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Research Paper

Financial incentives to increase engagement across the hepatitis C care cascade among people at risk of or diagnosed with hepatitis C: A systematic review

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ABSTRACT

Background: Reversing declining rates of people initiating and completing hepatitis C (HCV) treatment, observed in many countries, is needed to achieve global HCV elimination goals. Providing financial incentives to increase HCV testing and treatment uptake among people at-risk of or living with HCV infection could be an effective intervention. We conducted a systematic review to assess evidence regarding the effectiveness of financial incentives to improve engagement and progression through the HCV care cascade.

Methods: We searched MEDLINE, PubMed and EMBASE for studies published from January 2013 to January 2023 that evaluated financial incentives offered to people living with and at-risk of HCV to increase HCV antibody and or RNA testing, linkage to care, treatment initiation, treatment adherence, treatment completion, and sustained viral load (SVR) testing. Open-label randomised controlled trials (RCTs), controlled non-randomised studies, cohort or observation studies and mixed-methods studies were included, whereas literature reviews, case series and studies which did not report data were excluded.

Results: We identified 1,278 studies, with 21 included after full-text screening (14,913 participants); three randomised controlled trials and 18 non-randomised studies. Studies evaluated incentives aimed at improving test uptake ($n = 11$), engagement in care ($n = 13$), treatment initiation ($n = 8$), adherence ($n = 3$), completion ($n = 3$) and attainment of SVR ($n = 5$). Findings provided inconclusive evidence for the effectiveness of incentives in improving engagement in the HCV cascade of care. Determining incentive effectiveness to improve care cascade engagement was limited by low quality study designs, heterogeneity in type (cash or voucher), value (US$5 to $600) and cascade stage being incentivised. No randomised controlled trials assessed the effectiveness of incentives to promote HCV testing, and none showed an impact on treatment uptake. In non-randomised studies (observational comparative), some evidence suggested that incentives promoted HCV testing, but evidence of their role in promoting linkage to care, HCV treatment adherence and treatment completion were mixed.

Conclusion: Currently, there lacks high-quality evidence evaluating whether financial incentives improve HCV testing and treatment outcomes. Future research should seek to standardise methodologies, compare incentive types and values to enhance engagement in HCV care, and determine factors that support incentives effectiveness.

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Introduction

The availability of highly effective direct-acting antiviral (DAA) treatment for hepatitis C virus (HCV) represented a major development in the global response to HCV (World Health Organization, 2021). Following the availability of DAA treatment, the World Health Organization (WHO) set global HCV elimination targets for 2030 centred on achieving high HCV testing and treatment coverage to reduce HCV incidence by 90 % and HCV-related mortality by 65 % by 2030 (World Health Organization, 2016a,b).

Modelling suggests that elimination of HCV is feasible with appropriate targeting of DAA treatment to groups at heightened risk of HCV acquisition and onward transmission, especially in the context of high coverage of harm reduction interventions and blood and infection safety (Heffernan et al., 2019). In many countries, HCV disproportionately affects people who inject drugs (PWID), men who have sex with men (MSM), people living with HIV, and people in custodial setting (World Health Organization, 2016a,b). In countries with widespread access to DAA treatment, including the United States, Canada, the United Kingdom, Iceland, and Australia, initial rapid uptake of HCV treatment after DAAs became available (Bardsley et al., 2021; Hajarizadeh et al., 2023; Palmateer et al., 2014; Yousafzai et al., 2021) has been followed by sustained declines in testing and treatment rates (Bardsley et al., 2021; Hajarizadeh et al., 2023; Palmateer et al., 2014; Yousafzai et al., 2021). Current rates of testing and treatment are now likely to be insufficient in most countries to achieve the WHO elimination targets (Grebely et al., 2019; Hajarizadeh et al., 2023).

In the context of declining DAA prescribing rates, providing financial incentives to encourage engagement with HCV testing and treatment is being increasingly discussed (Cunningham et al., 2022; Lens et al., 2022). While various financial incentives aimed at health behaviour change have been explored, most financial incentive models related to hepatitis C care target the consumer. Such incentives encompass cash or cash-like rewards (gift cards), food, shopping or transport vouchers or services that result in a monetary change to an individual contingent on their performance of health-promoting behaviours (Adams et al., 2013; Flodgren et al., 2011). Financial incentives have been used in other areas to derive public health benefits, including the offer of incentives directed to clients to improve rates of progression through the HIV treatment cascade (Bassett et al., 2015; Cunningham et al., 2022). For HCV, incentives may be effective in helping overcome individual- and structural-level barriers to care experienced by affected populations, including health literacy (Pedrana et al., 2021), competing life priorities, and past experiences of discrimination by health providers (Gunn et al., 2021). More broadly, incentive-based strategies may also be targeted at providers. Provider-based incentives include salary reimbursements, payment service, providing care for patients, or performance-based contracting with bonuses (Flodgren et al., 2011). Incentive strategies may be targeted at organisations, such as increased funding for certain physician groups or departments based on care performance improvement (Flodgren et al., 2011; Scott et al., 2018).

Despite being recommended in international HCV care guidelines (World Health Organization, 2016a,b), the effectiveness of financial incentives to increase engagement and retention in HCV care is unclear. We conducted a systematic review to evaluate whether financial incentives are effective at increasing uptake and engagement across the HCV cascade of care, including diagnostic testing, treatment commencement, treatment adherence, treatment completion and tests for cure.

Methods

The systematic review and meta-analysis were reported in accordance with the PRISMA guidelines for reporting systematic reviews (Liberati et al., 2009). The review protocol was registered prospectively (PROSPERO registration number 2021: CRD42021272576).

Eligibility criteria

Studies examining people diagnosed or at risk of hepatitis C were included in the review. Open-label randomised controlled trials (RCTs), controlled non-randomised studies, cohort or observation studies and mixed-methods studies were included. Non-randomised studies included those with a historical control comparing the study outcome before and after the implementation of an intervention (e.g., historically controlled studies and interrupted time series studies), those in which a consistent population was observed before and after the implementation of the intervention (e.g., cohort studies and controlled before-and-after studies), and those with a non-randomised control population (e.g., non-randomised controlled studies and non-randomised cluster controlled studies).

Studies where financial incentives were specifically offered to participants with the aim of improving the following outcomes: HCV testing, linkage to care, treatment uptake, treatment adherence, treatment completion and sustained viral load (SVR) testing were included. Studies offering non-exchangeable incentives which offered no monetary change for participants (food items, objects etc.) were excluded from this review. Non-monetary incentive, including Medicaid beneficiary programs, wellness programs, penalties (deposit contracts), treatment subsidies or reimbursements, or provision of food or non-exchangeable items (lighters, hygiene kits etc.) were excluded from this review. Literature reviews, case series and studies which did not report data were excluded. Studies providing only reimbursements for study participation were excluded. Studies were also excluded if they did not report the monetary value of the incentive or did not directly measure outcomes associated with engagement in the HCV cascade of care. If multiple publications of the same study existed, the most recent or complete one was included.

Search strategy

We conducted a search up to 30 January 2023 of three online databases: Medline, PubMed and EMBASE. Abstracts of key conferences were searched, including International Liver Congress, International AIDS Society conference and the International Network on Health and Hepatitis in Substance Users conference. Search strings included medical subject headings and free text to the following (Supplementary materials 1):

1. Hepatitis C (HCV, hepatitis C virus);
2. Financial incentives (payment, subsidisation, rebate); and
3. Terms associated with outcomes terms of testing, treatment, adherence, linkage to care and SVR testing.

The search was restricted to English-language publications published from 2013 onwards, to coincide with the early availability of DAAs. Studies obtained by searches were imported and deduplicated in Covidence (Covidence Systematic Review Software, 2021) for eligibility screening. Results were collated and titles and abstracts screened independently by two reviewers (CS and JD) for relevance against the predefined eligibility criteria, with conflicts resolved by a third reviewer (MWT). For studies reporting at least one outcome of interest in the abstract, full texts were obtained and assessed to confirm eligibility. In instances where multiple publications reported data from the same cohort, the most recent publication was included.

Risk of bias assessment

Quality and risk of bias assessment was conducted for included studies using a modified version of the Cochrane Risk of Bias 2 (RoB 2) tool for RCTs, the National Institute for Clinical and Health Excellence (NICE) tool for observational studies and the Cochrane ROBINS-I tool for interventional non-randomised studies. The bias in measurement of

outcomes was not considered as awareness of incentives is inherent to the intervention. Methodological quality was assessed according to participant selection, control of confounding, participant follow-up and assessment of exposure.

Data extraction

Data were extracted by one reviewer (CS) and assessed using a standardised form developed in Excel (Microsoft Corporation, 2018) to collate the following study characteristics and outcomes: (1) study design and comparison used; (2) location and date of study; (3) sample size; (4) participant recruitment; (5) participant characteristics; (6) outcome measures and (7) main findings. A second reviewer (JD) checked the data extraction.

Effect sizes and p-values were extracted directly from papers without further calculations. Due to heterogeneity in the reporting standards for effect sizes, generally small sample sizes, type and monetary value of incentives and the variations in stage(s) of the HCV care cascade incentivised, planned meta-analyses were not possible. Instead, we present a narrative synthesis of study findings.

Outcomes included:

1. HCV testing uptake (antibody or RNA);
2. Linkage to and retention in clinical care;
3. HCV treatment uptake;
4. Adherence to hepatitis C treatment;
5. Completion of hepatitis C treatment; and
6. Test for cure (sustained virological response; SVR).

Data synthesis

Findings were presented according to study design: randomised trials, comparative, and non-comparative studies and further described by studies that targeted specific populations (e.g., people who use drugs).

Results

Included studies

Search terms retrieved 1278 articles; following removal of duplicates, 959 abstracts were reviewed and 35 proceeded to full text review. Twenty-one studies (12 journal articles; 8 conference abstracts; 1 poster) (Ahmad et al., 2015; Alimohammadi et al., 2018; Allsop et al., 2021;

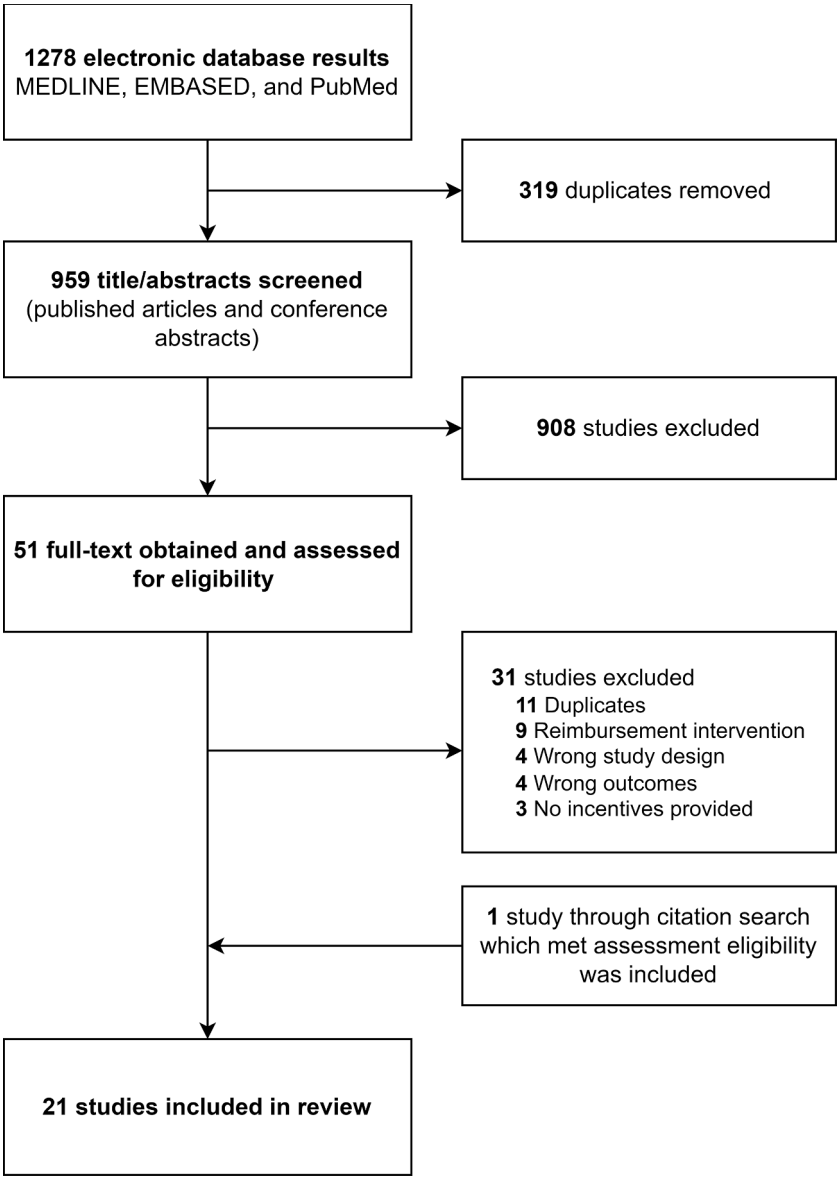

Fig. 1. Schematic diagram of search results and screening process.

Barclay et al., 2020; Biggs et al., 2016; Busschots et al., 2020; Chan et al., 2021; Harrod et al., 2020; Khalili et al., 2022; Lee et al., 2020; Leo et al., 2019; Litaker et al., 2021; Niruban et al., 2019; Norton et al., 2019; Pham et al., 2018; Seña et al., 2016; Sypsa et al., 2020; Treloar et al., 2018; Ward et al., 2019; Wohl et al., 2017; Zaller et al., 2016) met the inclusion criteria (Fig. 1) (excluded references in Supplementary materials 2), and included: three randomised trials (one non-controlled with head-to-head comparison (Wohl et al., 2017) and two controlled) (Barclay et al., 2020; Ward et al., 2019); six comparative studies (four pre/post intervention comparisons (Biggs et al., 2016; Lee et al., 2020; Litaker et al., 2021; Treloar et al., 2018), two concurrent clinic comparisons of patients receiving or not receiving incentives (Leo et al., 2019; Norton et al., 2019); and 12 non-comparative, single-arm observational studies (Ahmad et al., 2015; Alimohammadi et al., 2018; Allsop et al., 2021; Busschots et al., 2020; Chan et al., 2021; Harrod et al., 2020; Khalili et al., 2022; Niruban et al., 2019; Pham et al., 2018; Seña et al., 2016; Sypsa et al., 2020; Zaller et al., 2016) (Table 1).

Nine studies were conducted in the United States (Khalili et al., 2022; Lee et al., 2020; Leo et al., 2019; Litaker et al., 2021; Norton et al., 2019; Seña et al., 2016; Ward et al., 2019; Wohl et al., 2017; Zaller et al., 2016), three in Australia (Biggs et al., 2016; Chan et al., 2021; Treloar et al., 2018), two in Scotland (Ahmad et al., 2015; Barclay et al., 2020), two in Canada (Alimohammadi et al., 2018; Niruban et al., 2019), two in the United Kingdom (Allsop et al., 2021; Harrod et al., 2020), and one in Belgium (Busschots et al., 2020), Vietnam (Pham et al., 2018) and Greece (Sypsa et al., 2020). The observation period for measuring incentive effect (i.e., time from provision of financial incentive to outcome measurement) ranged from one day to 30 months (median: 12 months). Among 16 studies reporting drug use status, the median proportion of participants reporting recent injecting drug use was 36 % (range: 5 % to 77 %) and lifetime injecting drug use was 47 % (range: 14 % to 83 %). Among the five studies with available data, the median proportion of participants reporting recent housing instability was 47 % (range: 34 % to 99 %), and among the two studies with available data, the median proportion of participants reporting recent incarceration was 51 % (range: 26 % to 75 %).

Findings from randomised trials

Three randomised trials included a total of 1312 participants (range: 59 to 1059). Two included non-incentivised standard care control arms, and compared outcomes against standard care plus incentive or standard care plus monthly peer-mentor (treatment-experienced peer) meetings (intervention arms) (Ward et al., 2019), or a follow-up letter plus incentive or follow-up letter plus phone call (intervention arms) (Barclay et al., 2020). The third randomised trial was a head-to head comparison of two incentive types (fixed monetary amount versus lottery-determined monetary amount) (Wohl et al., 2017) (Table 1). The monetary value of financial incentives among the randomised trials ranged from US$21 to US$800. Measured outcomes included linkage and retention to care (clinic appointment attendance), treatment initiation, treatment adherence, and presenting for an SVR test and achieving cure; no randomised trials evaluated the impact of incentives for HCV testing uptake (Table 1).

Findings from the two controlled trials (Barclay et al., 2020; Ward et al., 2019) provided inconclusive evidence that incentives improved engagement in care. Among people previously diagnosed with HCV but not engaged in care, Barclay et al. (2020) found that the receipt of a follow-up letter plus incentive (£20 shopping voucher incentive) did not improve linkage to care (attending for liver assessment at three months; 12.0 %, 73 of 333) compared with follow-up letter (10.6 %, 38 of 359; $p = 0.55$). However, receipt of a follow-up letter plus phone call did improve linkage to care (15.5 %, 57 of 367) when compared to receipt of a follow-up letter only ($p = 0.05$).

Ward et al. (2019) compared three groups: usual care ($n = 36$) to usual care plus monthly peer-mentor meeting arms ($n = 45$) and cash incentives ($n = 54$) ($10 for initial treatment visit, sequentially increasing across follow-up to $50 for week-12 end of treatment visit; up to $220 in total). Although underpowered, the study found that receiving cash incentives (vs usual care or usual care with monthly peer-mentor meetings) did not significantly increase the proportion of participants who initiated treatment (76 %, 67 %, and 83 %, respectively; $p = 0.11$), completed treatment (95 %, 95 %, 93 %, respectively), or tested for SVR and cured (69 %, 61 % and 76 %, respectively; $p = 0.22$). Compared to usual care, patients receiving cash incentives or peer-mentors were more likely to initiate treatment (RR of 1.14 for cash arm, 95 % CI: 0.86 to 1.50; RR of 1.25 for peer-mentor arm, 95 % CI: 0.96 to 1.62) and attain SVR12 (RR of 1.24 for cash arm, 95 % CI: 0.92 to 1.68; RR of 1.12 for peer-mentor arm, 95 % CI: 0.82 to 1.54).

Wohl et al. (2017) compared fixed cash incentives (collectively up to $330) with lottery-based incentives (patients drew cards to receive up to $10 to $800 cash for attending medication dispensing appointments, for medication adherence of >90 %, or attain SVR 12). In both fixed cash and lottery based incentive groups, high levels of retention in HCV care (93 %, 25 of 27 and 97 %, 29 of 30 of scheduled visits attended at week-12 respectively; $p = 0.59$), treatment adherence (70 % and 75 %, respectively; estimated difference = 5.0 %; 95 % CI: −28.2 to 19.1), treatment completion (100 % and 86 %, respectively) and SVR attainment (93 % and 92 %, respectively; estimated difference for intention-to-treat analysis = 0.5 %; 95 % CI: −17.5 to 18.8) was observed with no statistically significant difference (Table 1).

Findings from observational comparative studies

Six non-randomised observational comparative studies included a total of 6729 participants (range: 40 to 5287); two with non-randomly allocated no incentive control groups (Leo et al., 2019; Norton et al., 2019) and four before (no incentive control period) and after comparison (Biggs et al., 2016; Lee et al., 2020; Litaker et al., 2021; Treloar et al., 2018). The monetary value of the incentives ranged between US$5 and US$600. Two studies (Biggs et al., 2016; Litaker et al., 2021) observed a statistically significant increase in HCV antibody testing with incentives, with one reporting no subsequent change in post-testing linkage to care (Biggs et al., 2016). Four studies found moderate improvements to linkage and retention in care (e.g. attending initial or follow-up appointments) (Biggs et al., 2016; Lee et al., 2020; Norton et al., 2019; Treloar et al., 2018), or treatment adherence (Leo et al., 2019) with incentives which was statistically significant. When comparing the control to intervention period, incentives promoted a 2.5 % (5.9 %, 3 of 55 versus 8.4 %, 5 of 55; respectively) to 47 % (23 %, 19 of 83 versus 70 %, 215 of 306; respectively) increase in the proportion of participants returning for a clinic appointment for HCV testing or treatment. No observational comparative studies specifically explored provision of incentives for treatment completion or attainment of an SVR, but several studies still reported SVR outcomes (Table 1).

Four studies investigated the impact of financial incentives but did not report targeting specific key populations of people at risk or known to be living with HCV (Biggs et al., 2016; Leo et al., 2019; Litaker et al., 2021; Treloar et al., 2018). Litaker et al. (2021) reported a three-fold increase in HCV antibody testing uptake during a period when participants (born between 1945 and 65) were offered a US$50 gift card compared to a non-incentive control period (3.36 times; 95 % = 2.71 to 4.16; $p < 0.01$) (Table 1). Leo et al. (2019) provided daily US$5 cash incentive for medication adherence via a mobile application and reported higher average medication adherence (96.2 %, $n = 35$) compared to those who opted not to receive incentive (87.6 %, $n = 58$; $p = 0.02$).

Biggs et al. (2016) and Treloar et al. (2018) used shopping vouchers to incentivise HCV testing and or linkage to care among Aboriginal Australians across three sexual health clinics. During a pilot study at one sexual health service over a 12-month intervention period (April 2013 to 2014), participants who received up to AU$30 in shopping vouchers ($20 for education session attendance and $10 for blood borne virus and

Table 1
Characteristics of included studies in the review.

Author (year)	Study setting, country	Participant demographic (sample size; % characteristic)	Study design	Intervention (Start to End date)	Incentive	Study outcomes	Study findings
Randomised controlled trials							
Barclay et al. (2020)	Hospital or outreach clinic, Scotland	General targeting of people at risk or affected by HCV (1059; 59 % have history of IDU)	RCT	Participants previously diagnosed with a HCV infection, but not engaged in clinical care, were randomised to one of three arms: 1) follow-up letter only, 2) letter plus phone call, or 3) letter plus incentive text offer with incentive. (Observation period: NR) Follow-up letters aimed to increase clinic appointment attendance within 4 months of receiving letter. Letters detailed consequences of untreated hepatitis C, availability or efficacy of new treatments, and a contact number to arrange appointment at a hospital or outreach clinic for an assessment of liver disease. The additional phone call was two additional attempts to contact participants if they did not respond to the letter within 4 weeks of receiving it. The additional text message offered participants an incentive to attend their appointment. The text was sent if participants had contacted the researchers within 4 weeks of receiving the letter	Attend clinic appointment - £20 shopping voucher ($26.18 USD)	Linkage to care	At 3 months, 12.7 % ($n = 135/1059$) of all participants attend their clinic appointment, of which: • 10.6 % received follow-up letter only, • 5.5 % letter plus phone call, and • 12.0 % received letter plus incentive text offer with incentive Significant differences in appointment attendance between follow-up letter (10.6 %, $n = 38/359$) and letter plus phone call (15.5 %, $n = 57/367$; $p = 0.048$) but not for letter plus incentive text offer (12.0 %, $n = 73/333$; $p = 0.55$)

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Table 1 (*continued*)

Author (year)	Study setting, country	Participant demographic (sample size; % characteristic)	Study design	Intervention (Start to End date)	Incentive	Study outcomes	Study findings
Randomised controlled trials							
Ward et al. (2019)	Johns Hopkins Moore Clinic for HIV care (USA)	People who use or inject drugs (194; 25 % current PWID)	RCT	Participants, with a HIV-HCV coinfection, engaged in HIV care but not HCV care within 8 months of entering the clinic, were randomised to one of three arms: 1) usual care, 2) usual care plus incentive or 3) usual care plus peer-mentor. Participants with usual care were provided with treatment, supported by a nurse-led multidisciplinary team. Participants with usual care plus incentives were offered cash. The monetary value of the incentive sequentially increased for each follow-up visit to reinforce clinic appointment attendance. Participants with usual care plus peer-mentor, were provided monthly face-to-face meetings with peer mentors previously treated for HIV and HCV. (Observation period: 14 months, August 2015 – October 2016)	Attend initial appointment - $10 USD cash Attend subsequent appointments after initial appointment– additional $5 USD cash per consecutive appointment attended since first (up to six) Week 12 appointment attendance - $50 USD cash Total up to $220 USD cash	Linkage to care, Retention in care, Treatment initiation	Overall, 76 % ($n = 110/144$) of participants initiated treatment. Non-statistically significant difference in treatment initiation among participants receiving incentives (76 %, $n = 41/54$) or peer-mentor (83 %, $n = 45/54$), compared to usual care (67 %, $n = 24/36$; $p = 0.11$) • Participants receiving incentive were 14 % more likely to initiate treatment than participants receiving usual care (RR = 1.14, 95 % CI: 0.86, 1.50). • Participants receiving peer-mentors were 25 % more likely to initiate treatment than participants receiving usual care (RR = 1.25, 95 % CI: 0.96, 1.62). High proportion of week-12 treatment completion across participants who initiated treatment and received usual care (95 %; $n = 23/24$), incentive (95 %; $n = 39/41$) or peer-mentor (93 %; $n = 42/45$). High proportion of attainment of cure (SVR) across participants who completed week-12 treatment and received usual care (92 %; $n = 22/23$), incentive 90 % ($n = 37/39$) or peer-mentor 92 % ($n = 41/42$). Non-statistically significant difference in the proportion of total enrolled participants achieved cure (SVR) across incentive (69 %; $n = 37/54$) and peer-mentor arms (76 %; $n = 41/54$), compared to the usual care (61 %; $n = 22/36$; $p = 0.22$). Compared to usual care, participants who received usual care with a: • Peer-mentor - 1.24 times more likely to achieve SVR (RR=1.24; 95 % CI = 0.92, 1.68) • Incentives - 1.12 times more likely to achieve SVR (RR=1.12; 95 % CI = 0.82, 1.54).

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Table 1 (*continued*)

Author (year)	Study setting, country	Participant demographic (sample size; % characteristic)	Study design	Intervention (Start to End date)	Incentive	Study outcomes	Study findings
Randomised controlled trials							
Wohl et al. (2017)	University of North Carolina (UNC) Infectious Diseases Clinic or Liver Centre (USA)	People who use or inject drugs (59; 46 % current drug use; 34 % experiencing recent housing instability)	Non-controlled RCT with head-to-head comparison	Participants diagnosed with HCV infection and prescribed DAA treatment were randomised to two conditions: 1) fixed incentives (fixed schedule of incentives offered), or 2) lottery-based incentive. Participants offered fixed incentives (predetermined monetary value) were given an incentive for each HCV monthly clinic appointment attended (for the duration of 8–24 week HCV treatment regime). Further incentives were offered for >90 % medication adherence (measured through electronic medication monitoring), with a bonus incentive for having an undetectable HCV viral load at the end of treatment (week 12) or 12-weeks post-treatment (week 24). Participants offered a lottery-based incentive were provided incentives at similar time-points as the fixed incentive condition, except that participants drew from a lottery bag containing varying incentive amounts and probabilities to draw each incentive. (Observation period: 3–4 months, NR)	Attend appointment (x5) – Fixed: $40 USD cash; Lottery: one draw to earn $10, $30 or $100 USD cash >90 % medication adherence (x4) – Fixed: $20 USD cash; Lottery: one draw to earn $10, $20 or $50 USD cash Undetectable viral load test result – Fixed: $50 USD; Lottery: two draws to earn $10, $30 or $100 USD cash Total up to $330 USD cash (fixed) or $800 USD cash (lottery)	Retention in care, Treatment adherence, Treatment completion, SVR attainment	Median and mean number of clinic appointments attended was 4 for both arms (SD = 1). High overall average appointment attendance across both arms for all appointments (92 %; $n = 54/59$). Non-statistically significant difference in the number of scheduled appointments attended between fixed and lottery incentive arms at: • week 2 (89 % ($n = 8/10$) and 80 % ($n = 17/19$), respectively; $p = 0.592$), • week-12 (93 % ($n = 25/27$) and 97 % ($n = 29/30$) respectively; $p = 0.59$), and • week-24 (89 % ($n = 25/28$) and 88 % ($n = 27/31$) respectively; $p > 0.99$), Estimated mean medication adherence ratio (days with ≥1 bottle opening:monitored days) was 0.91 for lottery incentives and 0.92 for fixed incentives. • Participants brought medication bottles to 85 % of scheduled clinic visits for pill counts • Less than 10 % of participants had their estimated medication adherence fall below 90 % at any monthly clinic appointment High proportion of participants had a medication adherence >90 % for both fixed (75 %; $n = 21/28$) and lottery (70 %; $n = 21/31$) incentive arms (estimated difference between arms = 5.0 %; 95 % CI, −28.2 to 19.1). High proportion of week-12 treatment completion among participants in the fixed (100 %, $n = 100/100$) or lottery incentive arm (86 %, $n = 24/28$). High rates of SVR in the intention-to-treat analysis for participants in the fixed (92.3; $n = 24/26$) and lottery incentive arms (92.9; $n = 26/28$) (estimated difference between arms = 0.5 %; 95 % CI: −17.5 to 18.8). High rates of SVR in the per-protocol analysis for participants in the fixed (90.9; $n = 24/26$) or lottery incentive arm (92 %; $n = 26/28$) (estimated difference between incentive groups = 1.9 %; 95 % CI: −16.0 to 23.6)

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Table 1 (*continued*)

Author (year)	Study setting, country	Participant demographic (sample size; % characteristic)	Study design	Intervention (Start to End date)	Incentive	Study outcomes	Study findings
Observational comparative studies							
Biggs et al. (2016)	Western Sydney Sexual Health Centre (Australia)	Indigenous people at risk or affected by HCV (306; 46 % have history of IDU)	Observational single-arm intervention with before and after comparison	Health promotion campaign with an incentive model where participants were offered incentive to complete education session with a sexual health worker or project officer. The first incentive was given to participants if they attended a co-located sexual health clinic, undergo STI/BBV test, and or obtain their first hepatitis B vaccine shot. An Aboriginal, Torres-Strait or Non-Indigenous staff accompanies the participant to the clinic. The second incentive was offered for participants to return to receive STI/BBV test result and or second hepatitis B vaccine shot. The third incentive given when participants receive their last hepatitis B vaccination shot. Additional incentives were given to participants if they recruit a peer (up to 3) into the program. Further incentives were given to participant if their recruited peer relays accurate HCV transmission information to an Aboriginal worker. 5-year control period was chosen to obtain a sufficient sample of Aboriginal clients to compare to. (Intervention period: 12 months, April 2013–14; Control period: 64 months, January 2008 – April 2013)	Education session - $20 AUD shopping voucher ($26.18 USD) Clinic appointment attendance and complete STI/BBV test, and or first hepatitis B vaccine shot - $10 AUD voucher ($6.82 USD) Receive STI/BBV test result and or second hepatitis B vaccine shot - $10 AUD voucher; Last hepatitis B vaccine shot - $10 AUD voucher. Peer recruitment - $10 AUD Voucher per peer (up to 3). Peer relays accurate HCV information - $10 AUD voucher per peer (up to 3) Total up to $110 AUD shopping vouchers ($74.10 USD)	Testing uptake, Linkage to care, Retention in care	Statistically significant difference in the number of participants underwent HCV antibody testing in the control period (23 %; $n = 19/83$) compared to intervention period (70 %; $n = 215/306$; $p < 0.001$) • 45 % ($n = 42/94$) participants who tested HCV positive in the incentive program accepted referral for further management. Non-significant difference in the proportion of participants with a return visit to clinic within 12 months during the control period (61 %; $n = 51/83$) and intervention period (55 %; $n = 169/306$; $p = 0.311$). Decrease in appointment attendance from 76 % to 51 %, lower than control period

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Table 1 (*continued*)

Author (year)	Study setting, country	Participant demographic (sample size; % characteristic)	Study design	Intervention (Start to End date)	Incentive	Study outcomes	Study findings
Observational comparative studies							
Lee et al. (2020)	Boston Medical Center (USA)	People use drugs (241; 27 % current drug use; 30 % experiencing recent housing instability)	Clinic-based incentive program with before and after comparison	Participants with an active HCV infection who initiated treatment were offered incentives to support their initial, follow-up and three-month post-treatment clinic appointment attendance with a HCV provider. (Intervention period: 3 months, 1st April – 30th June 2017) The intervention period was compared with a control period with no intervention. (Control period: 3 months, April 1st to June 30th, 2016). An additional post-intervention period (no incentive) was also analysed (Post-intervention period: 3 months, June to September 2017)	Clinic attendance - $15 USD gift cards (up to 3) Total up to $45 USD gift cards	Linkage to care, Retention in care, SVR attainment	327 clinic appointment scheduled by 241 unique patients across the entire study period 198 visits (149 unique patients) were during the intervention period and 129 visits (94 unique patients) during the control period. Statistically significant ($p = 0.03$) increase in the patient visits attended during the intervention period (72.7 %; $n = 144/198$; $p = 0.03$), compared to the control period (61.2 %; $n = 79/129$) • During the intervention period, 70.7 % ($n = 101/144$) of scheduled clinic appointments were scheduled by patients informed of the incentive • 78 % ($n = 78/101$) of appointments were attended among this subgroup. Statistically significant increase in the proportion of patients attending their initial appointment from 51 % ($n = 41/79$) in the control period to 70 % ($n = 101/144$; $p = 0.02$) in the intervention period. Non-significant differences observed for the proportion of patients attending their follow-up appointment between control (68 %, $n = 54/79$) and intervention period (72 %, $n = 104/144$; $p = 0.72$). Clinic appointments were 94 % more likely to be attended during the intervention period than comparison period (adjusted odds ratio = 1.94; 95 % CI=1.16 to 3.24; $p = 0.01$). • Incentives associated with an average increase of 15.4 attended visits per 100 scheduled appointments compared to control period ($p = 0.01$). 94 % ($n = 82/87$) attained SVR achievement in intervention period compared to 100 % of patients ($n = 45/45$) in comparison period. Three months post-intervention, 133 unique patients had appointments scheduled. • Statistically significant downward trend in appointment attendance with monthly rate of 5.1 additional missed appointments per 100 appointments ($p < 0.01$), despite no significant trend over the entire study ($p = 0.11$).

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Table 1 (*continued*)

Author (year)	Study setting, country	Participant demographic (sample size; % characteristic)	Study design	Intervention (Start to End date)	Incentive	Study outcomes	Study findings
Observational comparative studies							
Leo et al. (2019)	Smart-phone-based application (USA)	General targeting of people at risk or affected by HCV (124; NR)	Non-randomised comparative observational	Participants, diagnosed with a HCV infection and were prescribed treatment, were offered two conditions via telephone and mail: 1) register for the mobile application with incentives (participants), 2) do not register for mobile application (non-participants). Participants using the mobile application were offered incentives to increase daily adherence to prescribed medications. Additional incentives were offered to increase monthly adherence to treatment. Medication adherence was measured as the proportion of days covered by medication per individual. Adherence was assessed through retrospective analysis of pharmacy claims data. (Observation period: 9 month, 1st January 2018 – 30th November 2018)	Daily dose of DAA pills - $5 USD cash ≥85 % DAA pill adherence in prior month - $60 USD cash Total up to $600 USD cash	Treatment adherence	Of the 124 eligible participants, 32 % (n = 40/124) registered for the mobile application with incentives. • 87 % (n = 35/40) of participants had a medication adherence of over 95 % • When reminded, 97 % of doses were taken within 4 h, and 98 % within 5 h. • 95 % (n = 38/40) of participants completed treatment 87 % (n = 35/40) participants and 69 %% (n = 58/84) non-participants were eligible for the retrospective claims analysis. • Statistically significant increase in average medication adherence between non-participants (87.6 %, n = 58) and participants (96.2 %, n = 35; p = 0.025)
Litaker et al. (2021)	Sendero Health Plans, Inc. (USA)	General targeting of people at risk or affected by HCV (5287; NR)	Observational single-arm intervention with before-after comparison	Participants (born between 1945 and 65) without a documented HCV antibody test in the Sandero database were sent an outreach letter and educational material in a screening campaign. Participants were offered an incentive if they completed an HCV antibody test during the study period. (Intervention period: 1.5 month, 14th November to December 31st, 2018) Intervention period was compared to a comparison period in the year prior with no education material, outreach letter or incentives. (Comparison period: 1.5 months November 14th to December 31st, 2017)	Complete HCV antibody test - $50 USD gift card	Testing uptake	Increase in the number of participants undergoing HCV antibody test from 11.2 % (n = 89/795) in the comparison period to 37.6 % (n = 316/840) in the intervention period Participants were 3.36 times more likely to be screened during intervention period than comparison period (prevalence ratio = 3.36; 95 % CI = 2.71 to 4.16; p < 0.0001)

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Author (year)	Study setting, country	Participant demographic (sample size; % characteristic)	Study design	Intervention (Start to End date)	Incentive	Study outcomes	Study findings
Observational comparative studies							
Norton et al. (2019)	Community-based NSP and the Comprehensive Health Care Center, (USA)	People who inject drugs (39; 50 % experiencing recent housing instability; 44 % current IDU)	Non-randomised comparative observational	Participants were first consecutively allocated to the 1) enhanced standard of care plus incentives group before enrolling participant to the 2) enhanced standard of care group. The enhanced standard of care included: an expedited appointment to the health center (HCV evaluation and assess treatment eligibility and liver fibrosis), a round-trip transit card, and support and appointment reminders from an HCV coordinator. Participants were offered incentives for attending each of their nine or ten treatment visits. Incentives were also given for every blister pack returned to increase medication adherence, in addition to an incentive offered for having an undetectable HCV viral load in the week 4 treatment visit. (Observation period: 13 months, March 2015 – April 2016)	Attend appointment- $25 USD cash (up to nine or ten) Return weekly blister packs - $10 USD cash (up to 12 or 24) Undetectable viral load test result during week 4 appointment - $50 USD cash Total up to $395 (12-week regime) or $540 cash (24-week regime)	Retention in care, Treatment initiation, Treatment adherence, Treatment completion, SVR attainment	Statistically significant difference between the number of participants who were HCV RNA positive attended baseline evaluation visit who received enhanced care (30 %; $n = 6/20$) or enhanced care with incentives (73.7 %; $n = 14/19$; $p = 0.01$) • Treatment eligibility of participants was assessed in enhanced care (66.7 %; $n = 4/6$) and enhanced care with incentive groups (85.7 %; $n = 12/14$) Non-statistically significant difference between the number of participants (attended their first appointment and treatment eligible), who initiated HCV treatment and received enhanced care (100 %; $n = 4/4$) or enhanced care with incentives (75 %; $n = 9/12$; $p = 0.53$). No differences in treatment adherence between the two conditions. • Mean treatment adherence for all 13 participants who initiated treatment was 81 % in week 1, decreasing by 1.4 % (95 %CI: −2.4, −0.3; $p = 0.01$) per week over a 12-week treatment period. All participants in both care conditions completed treatment. Non-statistically significant difference between the number of participants with an SVR result at week 12 or 24 who received enhanced care (75 %, $n = 3/4$) or enhanced care with incentives (75 %, $n = 9/12$; $p = 1.0$).

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Author (year)	Study setting, country	Participant demographic (sample size; % characteristic)	Study design	Intervention (Start to End date)	Incentive	Study outcomes	Study findings
Observational comparative studies							
Treloar et al. (2018)	Two sexual health clinics in Western Sydney (Australia)	Indigenous people at risk or affected by HCV (732; 28 % have history of IDU)	Observational single-arm intervention with before and after comparison	Health promotion campaign with an incentive model where participants were offered incentive to complete education session with a sexual health worker or project officer. The first incentive was given to participants is they attended one of two co-located sexual health clinic, undergo STI/BBV test, and or obtain first hepatitis B vaccine shot. An Aboriginal, Torres-Strait, or Non-Indigenous staff accompanies the participant to the clinic. The second incentive was offered for participants to return to receive STI/BBV test result and or second hepatitis B vaccine shot. The third incentive given when participants receive their last hepatitis B vaccination shot. Additional incentives were given to participants if they recruit a peer (up to 3) into the program. Further incentives were given to participant if their recruited peer relays accurate HCV transmission information to an Aboriginal worker. (Intervention period for site 1: 30 months, April 2013 – October 2015; Intervention period for site 2: February 2015 - 2016) Observation period with incentive model compared with control period with no incentive model (Control period for site 1: 12 months, April 2011- 12; control period for site 2: February 2013–14)	Education session - $20 AUD shopping voucher ($26.18 USD) Clinic appointment attendance and complete STI/BBV test, and or first hepatitis B vaccine shot - $10 AUD voucher ($6.82 USD) Return for STI/BBV test result and or second hepatitis B vaccine shot - $10 AUD voucher Last hepatitis B vaccine shot - $10 AUD voucher; Peer recruitment - $10 AUD voucher per peer (up to 3). Peer relays accurate HCV information - $10 AUD voucher per peer (up to 3) Total up to $110 AUD shopping vouchers ($74.10 USD)	Retention in care	Statistically significant increase in the proportion of participants attending site 1 between the control (11 %, $n = 75/677$), intervention period (52 %, $n = 353/677$; $p < 0.001$), and within the year 2016 (31 %; $n = 210/677$; $p < 0.001$) Statistically significant increase in the proportion of participants attending site 2 from 5.9 % ($n = 3/55$) during the control period to 8.4 % ($n = 5/55$; $p < 0.001$) during the intervention period
Observational single-arm studies							
Ahmad et al. (2015)	Needle exchange centres in Tayside, (Scotland)	People who use or inject drugs (119; NR)	Observational single-arm intervention	Participants prescribed interferon or ribavirin treatment offered incentive to increase weekly clinic appointment attendance and engagement throughout their treatment (Observation period: 20 months, NR)	Attend clinic appointment (up to six)- £5–10 grocery vouchers ($6.55-$13.10 USD) with high protein drinks offered Total up to £120 grocery vouchers ($154.70 USD)	Retention in care, Treatment initiation, Treatment completion, SVR attainment	119 participants discussed participation in study with specialist nurses (46 ineligible for treatment) • 72.6 % ($n = 53/73$) of eligible participants consented to participate in the study. 80.4 % ($n = 41/51$) of eligible participants who consented to participate in the study initiated treatment • 53.7 % ($n = 22/41$) completed treatment. • 85 % ($n = 17/20$) had a virological response at 3 months, and 80 % ($n = 12/15$) at 6 months

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Author (year)	Study setting, country	Participant demographic (sample size; % characteristic)	Study design	Intervention (Start to End date)	Incentive	Study outcomes	Study findings
Observational single-arm studies							
Alimohammadi et al. (2018)	Community pop-up clinics in Vancouver's Downtown Eastside and Vancouver Infectious Diseases Centre (VIDC), (Canada)	People who use or inject drugs or people experiencing homelessness (1283; 73 % with history of IDU; 28 % experiencing recent housing instability)	Observational single-arm intervention	Outreach pop-up clinics offered incentives to participants for completing an OraQuick Rapid HCV Antibody test and wait to receive results at pop-up clinics. An additional incentive was given for attending the initial and follow-up appointment at VIDC (Observation period: 12 months, August 2016–17)	Complete rapid test and receive results - $10 CAD gift card ($7.58 USD) Attend follow-up clinic appointment - $10 CAD meal voucher ($7.58 USD) Total up to $20 CAD gift cards ($15.16 USD)	Testing uptake, Linkage to care, Treatment initiation, SVR attainment	1283 tests were performed within 12 months • 274 participants were found to be HCV antibody positive 50 % ($n = 83/166$) attended their initial and follow-up clinic appointment). 61.4 % ($n = 51/83$) who were successfully engaged in care-initiated HCV treatment. Per protocol SVR rate was 100 % ($n = 28/28$). Intention to treat (ITT) SVR rate was 85 % ($n = 28/33$) • 18 patients were still on therapy, 2 discontinued treatment, and 3 were lost to follow-up.
Allsop et al. (2021)	Low Newton prison, (United Kingdom)	People in custodial settings (307; NR)	Observational single-arm intervention	Weekend test and treat initiative where prisoners were given a small incentive for completing BBV fingerpick dry blood spot testing (Observation period: 2 days, January 2020)	NR	Testing uptake, Treatment initiation	99 % ($n = 305/307$) of participants accepted general BBV testing over the weekend 73.9 % ($n = 17/23$) HCV RNA positive prisoners who received the small incentive initiated treatment (3 already initiated treatment; 3 released before treatment initiation)
Busschots et al. (2020)	Antwerp (urban) and Limburg (rural), (Belgium)	People who use or inject drugs (425; 34 % history of IDU)	Observational single-arm intervention	Outreach screening centres offered participants an incentive to return and receive their QraQuick Rapid Antibody test result at outreach screening centres (Observation period: 1 month, July - August 2019)	Receive test results - €10 cash ($11.25 USD)	Testing uptake	425 PWID tested for HCV antibodies
Chan et al. (2021)	Three primary NSPs (service A, B, C) and one private general practice (service D), (Australia)	People who use or inject drugs (91; NR)	Observational multi-site intervention	Event-based testing campaign conducted across four health services which determined their own incentive structures. Incentives were offered to participants who self-reported not having an HCV test in 6 (service B) or 12 months (service A, C and D) to complete HCV test. Each service was given $500 AUD for the campaign. The campaign ran for 1–3 days at each service. (Observation period: 9 days, July – August 2019)	Service A: $10–20 AUD gift cards ($6.82-$13.63 USD) Service B: $10–20 AUD cash; catering; merchandise; peer networker Service C: $10–20 AUD gift cards; show bags; catering; door prizes Service D: $10-$20 AUD cash	Testing uptake, Linkage to care, Retention to care, Treatment initiation	91 people (37 % non-regular service clients; $n = 34/91$) who were not actively engaged in HCV care tested for HCV.56 % ($n = 51/91$) of participants discussed their results with a GP or nurse 3-months post-campaign (71 %, $n = 36/51$ regular service clients; 29 %, $n = 15/51$ non-regular service clients) • The percentage of participants discussing their results were: 57 % in service A ($n = 8/14$), 50 % in service B ($n = 8/16$), 73 % in service C ($n = 29/40$) and 29 % in service D ($n = 6/21$). 62.5 % ($n = 15/24$) of participants who tested HCV RNA positive had returned for their results (87 %, $n = 13/15$ regular service clients; 13 %, $n = 2/24$ were non-regular service clients). 66.7 % ($n = 10/15$) HCV RNA positive participants had medical records of initiating treatment (90 %, $n = 9/10$ regular service clients; 10 % $n = 1/10$ was non-regular service clients)

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Author (year)	Study setting, country	Participant demographic (sample size; % characteristic)	Study design	Intervention (Start to End date)	Incentive	Study outcomes	Study findings
Observational single-arm studies							
Harrod et al. (2020)	Temporary housing venues, hotel car parks and day centres across Guildford and Woking (England)	People experiencing homelessness (124; 14 % have history of IDU, 8 % current IDU)	Observational single-arm intervention	One-day outreach clinics where participants first completed an HCV risk questionnaire and then offered an incentive to complete a Qraquick HCV antibody test. Participants were also offered a Fibroscan whilst waiting for results (Observation period: 1 day, NR 2020)	Complete rapid test - food voucher	Testing uptake,	124 tests were performed: • 6.4 % (n = 8/124) of participants were positive for HCV antibodies • 50 % (n = 4/8) of participants who tested positive were found to be re-engage with HCV clinical care and achieved SVR. All the participants including participants who were lost to follow-up were found tohave an SVR attainment rate of 100 % (n = 8/8).
Khalili et al. (2022)	4 homeless shelters in San Francisco and Minneapolis (USA)	People experiencing homelessness (479; 66 % history of IDU; 26 % recent incarceration; 10 % Indigenous)	Observational single-arm intervention	Onsite rapid HCV testing campaign where participants were offered information about HCV and an incentive to complete rapid HCV testing. Participants with a positive test result were given a 30-minute HCV education session with a HCV coordinator. Participants also completed a pre-/post- HCV education video questionnaire (Observation period: NR)	Complete test - $25 USD cash	Testing uptake	Among 479 clients (279 in San Francisco, 200 in Minneapolis) were tested, of which 94 were HCV antibody positive, 60 HCV RNA positive and 17 initiated HCV therapy.
Niruban et al. (2019)	Subsidised housing locations and community based organisations (Canada)	People who use or inject drugs and people experiencing homelessness (342; 57 % current drug use; 19 % history of IDU)	Observational single-arm intervention	Street-based outreach campaign where participants were offered incentive to increase uptake of STI/BBV testing. Additional incentive offered for returning to collect tests and or initiating treatment (Observation period, 4 months, October 2018 – February 2019)	Up to two $10 CAD gift card ($7.58 USD) Total up to $20 CAD gift cards ($15.16 USD)	Testing uptake	393 testing visits were completed amongst 342 individuals. • 278 tests were for HCV with a positivity rate of 5.4 % (n = 15/278) Eight percent of visits involved treatment for an STI
Pham et al. (2018)	Ho Chi Minh City (Vietnam)	General targeting of people at risk or affected by HCV (203; 19.2 % physicians; 68.9 % midwives; 11.8 % technicians/ nurse assistants)	Observational single-arm intervention	HCV screening campaign where health care workers offered an incentive to increase uptake of HBV-HCV serological testing and completion of questionnaire (Observation period: NR)	Complete test and questionnaire - $5 USD cash	Testing uptake	96.7 % (n = 203/210) undertook HCV testing 0.5 % was positive for HCV infection (n = 1/203)
Seña et al. (2016)	STD clinic, county jail, community testing sites, residential substance abuse recovery program and a healthcare clinic for the homeless in Durham (USA)	People who use or inject drugs, people in custodial settings, people experiencing homelessness and general targeting of people at risk or affected by HCV (2004; 18.5 % history of IDU)	Observational single-arm intervention	County-level HCV onsite and outreach screening campaign where participants undertook an HCV antibody & confirmatory RNA testing. Participants with a positive HCV antibody test were offered a post-test counselling. Additionally, participants were offered an HCV patient navigator and incentive to increase clinic appointment attendance (Observation period: 14 months, December 2012 – February 2014)	Attend appointment - $10 USD gift card or bus pass	Linkage to care	Total of 2004 HCV test conducted • 471 tests at a STD clinic, 708 tests in a county jail, 741 tests at community testing sites, and 84 tests at a homeless health-care clinic • 16.3 % were positive for HCV infection 81.7 % (n = 197/241) participants were identified with chronic HCV infection and received post-test counselling • 68 % (n = 134/197) were referred to care • 91.8 % (n = 123/134) attended their first clinic appointment. Overall, 51 % (n = 123/241) of participants attended an initial appointment for HCV care

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Author (year)	Study setting, country	Participant demographic (sample size; % characteristic)	Study design	Intervention (Start to End date)	Incentive	Study outcomes	Study findings
Observational single-arm studies							
Sypsa et al. (2020)	Community based "seek-test-treat" program (Greece)	People who use or inject drugs and people experiencing homelessness (1365; 77 % current IDU; 24 % experiencing recent housing instability)	Observational single-arm intervention	'Seek-test-treat' program which offered monetary incentives for participants (Observation period: 17 months, April 2018 – September 2019)	Program participation – unspecified monetary incentives	Retention in care, Treatment initiation	28.9 % ($n = 395/1365$) was found to have an HCV monoinfection and eligible for treatment. 47.6 % ($n = 188/395$) of tested participants found to have an HCV monoinfection were linked to HCV care. 42.2 % ($n = 167/395$) of participants initiated treatment. Factors associated with higher risk of not being linked to care (aOR [95 % CI]) were: • Homelessness (homeless versus not homeless: 2.6 [1.6, 4.4], $p < 0.001$) Being a migrant (non-Greek versus Greek origin: 3.7 [1.8, 7.5], $p < 0.001$).
Zaller et al. (2016)	Two probation and parole offices (USA)	People in custodial settings (130; 83 % history of IDU; 75 % current incarceration; 5 % current IDU)	Observational single-arm intervention	Participants on probation or parole offered incentives for completing a pre-HCV video knowledge questionnaire, watch a HCV education video, complete a post-HCV video knowledge questionnaire. Participants were then offered a QraQuick HCV Rapid Antibody Test. Incentives were also offered to increase completion of HCV confirmatory testing, return for test results and attendance for initial appointment at the Immunology Centre when the participant's chronic HCV infection is confirmed. (Observation period: 12 months, NR)	Complete pre- and post-knowledge questionnaire - $20 USD cash Complete confirmatory testing - $15 USD cash Receive test results - $20 USD cash Attend appointment - $25 USD cash Total up to $80 USD cash	Testing uptake, Linkage to care, Retention in care	130 participants underwent HCV antibody testing • 60 % ($n = 78/130$) who tested for HCV never or didn't know about HCV testing 30 % ($n = 4/12$) of participants with a reactive HCV test result undertook HCV confirmatory testing • Two participants with a confirmed HCV infection did not return to the immunology centre for their schedule appointment with an HCV provider

NR, not reported.

sexually transmitted infection diagnostic tests and/or hepatitis B vaccination) were more likely to receive a HCV antibody test (70 %, 215 of 306) compared with people who attended the service in the retrospective 64-month control period (23 %, 19 of 83; $p < 0.01$) (January 2008 to April 2013). However, an $10 incentive did not improve rates of returning to receive the test result (169 of 306, 55 % versus 51 of 63, 61 %; respectively; $p = 0.31$) (Biggs et al., 2016). Subsequent deployment of the pilot incentive model in two other sexual health clinics increased the proportion of clients attending the HCV education session and testing for sexually transmitted infections and/or hepatitis B vaccination (75 of 677, 11 % versus 353 of 677, 52 %, respectively; $p < 0.01$) at one site (Treloar et al., 2018) (Table 1).

Two studies investigated the effectiveness of financial incentives to improve engagement in HCV care among people who used drugs (PWUD) specifically (Lee et al., 2020; Norton et al., 2019). Gift card incentives of US$15 per appointment increased treatment monitoring visit attendance (72.7 %, 144 of 198) during a two-month intervention period (April – 30th June 2017) compared to the same period the year prior (61.2 %, $n = 79/129$; $p = 0.03$), but impact was driven by higher attendance for initial appointments (101 of 144, 70 % versus 41 of 79, 51 %; $p = 0.02$) and not follow-up appointments (104 of 144, 72 %; versus 54 of 79, 68 %; $p = 0.72$) (Lee et al., 2020). Clinic appointments were 94 % more likely to be attended during the intervention period than comparison period (adjusted odds ratio = 1.94; 95 % CI=1.16 to 3.24; $p = 0.01$) (Lee et al., 2020). Clients attending an integrated needle and syringe program/primary care service were consecutively recruited to a cash incentivised HCV care model ($n = 19$; up to US$540; US$25 cash per clinic appointment attended; US$10 for returning weekly blister packs to indicate medication adherence; US$50 for SVR4 appointment) or a no incentive enhanced standard of care model ($n = 20$) (Norton et al., 2019). Compared to standard of care, more participants in the incentive model attended their first appointment (14 of 19, 73.7 % versus 6 of 20, 30 %, respectively; $p = 0.01$). While under-powered to detect significant differences, no difference was found in the proportion of RNA positive clients initiating HCV treatment (4 of 4, 100 % versus 9 of 12, 75 %; $p = 0.53$) or SVR12 attainment (3 of 4, 75 % versus 9 of 12, 75 %; respectively, $p = 1.00$).

Findings from observational single-arm studies

Twelve single-arm studies (no comparator) included 7292 participants (range: 91 to 2004), with the monetary value of incentives ranging from US$5 to US$80. Assessment of testing uptake was limited because most studies did not report the number of individuals eligible for HCV testing in the research settings or how many were offered a financial incentive. Participant engagement across the HCV cascade of care was generally high in these observational single-arm studies (Table 1). Below we describe findings by specific populations recruited; where possible, disaggregated findings are presented for studies that included and described findings across multiple specific populations.

Seven studies (Ahmad et al., 2015; Alimohammadi et al., 2018; Busschots et al., 2020; Chan et al., 2021; Niruban et al., 2019; Seña et al., 2016; Sypsa et al., 2020) examined the use of financial incentives to improve uptake of HCV care among PWUD, which included a total of 5629 participants (range 91 to 2004 participants; one study did not report overall sample size) (Table 1). Two studies examined absolute numbers of participants undertaking HCV testing (Busschots et al., 2020; Niruban et al., 2019). Four studies examined linkage to care (Alimohammadi et al., 2018; Chan et al., 2021; Seña et al., 2016; Sypsa et al., 2020), finding: high rates of baseline and follow-up care appointments (123 of 134, 91 %) among people offered a US$10 gift card or bus pass to people testing HCV RNA positive (Alimohammadi et al., 2018). Three studies examined treatment initiation (Ahmad et al., 2015; Chan et al., 2021; Sypsa et al., 2020) finding high rates of treatment (interferon or ribavirin) initiation (41 of 51, 80.4 %) and completion (22 of 41, 53.7 %) among people offered £5–£10 in grocery vouchers and high protein drinks to needle and syringe program attendees (Ahmad et al., 2015). High rates of treatment initiation (10 of 15, 66.7 %) were reported in a multi-site study offering AU$10 cash or gift cards for HCV RNA positive participants in a weekend testing campaign (Chan et al., 2021).

Six studies (Alimohammadi et al., 2018; Harrod et al., 2020; Khalili et al., 2022; Niruban et al., 2019; Seña et al., 2016; Sypsa et al., 2020) used financial incentives to encourage HCV testing and engagement in care among people experiencing homelessness, which included a total of 5691 participants (range: 124 to 2004 participants). Two studies (Harrod et al., 2020; Seña et al., 2016) used incentives to link people testing HCV RNA positive who were experiencing homelessness, with 50 % (4 of 8) of those offered food vouchers (Harrod et al., 2020) and 91 % of those offered US$10 cash (123 of 134) (Seña et al., 2016) attending their first clinic appointment. One study reported findings from incentivising US$25 cash for onsite rapid HCV testing (Khalili et al., 2022) and then US$75 cash for post-diagnosis HCV education participation, treatment initiation, and SVR attainment for people experiencing homelessness at four homeless shelters. The study found 99.2 % (766 of 772) eligible participants underwent HCV Ab testing, of which 21.1 % (162 of 766) were positive. Around 66 % (66 of 107) RNA positive participants attended an HCV post education session and initiated treatment, where 81.8 % (66 of 54) attained an SVR.

Three studies (Allsop et al., 2021; Seña et al., 2016; Zaller et al., 2016) examined the use of incentives among people in prison, probation, and parole settings, including a total of 2441 participants (range: 130 to 2004). One study examined testing uptake where an offer of a small incentive led to 305 of 307 (99 %) female prisoners to undergo general BBV testing (Allsop et al., 2021). A study of cash incentives offered to participants on probation or parole attend an immunology clinic for HCV education (US$20), diagnostic testing (US$15), returning for results (US$20), and returning for clinical consultation if RNA positive (US$25), reported 30 % (4 of 12) HCV antibody positive participants returned for a HCV RNA test; among two diagnosed with chronic HCV infection, none attended their scheduled clinic appointment (Zaller et al., 2016).

Quality assessment

Overall risk of bias was moderate among all three randomised controlled trials (this related mostly to blinding not being possible; Supplementary materials 3), serious among three of six comparative studies (none adjust for any potential confounders) and moderate for all of 14 non-comparative studies (Supplementary materials 4). When assessing selection bias across all 21 included studies, ten studies were classified as being moderate risk, with all recruiting from one or two clinics or study settings and 13 studies utilising non-random sampling. 10 of 19 non-randomised studies were at least moderate risk of bias for missing data; three did not record basic demographic data on the recruited participants and five studies did not list reasons for loss to follow-up.

Discussion

To our knowledge, this is the first systematic review to comprehensively identify and evaluate the use of financial incentives to improve progression through steps of the HCV care cascade. While numerous studies testing the effectiveness of financial incentives for improving engagement in HCV care were identified, it was difficult to make conclusions about the effectiveness of incentives for improving engagement in HCV models of care across the 21 studies included. Variations in study settings, designs, and populations targeted, measurement or reporting of outcomes alongside mostly low-quality and non-comparative study designs, limited our ability to assess the effectiveness of incentives in increasing HCV care engagement. Three randomised trials showed no significant impact of incentives on retention in care, treatment initiation, treatment adherence, treatment completion, and SVR12 attainment. No randomised trials have investigated the effectiveness of incentives for improving HCV testing uptake. In non-randomised observational studies, evidence supporting the impact of incentives was strongest for improving testing uptake, with only modest or no impact on subsequent retention in care. Some non-comparative observational studies found high rates of engagement in testing uptake, linkage or retainment in care and treatment completion, but without comparative data, findings provide weak evidence of the impact of incentives to inform practice. Further research is needed to inform increasing policy and practice interest in financial incentives as part of a suite of interventions to increase HCV care engagement and sustain elimination efforts (Pedrana et al., 2021).

The stages of the HCV cascade of care which were incentivised, and value of incentivisation vary considerably in current research. While exploring ways to best incentivise testing (Allsop et al., 2021; Biggs et al., 2016; Chan et al., 2021; Harrod et al., 2020; Khalili et al., 2022; Litaker et al., 2021; Niruban et al., 2019; Pham et al., 2018), returning for the test result (Alimohammadi et al., 2018; Biggs et al., 2016; Busschots et al., 2020; Zaller et al., 2016), attending appointments to initiate treatment (Ahmad et al., 2015; Alimohammadi et al., 2018; Barclay et al., 2020; Biggs et al., 2016; Lee et al., 2020; Seña et al., 2016; Treloar et al., 2018; Wohl et al., 2017; Zaller et al., 2016), retention in care (Ahmad et al., 2015; Biggs et al., 2016; Chan et al., 2021; Lee et al., 2020; Norton et al., 2019; Sypsa et al., 2020; Treloar et al., 2018; Wohl et al., 2017), and SVR testing and cure (Ahmad et al., 2015; Alimohammadi et al., 2018; Norton et al., 2019; Wohl et al., 2017) are important, this heterogeneity across a limited number studies of generally low quality provides collectively weak evidence. The large heterogeneity observed across HCV care outcomes limits the ability to provide good quality evidence to inform policy and incentive practice to improve engagement with HCV care. Future research should aim to simplify incentive practice and explore the comparative impact of different incentive values across varying populations and contexts, potentially resulting in differences in the effectiveness of specific incentive types and amounts between contexts. Understanding the most effective incentive value, frequency and schedule of incentive provision for specific populations may support high HCV care engagement. Importantly, further research should be guided by the local context, including community needs, programs, and identified gaps in the cascade of care when determining what outcomes to incentivise.

Our findings are consistent with those reported in a recent systematic review which evaluated multiple interventions to promote engagement in HCV care, which reported inconclusive evidence for the effectiveness of financial incentives in HCV care and inconsistent effects for testing uptake and linkage to care (Cunningham et al., 2022). In contrast, provider financial incentives was found to improve uptake of HCV antibody tests (Cunningham et al., 2022). Our findings suggest incentives are more efficacious in improving testing uptake rather than post-diagnosis linkage to care. In this context, research incentivising

point-of-care testing programs that offer opportunities for complete antibody and RNA testing, or same-day commencement of treatment may offer particular utility for guiding practice. To note, most studies reported findings related to the impact of incentives in improving testing uptake. Thus, it appears that incentives may have more impact on testing uptake due to the abundance of data on the outcome. Conversely, few studies reported data on the effect of incentives for treatment adherence, treatment completion or SVR attainment. As a result, the review found incentives to have less impact on these outcomes. To understand the effectiveness of incentives for HCV care, future studies should endeavour to examine the use of incentives on outcomes outside of testing uptake and treatment initiation.

Understanding threshold values sufficient to incentivise post-diagnosis engagement in care and treatment commencement also warrants further research. Some studies that offered incentives with a combined monetary value more than US$100 all collectively incentived across successive steps in the care cascade to promote retention in care or treatment initiation, adherence or completion (Ahmad et al., 2015; Biggs et al., 2016; Leo et al., 2019; Norton et al., 2019; Treloar et al., 2018; Ward et al., 2019; Wohl et al., 2017). Modelling using costing data from a community testing campaign focused on people who inject drugs, found incentives of up to AU$500 per RNA-positive person completing testing and up to AU$200 per diagnosed person initiating treatment would be cost beneficial even with relatively modest improvements in diagnoses (from 63 % to 74 %) and treatment initiation (from 67 % to 83 %) (Palmer et al., 2021).

However, consideration of monetary values shown to be cost effective should be balanced against consumer acceptability and the balance between incentive and coercion (Hoskins et al., 2019), especially targeting communities characterised by social and economic disadvantaged. Thematic analyses of Aboriginal healthcare worker interviews by Treloar et al. (2018) found that a stigma-free client-focused model of health care was a key facilitator for high program engagement. However, some healthcare workers believed incentives were like 'bribes', and were discordant with their personal values. Therefore, research methods such as co-design may overcome issues of acceptability and trust related to the provision or receiving of incentives by incorporating the perspectives of targeted stakeholders. Wolstenholme et al. (2020) conducted co-design workshops with prior 12 HCV service users and 10 key stakeholders on incorporating an incentive program within a nurse-led HCV service. The workshop designed incentives to reward service users for appointment attendance and to enable transportation to their appointment, both of which was found to be feasible and acceptable to service users. Only one of the twenty-one included studies consulted with key stakeholders for their incentive program. Thus, future research and practice should consider that key stakeholders, including healthcare workers and targeted populations, are appropriately consulted when designing and implementing an incentives program for HCV models of care.

The limited number of randomised trials and design limitations in observational comparative studies made it difficult to determine the independent effect of incentives on engagement in care outcomes. Similarly, inconsistent reporting of outcomes and indicators limited assessment of the effect of incentives. Thirteen of the twenty-one included studies integrated incentives alongside other interventions (Bajis et al., 2017; Cunningham et al., 2022), including HCV educational sessions, facilitated referral, counselling, and involvement of peers or nurses in helping navigate care pathways. While such integrated interventions limit understanding of the specific role of incentives in driving engagement in HCV care, they can also offer important insights into aspects of models of care that synergistically support incentives effectiveness. Upcoming research such as the Motivate C trial investigates the impact of cash incentives for clients, in conjunction to cash incentives for primary providers with the inclusion of a patient navigator which may support the effectiveness of incentives (The University of Sydney, 2023). Thus, incentives may drive high engagement when offered during person-centred models of care. Further studies should endeavour to explore essential elements of models of care that underpin the impact of incentives on engagement in the completing the HCV care cascade.

Limitations

There are several limitations with this review. First, a meta-analysis on the effects of incentives was unable to be conducted due to high heterogeneity between the types of incentives given and amount in value. Second, an English language limitation in the search strategy may cause the review to miss some studies conducted in languages other than English. Third, the lack of randomised controlled trials, and design limitations in comparative and observational studies make it difficult conclude impacts on HCV testing and treatment behaviours due to incentives alone or in combination with other co-interventions.

Conclusion

This systematic review showed that current evidence for the effectiveness and cost-effectiveness of incentives for improving HCV testing and treatment outcomes is weak and constrained by generally poor study and analysis designs. To better understand the potential role of incentives in strategies to improve engagement in HCV care, future research should endeavour to comparative incentive types and methods for analysis to examine the effective of differing monetary values of incentives and should seek to identify necessary components of models of care that help facilitate the effectiveness of incentives.

CRediT authorship contribution statement

C. Shen: Writing – review & editing, Writing – original draft, Visualization, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **J. Dawe:** Writing – review & editing, Investigation, Formal analysis, Data curation. **M.W. Traeger:** Writing – review & editing, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **R. Sacks-Davis:** Writing – review & editing. **A.E. Pedrana:** Writing – review & editing. **J.S. Doyle:** Writing – review & editing. **M.E. Hellard:** Writing – review & editing. **M Stoové:** Writing – review & editing, Supervision, Methodology, Investigation, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

MWT has received investigator-initiated research funding, speakers honoraria and consultant fees from Gilead Sciences for activities unrelated to this work. AP has received investigator-initiated research funding from Gilead Sciences and AbbVie and consultant fees from Gilead Sciences for activities unrelated to this work. JSD and MEH receives funding from Gilead Sciences and Abbvie for investigator-initiated research, unrelated to the submitted work. MS has received investigator-initiated research funding from Gilead Sciences and AbbVie and consultant fees from Gilead Sciences for activities unrelated to this work. Burnet Institute receives funding support (outside this study) from the Victorian Government Operational Infrastructure Fund.

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Supplementary materials

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