 5%–10%.[11,16,47] Treatment uptake was also higher than reported from mobile HCV clinics in Brisbane, Copenhagen and Madrid.[32,35,37] Despite being similar mobile units, these studies were conducted in urban settings and did not integrate peer support with POC testing and treatment initiation without additional specialist consultation.

The design of this study did not allow the inclusion of a control group who received testing and treatment without peer involvement. Yet, the study demonstrates higher treatment uptake and retention in the care cascade than reported from standard of care pathways and also from models specifically targeting PWID in Norway. For instance, a recent RCT on integrated HCV treatment in OAT reported 72% treatment uptake in the standard of care arm with treatment provided at a hospital outpatient clinic.[48] Preliminary results from an ongoing trial of immediate treatment among hospitalized PWID indicate that only 30% of individuals referred to standard outpatient carecompleted treatment within 6 months.[49] Finally, treatment uptake after 7 years of ambulant work among HCV RNA positive PWID in a low-threshold clinic in downtown Oslo was 74%.[16]

Evidence from qualitative studies and RCTs show that peer support is valuable to remove barriers to HCV care, including stigma, and to improve engagement with healthcare services.[19–23] In our view, specific success factors could therefore be attributed to the peer-driven approach. First, having a bus driver with user experience may have increased trust among PWID and thus enhanced participant recruitment. Second, a committed social educator employed by a peer-support organization has probably contributed to a patient–provider relationship characterized by the absence of stigma. Third, thorough planning of the tour schedule enabled communication with local staff and hospital departments in advance, enhancing patient recruitment, linkage to care and collaboration with local healthcare professionals. Finally, empowerment of local municipalities and low-threshold services may have generated increased HCV awareness and positive ripple effects in the communities.

Despite the ambition to provide assessment and linkage to care within the same day, the median time from enrolment to treatment was 13 days. Although overall treatment uptake was high, the hazard

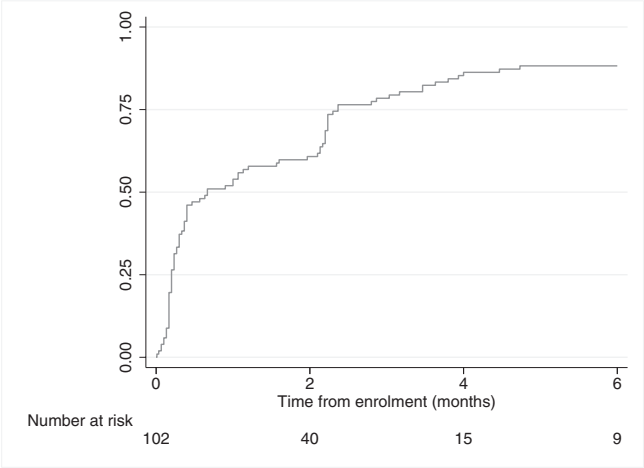

FIGURE 2 Kaplan–Meier estimate of time from enrolment to treatment uptake among all HCV RNA positive participants

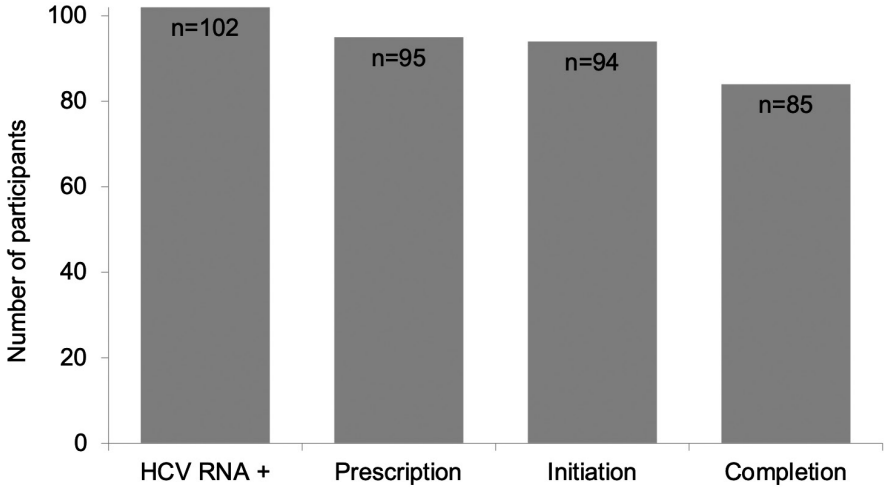

FIGURE 3 The cascade of care showing the total number of HCV RNA positive participants with prescription, initiation and completion of DAA treatment following enrolment

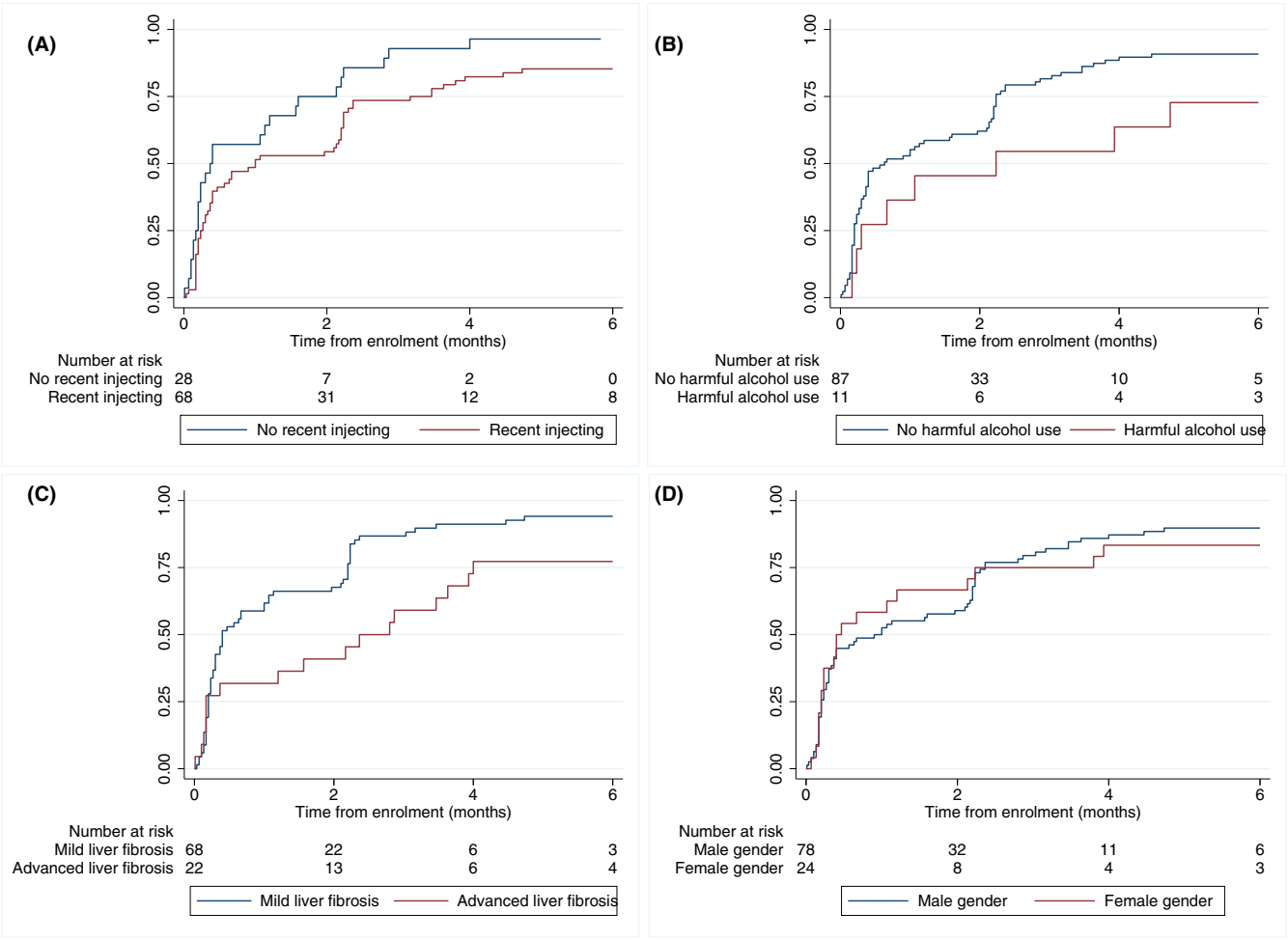

FIGURE 4 (A-D) Kaplan–Meier estimates of time from enrolment to treatment uptake stratified by (A) recent injecting drug use, (B) harmful alcohol consumption, (C) stage of liver disease and (D) gender

TABLE 2 Cox regression analysis of factors associated with treatment uptake within 6 months after enrolment

Factor	Primary outcome, *n* (%)	Unadjusted model		Adjusted model	
		HR (95% CI)	*p*	aHR (95% CI)	*p*
Age (per 10-year increase)	N.A.	0.99 (0.76–1.28)	.916	1.15 (0.84–1.57)	.381
Female gender (vs male)	20/24 (83)	0.95 (0.58–1.56)	.832	1.25 (0.71–2.20)	.436
Unstable housing (vs stable)	5/6 (83)	0.82 (0.33–2.02)	.665	-	-
Welfare pension (vs not)	73/83 (88)	0.83 (0.45–1.53)	.548	-	-
Recent injecting drug use (vs not)	58/68 (85)	0.60 (0.38–0.95)	.029	0.60 (0.36–0.98)	.042
Current opioid agonist treatment (vs not)	33/37 (89)	1.16 (0.75–1.80)	.495	-	-
Any somatic comorbidity (vs none)	16/17 (94)	0.91 (0.53–1.57)	.741	-	-
Harmful alcohol consumption (vs not)	8/11 (73)	0.52 (0.25–1.08)	.078	0.44 (0.20–0.99)	.046
Advanced fibrosis/cirrhosis (vs mild)	17/22 (77)	0.50 (0.29–0.86)	.012	0.44 (0.25–0.80)	.007

of treatment was reduced by 40% in individuals with recent injecting drug use and by 56% in individuals with harmful alcohol consumption. While some delays may have been caused by the Covid-19 pandemic, it emphasizes that some marginalized individuals with ongoing drug or alcohol dependence face barriers to HCV care at individual and provider levels that may lead to drop out from the care cascade. These findings are important both from a clinical and public health perspective, as a delayed treatment for individuals with ongoing risk behaviours will lead to continued viraemia, potentially causing progression of liver disease as well as onwards HCV transmission.

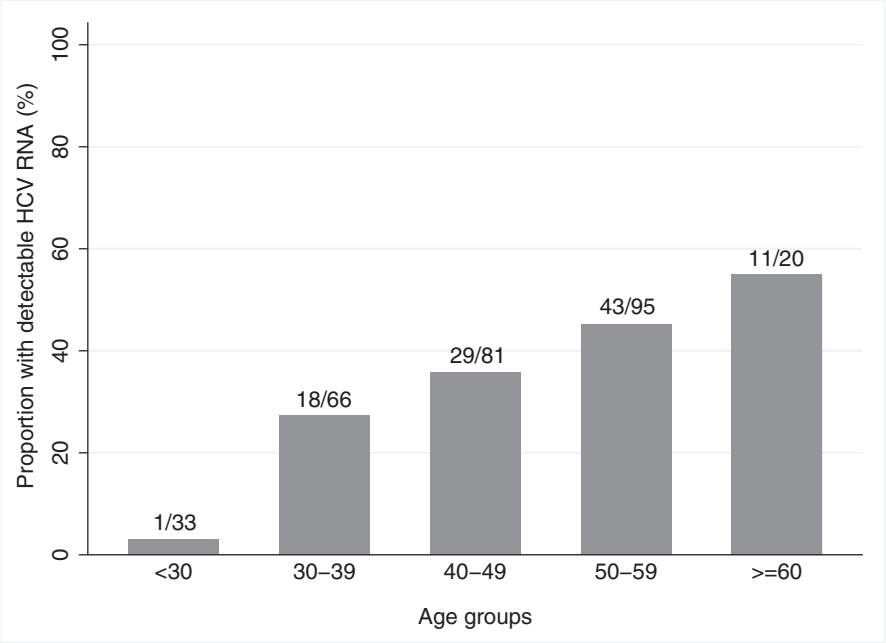

FIGURE 5 Proportions of tested individuals with detectable HCV RNA according to age groups

Furthermore, time to treatment was negatively associated with an advanced stage of liver disease. The hazard of treatment was reduced by 56% in individuals with advanced liver fibrosis/cirrhosis compared to those with milder liver fibrosis. This finding is slightly counterintuitive but could be explained by a model of care that encouraged specialist assessment for individuals with more advanced liver disease. Despite the best intentions, a dropout from the cascade of care was observed in two individuals with advanced liver fibrosis/cirrhosis who still remained untreated at the time of data lock. This is unfortunate, as these cases probably also could have been managed via telemedicine. However, owing to the peer workers' limited training and experience in hepatology, we chose to design the model of care as safe as possible and in line with the established standards of Norwegian HCV care. Although specialist assessment is required for some individuals, this finding emphasizes the importance of individualized follow-up without creating unnecessary treatment barriers for vulnerable individuals, particularly those with liver cirrhosis.

HCV RNA prevalence among tested individuals increased proportionally with age, ranging from 3% among those <30 years to 55% among those ≥60 years. The overall viremic prevalence of 34% is consistent with the previous literature[4] and the findings in higher age groups are similar to results from the needle exchange program in Stockholm, Sweden, where 57% HCV RNA prevalence was reported.[50] Although it is encouraging that HCV RNA prevalence was low among the youngest, the high prevalence among older individuals is concerning as it may reflect a failure of established pathways for HCV testing and treatment in decentralized parts of Norway. The significant differences in regional prevalence from 20% to 100% may reflect both small samples in some regions and clustering of 'high-risk' individuals attending the clinic in groups. For instance, in Stavanger (the only region with 100% HCV RNA prevalence), nine of nine tested individuals had detectable HCV RNA.

Collectively, the findings have important implications for HCV care and should inform HCV elimination efforts locally and internationally. The mobile decentralized model may represent a superior alternative to an established referral-based standard not sufficiently adapted for marginalized individuals residing outside the urban centres. Locally, given that injecting drug use and drug overdoses occur in most Norwegian municipalities,[51] the model could have rich potential as a tool to achieve HCV elimination. Internationally, particularly against the backdrop of the ongoing opioid epidemic, similar mobile units could be key to disseminate HCV care and achieve micro-elimination in rural areas with limited infrastructure. Taken a step further, the mobile clinic could also serve as a blueprint for addressing other somatic health problems (e.g. skin and soft tissue infections, diabetes, HIV, Covid-19, prophylactic vaccines) that are prevalent among PWID and other marginalized groups.

The key strengths of this study are the inclusion of a real-world rural PWID population, the prospective data collection and the innovative peer-driven model of care. To the best of our knowledge, this is the first study reporting on the effectiveness of a decentralized mobile HCV clinic integrating POC HCV RNA testing, liver disease staging, linkage to care and peer support.

This study has limitations. First, being an uncontrolled study, the high treatment uptake observed may not be attributable to the model of care alone. However, the relatively short time frame for the accomplishment of the primary outcome, including the use of time-to-event analysis, has strengthened the likelihood of a causal effect between assessment in the clinic and the outcome. Second, the choice of registry-based outcomes, collected retrospectively without the need for individual follow-up, must be considered proxies for initiation and completion of treatment instead of measures of actual adherence to the prescribed DAAs. Although this pragmatic approach was an efficient and resource-saving method to minimize challenges of loss to follow up, it may have overestimated treatment

uptake and completion. Finally, the inclusion of individuals with high levels of HCV awareness and health concerns may have biased the study and overestimated HCV RNA prevalence. On the other hand, the potential stigma associated with assessment in the mobile clinic may have prevented some individuals from seeking care. In fact, following feedback from study participants regarding perceived stigma, proLAR nett decided to remove the bus logo during the study. Minimizing stigma is one of the key issues moving forward and insights from this treatment model could help inform future work.

In conclusion, this study demonstrates that a peer-driven mobile HCV clinic is an effective and feasible model of care that should be considered for broader implementation in order to reach PWID living outside the urban centres.

AUTHOR CONTRIBUTIONS

HM, RB, MB and OD contributed to study conception and design. RB, ME, ED and HM contributed to data collection. HM, AKF, KBK, MB and OD contributed to data analysis and interpretation of the findings. HM drafted the original manuscript. All authors contributed to the revision and approval of the final manuscript.

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CONFLICT OF INTEREST

HM has received advisory board fees and lecture fees from Gilead, Abbvie and MSD. OD has received grants and research support from Abbvie, Gilead and MSD; advisory board fees from Gilead and MSD and lecture fees from Abbvie and MSD. The other authors report no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available owing to privacy or ethical restrictions.

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