Development and optimisation of a reception testing protocol designed to eliminate HCV in the UK prison population

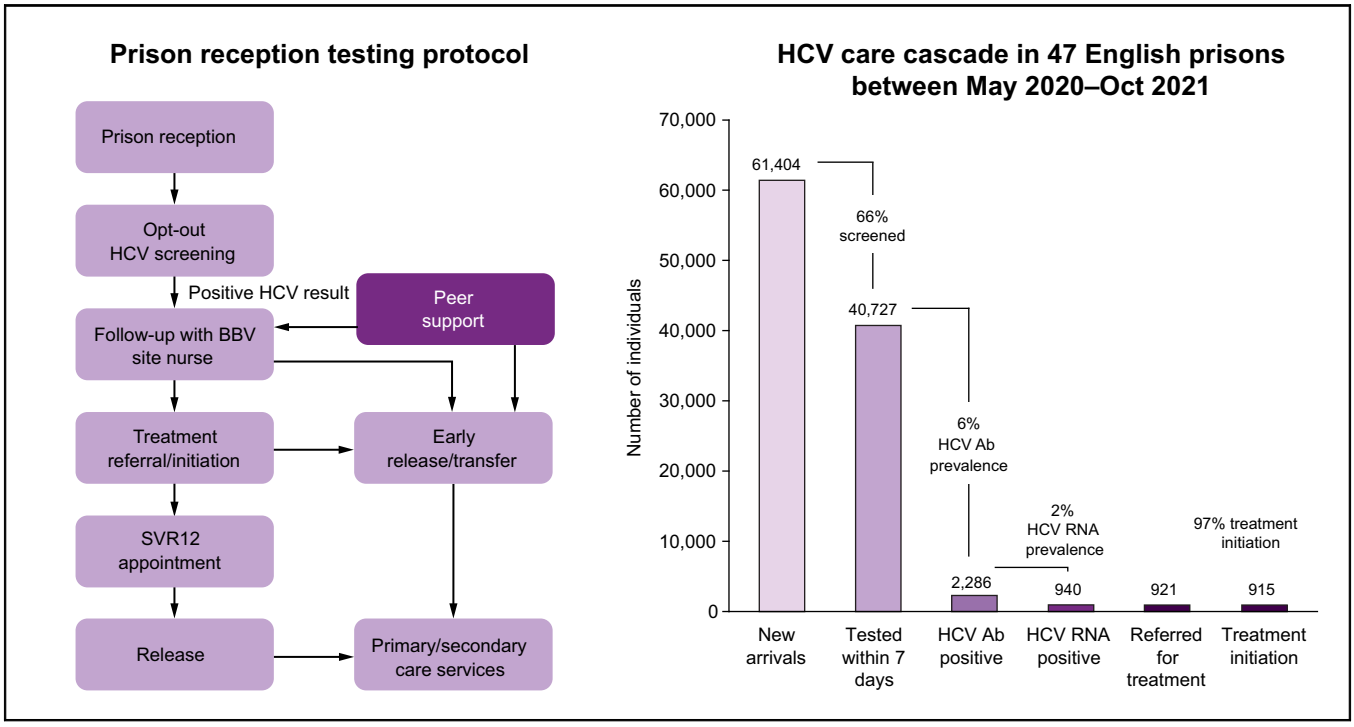
Authors

Emily Mongale, Samantha Allen, Iain Brew, Arran Ludlow-Rhodes, Nichola Royal, Julia Waldron, Hannah Alexander, Lee Christensen, Kate Dorrington, Andrew Milner, Louise Missen, Andy Jones, Philip J.F. Troke

Correspondence

Emily.Mongale@practiceplusgroup.com (E. Mongale).

Graphical abstract



Highlights

- This is the largest hepatitis C virus (HCV) test and treat initiative in prisons conducted to date.
- This nurse-led initiative resulted in high rates of HCV test offering and uptake across 47 prisons in England.
- The reception testing initiative led to an increase in HCV antibody testing from 32% prior to the project starting to 86% in Year 3.
- In Years 2 and 3, 97.3% of residents diagnosed as HCV-positive initiated treatment with direct-acting antivirals.

Impact and implications

Prisons represent an area of high HCV prevalence and so initiatives that improve testing and treatment of residents are needed to eliminate HCV from prisons. The reception testing protocol improved HCV screening in new arrivals across 47 prisons in England and could be a viable way for countries to achieve HCV micro-elimination in their prison systems. The reception testing protocol presented here can be adapted to the individual needs of prisons, globally, to improve HCV screening and treatment in this setting.

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Research article

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Development and optimisation of a reception testing protocol designed to eliminate HCV in the UK prison population

Emily Mongale,[1,*] Samantha Allen,[1] Iain Brew,[1] Arran Ludlow-Rhodes,[1] Nichola Royal,[1] Julia Waldron,[1] Hannah Alexander,[1,2] Lee Christensen,[3] Kate Dorrington,[4] Andrew Milner,[4] Louise Missen,[4] Andy Jones,[4] Philip J.F. Troke[4]

[1]*Practice Plus Group, 5–6 Napier Court, Napier Road, Berkshire RG1 8BW, UK;* [2]*Defence Primary Healthcare, UK;* [3]*The Hepatitis C Trust, 27 Crosby Row, London SE1 3YD, UK;* [4]*Gilead Sciences Ltd, 280 High Holborn, London WC1V 7EE, UK*

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Background & Aims: Micro-elimination of hepatitis C virus (HCV) in high-risk populations is a feasible approach towards achieving the World Health Organization's targets for viral hepatitis elimination by 2030. Prisons represent an area of high HCV prevalence and so initiatives that improve testing and treatment of residents are needed to eliminate HCV from prisons. This initiative aimed to improve the HCV screening and treatment rates of new residents arriving at prisons in England.
Methods: A rapid test and treat pathway was developed and implemented in 47 prisons in England between May 2019 and October 2021 as a healthcare service improvement initiative. Prison healthcare staff performed opt-out HCV testing for all new residents at each prison within 7 days of arrival, and those who were positive for HCV RNA were offered treatment with direct-acting antivirals (DAAs). The Hepatitis C Trust provided peer support for all residents on treatment and those who were released into the community.
Results: Of 107,260 new arrivals, 98,882 (92.2%) were offered HCV antibody testing, 63,137 (63.9%) were tested and 1,848 were treated. Testing rates increased from 53.7% in Year 1 to 86.0% in Year 3. Between May 2020 and October 2021, 40,727 residents were tested, 2,286 residents were positive for HCV antibodies and 940 residents were HCV RNA positive, giving an antibody prevalence of 5.6% and an RNA prevalence of 2.3%. A total of 921 residents were referred for treatment and 915 initiated DAA treatment (97.3% of whom were HCV RNA positive).
Conclusions: This initiative showed that an opt-out HCV test and treat initiative in prison receptions is feasible and can be adapted to the needs of individual prisons as a viable way to achieve HCV micro-elimination.
Impact and implications: Prisons represent an area of high HCV prevalence and so initiatives that improve testing and treatment of residents are needed to eliminate HCV from prisons. The reception testing protocol improved HCV screening in new arrivals across 47 prisons in England and could be a viable way for countries to achieve HCV micro-elimination in their prison systems. The reception testing protocol presented here can be adapted to the individual needs of prisons, globally, to improve HCV screening and treatment in this setting.

Introduction

Hepatitis C virus (HCV) infection is a major global health issue with an estimated 58 million people living with chronic HCV infection globally.[1] In England an estimated 89,000 people have chronic HCV infection.[2] Treatment of chronic HCV infection with direct-acting antiviral (DAA)-based regimens has resulted in a large proportion of patients achieving cure, which is defined as having a sustained virological response (SVR) 12 weeks after end of treatment,[3] and has provided the opportunity to strive for HCV elimination. Between 2014 and 2018, only 41% of HCV RNA-positive patients in England were successfully linked to treatment, and, of these, 86% commenced DAA treatment,[2] highlighting that even with highly effective DAA treatments, screening and linkage to care of patients with chronic HCV remains a challenge.

The World Health Organization (WHO) has set global targets to eliminate HCV as a major public health threat by 2030. Part of this elimination goal was to achieve a 10% reduction in HCV-related deaths by 2020.[4] To meet these targets, the European, American, Asian-Pacific and Latin American Associations for the Study of the Liver issued a call to action to implement simplified approaches to HCV testing and cure.[5] The WHO elimination targets have also been adopted by national health authorities, including the UK National Health Service (NHS), which signed up to the WHO Global Health Sector Strategy in 2016.[2] HCV

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* Corresponding author. Address: Practice Plus Group, 5–6 Napier Court, Napier Road, Berkshire RG1 8BW, UK.
E-mail address: Emily.Mongale@practiceplusgroup.com (E. Mongale).

elimination efforts in England resulted in a 30% reduction in HCV prevalence between 2015 and 2019.[2] Furthermore, England met the WHO target to reduce HCV-related mortality by 10% 3 years early, with a 20% reduction in HCV-related deaths between 2015 and 2018.[2]

A major challenge to achieving HCV elimination is in the treatment of vulnerable populations, for whom traditional HCV care pathways are not properly optimised. HCV infection is highly prevalent in such populations, which include people who inject drugs (PWID), are homeless, are incarcerated or who suffer from mental health disorders.[4]

People in prison represent a high-risk group for chronic HCV infection and reinfection,[3,6,7] and include a spectrum of individuals who also engage with drug use and/or suffer from mental health disorders.[7–9] Due to this, it is unsurprising that prisons have a higher prevalence of HCV when compared with the general population.[10] The prison system also represents a structural barrier that may prevent individuals with chronic HCV infection from accessing the treatment they need.[4] A survey of 43 prisons in the United States highlighted that only one quarter provided routine testing for HCV for residents.[11] Data from 2016 showed that 35% of the prison population in England had a history of intravenous drug use, with 18% currently injecting drugs,[12] and data from Scotland highlighted that incarceration of PWID accounts for a quarter of HCV transmission among PWID.[13] It was estimated that if 80% of HCV-infected residents in the Scottish prison system with sentences longer than 16 weeks were treated, HCV incidence and chronic prevalence among PWID in Scotland could be almost halved in 15 years,[13] reinforcing the need for efficient HCV treatment for this population.

High-income countries are projected to meet the WHO 2030 HCV elimination targets 20 years late.[14] This is partly due to infection rates in underserved populations, such as prison communities, highlighting the need for micro-elimination pathways that are tailored to these populations. However, globally, studies focussed on enhancing engagement in the HCV care cascade for people in prison are lacking.[15] In order to improve engagement with blood-borne virus (BBV) healthcare for residents in prison, initiatives have been introduced to identify individuals entering the prison system who are HCV positive. In England, opt-out BBV testing has been available in prisons since 2013, with full implementation of the programme in all adult prisons occurring in March 2018 following the launch of the prison national BBV opt-out policy in 2017.[16] Despite the introduction of these policies, between April 2018 and March 2019 only 32% of new receptions and transfers in prisons in England were tested for HCV.[2] Of the anti-HCV antibody-positive individuals identified during this period, 75% were tested for HCV RNA and 81% of these were found to have chronic HCV infection.[2]

To improve HCV testing rates, NHS England (NHSE) made an innovative deal in 2019 with three pharmaceutical companies to collaborate in proactively identifying and treating patients who may be unaware they have HCV infection.[17] The conditions of this deal included pharmaceutical companies providing HCV treatments at the best possible price and launching new initiatives to identify undiagnosed patients and ensure their effective referral to treatment.[17] Here we describe one of these initiatives, which aimed to identify HCV-positive individuals within the first week of arriving at English prisons whose healthcare is provided by Practice Plus Group (PPG).

Materials and methods

Project oversight

This project is a 5-year collaboration between PPG, The Hepatitis C Trust and Gilead Sciences Ltd as part of the 2019 NHSE HCV elimination plan and was delivered as a healthcare service improvement initiative. PPG is England's largest independent provider of NHS services, including healthcare for prisons. In January 2019, PPG recorded an average HCV testing uptake of 29.3% across the 45 prisons for which they provided healthcare (personal communication from Dr Iain Brew). The Hepatitis C Trust is a patient led and run UK charity for individuals with HCV. Gilead Sciences Ltd is a pharmaceutical company that provides DAA treatments in England but also has significant knowledge and expertise regarding the diagnosis and treatment of patients with HCV through their Medical Scientists. Gilead Medical Scientists did not have any impact on the choice of drugs used during the project. In addition, the NHSE procurement tender structure ensures that any change in DAAs used in a setting is matched by reciprocal changes in another setting to ensure DAA use nationally aligns to the NHSE-specified market share arrangement in place with all HCV pharmaceutical industry partners.

Development of the reception test and treat pathway

The reception test and treat pathway was developed as a stepwise process to enhance BBV testing that was part of the existing national opt-out screening policy in 2018,[16] and aimed to identify HCV-positive individuals within the first 7 days of arrival in prisons (Fig. 1). To oversee the pathway optimisation and evolution, a steering committee was formed at each prison. No extra staff were provided to implement BBV screening at reception. New arrivals were offered an opt-out HCV antibody test within the first week, using either dried blood spot testing or rapid point-of-care (POC) testing using the InTec Rapid Anti-HCV Test (InTec Products), if available. The advantage of POC testing is the rapid result, which is particularly important in remand sites where patients may be released or transferred within days.[18] Consenting individuals who were tested were advised of their result by a BBV nurse within 5 days. Individuals who were positive for HCV antibodies were asked to consent to a venous blood sample being taken to test for HCV RNA and whether they would like to be engaged by peers from The Hepatitis C Trust.

Individuals attended a follow-up appointment with an onsite BBV nurse to discuss results. As the initiative spanned from pre- to post- pandemic, adaptations to the screening of residents were necessary. Liver staging was performed in individuals who were HCV RNA positive, initially by FibroScan® assessments which were conducted by trained nurses. Aspartate aminotransferase-to-platelet ratio index, fibrosis-4 index and the enhanced liver fibrosis score were used to rule out cirrhosis during the pandemic as FibroScan® assessments were not possible. HCV genotype (GT) was also assessed in the majority of individuals, or historical records were referenced for pre-existing GT results, if available. HCV RNA-positive individuals were referred to an NHS HCV operational delivery network (ODN) specialist to initiate treatment with DAAs. Post-pandemic, residents could also have a web-based consultation to obtain a prescription, although this may not have been possible at all sites. GT-specific and pangenotypic DAAs were available and

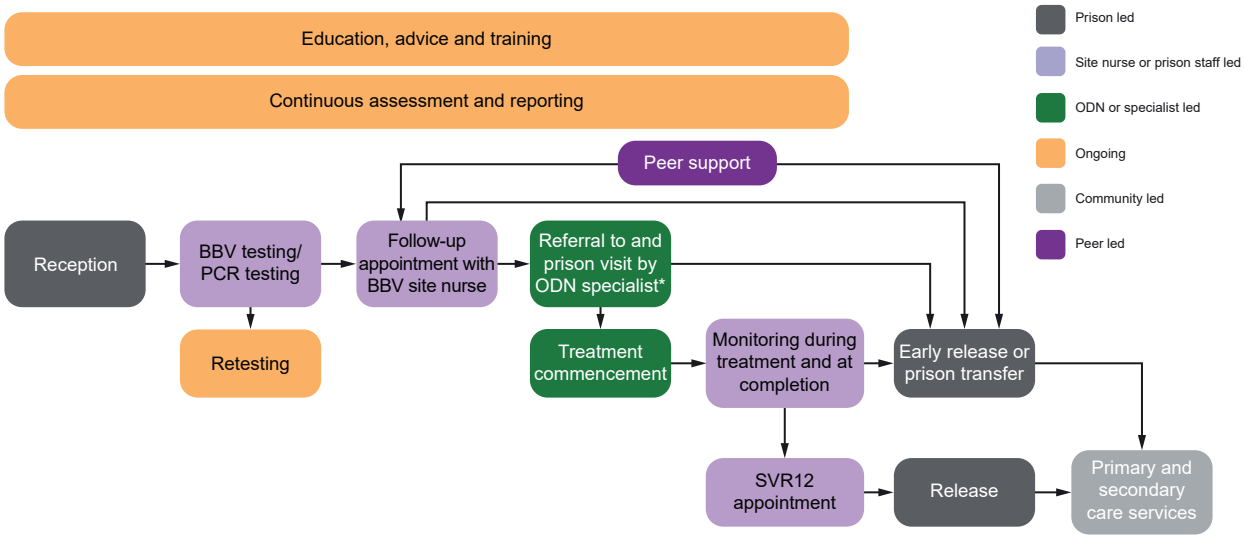

Fig. 1. Reception testing flowchart. A flowchart of the steps that residents follow when opting into the reception testing pathway, and which stakeholders are involved at each stage. *ODN specialist may be prison nurse or healthcare professional trained in using FibroScan®. BBV, blood-borne virus; ODN, operational delivery network; SVR12, sustained virologic response at 12 months.

treatment decisions were made by the multidisciplinary team in line with NICE (National Institute for Health and Care Excellence) guidelines.[19] A recorded GT was not a requirement for starting treatment, but a GT appropriate treatment was selected for those with an available GT result. Treatment was prescribed by an ODN specialist and was transported to prisons with the aim of initiating treatment as soon as possible.

Individuals were monitored regularly while on treatment, and those with cirrhosis were assessed for hepatocellular carcinoma with ongoing surveillance every 6 months. Individuals also attended an SVR12 appointment 12 weeks after finishing treatment to assess cure. For those who were released while on treatment, peers from The Hepatitis C Trust ensured they were followed up and linked to care within the community. Residents could initiate treatment on the same day they were released via the Follow Me programme,[20] where they received the full course of treatment before release (medicine in-possession). Inter-prison transfer was common in this population. Use of SystmOne, a national online digital system, allowed staff access to all medical records for patients who were transferred. Where possible, continuity of care was ensured between prisons. The Hepatitis C Trust supported patients transferred to prisons that did not have healthcare provided by PPG. Patients who went to court were given the whole supply of their medication in preparation for potential immediate release from court. For more information on the development of the reception test and treat pathway, please refer to the supplementary appendix.

Regional pathway improvement teams

The 45 prisons originally in this initiative were divided into six geographical regions, and each region was assigned a regional BBV lead nurse, employed by PPG, who was dedicated fully to this initiative and was supported by a national BBV lead nurse. Gilead Sciences provided funding for the six regional BBV nurses and one national BBV lead nurse. The regional BBV lead nurses were partnered with a Gilead Medical Scientist and The Hepatitis C Trust peer coordinator to form a regional BBV team that implemented the HCV reception test and treat pathway and made continual refinements to address individual issues and challenges that arose throughout the project. BBV lead nurses and Gilead Medical Scientists educated the prison healthcare staff on the reception testing process, while The Hepatitis C Trust educated residents and prison officers on HCV. Improvements to data recording and quality on the patient database SystmOne, the main clinical database used by healthcare centres in the UK, helped to effectively measure the success of the initiative and to identify patient attrition.

Setting and population

At the start of the initiative, 45 prisons where healthcare was provided by PPG were included. One prison changed to another healthcare provider, and three additional prisons had their healthcare provided by PPG during the initiative, bringing the total number of prisons included in this project to 47 by 2020. All categories of prison were represented (female [open and closed], young offenders, remand, training, open and Category A [high security]). These prisons represented around 40% of the English prison estate and had an approximate standing population of 30,000 residents with 5,000 new receptions per month, although this was reduced to 4,000 new receptions during the COVID-19 pandemic.

Outcome assessment

In planning this initiative, representatives from PPG, The Hepatitis C Trust and Gilead Sciences agreed on targets that were to be achieved by the last 3 months of each year. Targets for testing included offering ≥80% and ≥90% of new residents entering prison an HCV test within 7 days of arrival in Year 1 and Years 2/3, respectively, and testing ≥50%, ≥70% and ≥80% of new residents for HCV antibodies within 7 days of arrival in Year 1, Year 2 and Year 3, respectively. Treatment targets included ≥50%, ≥65% and ≥75% of HCV RNA-positive patients initiated on treatment before leaving prison in Year 1, Year 2 and Year 3, respectively. Across the whole project it was anticipated that ≥90% of HCV antibody-

Table 1. Prisons involved in this initiative.

Prison category	Number of prisons
Female open	1
Female closed	3
Category A: Long-term high security	2
Category B: Remand*	10
Category C: Training*	21
Category D: Open*	5
YOI (aged <21 years)†	6

YOI, young offender institution.
* Contains prisons that were newly provided with care by Practice Plus Group as of April 2020.
† One prison in this category no longer had care provided by Practice Plus Group prison as of April 2020.

positive patients were to be tested for HCV RNA, and ≥90% of HCV RNA-positive patients were to be referred for treatment. The data collected during this initiative were analysed retrospectively to ascertain if the screening and treatment targets were met.

Data collection

An HCV dashboard that was compatible with SystmOne was developed by PPG and Gilead Sciences to allow for easy input of anonymised patient data collected during routine clinical care. The dashboard provided a report for the entire PPG prison network and could be stratified by region, prison category and individual prison. As patient data were anonymised and collected for service assessment and optimisation purposes, ethics approval was not required to collect these data. For each prison, multiple data points were recorded, including total number of individuals arriving at reception, number of residents who were HCV antibody positive and RNA positive and number of HCV RNA-positive individuals referred for treatment. The dashboard was also designed to identify weaknesses in the pathway by measuring activity at each step of the reception testing pathway. During the initiative, PPG updated the SystmOne reporting templates and provided training to staff to maintain accuracy of data recording.

Results

Number of prisons and analysis period

The reception testing protocol was implemented in 47 prisons from six different regions in England between May 2019 and October 2021 (Table 1). From April 2020, PPG began providing healthcare for three additional prisons, whilst one prison switched to another healthcare provider at this time; data from this prison were not included from this date (Table 1).

HCV antibody testing

Between May 2019 and October 2021, there were 107,260 new arrivals who had not had a BBV test recorded within 12 weeks of arrival across all prisons in the PPG network, and overall, 92.2% (n = 98,882) of these new arrivals were offered an HCV antibody test (Table 2). Overall, 7.8% of all new arrivals were not offered an HCV antibody test, with the proportions of those not offered a test being 8.9% (n = 4,093), 9.3% (n = 3,805) and 2.3% (n = 480) in Year 1 (May 2019 to April 2020), Year 2 (May 2020–April 2021) and Year 3 (May 2021 to October 2021), respectively (Table 2). Reception testing rates decreased in March and April 2020 when a national lockdown was implemented in the UK due to COVID-19 but began to increase again in May 2020 (Fig. 2). The targets for offering HCV antibody tests to new arrivals within 7 days of arrival in prison were achieved in the final quarters of Years 1 and 2 (85.2% *vs* a target of ≥80% in Year 1 and 97.6% *vs* a target of ≥90% in Years 2 and 3).

Of those offered an HCV antibody test at reception (n = 98,882), 63.9% were tested within 7 days of arrival over the whole analysis period (Table 2). The average proportion of new arrivals completing an HCV antibody test within 7 days of arrival increased from 53.7% (n = 22,410) in Year 1 to 63.3% (n = 23,402) in Year 2 and 86.0% (n = 17,325) in Year 3 (Table 2). This ranged from 35.3% in May 2020 to 88.8% in July 2021 (Fig. 2). The targets for HCV antibody testing uptake were achieved in the final quarters of Year 1 and 2 (58.2% *vs* a target of ≥50% in Year 1 and 78.6% *vs* a target of ≥70% in Year 2) (Fig. 2). When stratifying HCV antibody testing uptake by prison category, the proportion of individuals tested within 7 days of arrival increased over time in all categories (Fig. 3).

Of those who completed HCV antibody tests (n = 63,137), 5.3% were identified as HCV antibody positive across the whole analysis period (Table 2). HCV antibody prevalence ranged from 2.6% to 14.5% across prison categories, with the highest prevalence in female prisons (n = 491/3,382) and lowest prevalence in open prisons (n = 72/2,748) (Fig. 4).

Referrals and treatment

Prior to 2020, new HCV RNA-positive diagnoses could not be accurately measured using the SystmOne database due to coding issues, which limited an analysis of referral in Year 1, though this did not prevent patients being referred and initiating therapy. Manual reporting of treatment initiations identified 933 residents who initiated treatment between May 2019 and April

Table 2. Overview of HCV testing.

Category	Year 1 May 19–Apr 20	Year 2 May 20–April 21	Year 3 May 21–Oct 21	Overall
HCV antibody tests				
New arrivals without a BBV test recorded within the previous 12 weeks	45,856	40,783	20,621	107,260
Number of these arrivals offered an HCV antibody test during reception process (%)	41,763 (91.1)	36,978 (90.7)	20,141 (97.7)	98,882 (92.2)
Number of arrivals that were offered HCV antibody test and tested within 7 days (%)*	22,410 (53.7)	23,402 (63.3)	17,325 (86.0)	63,137 (63.9)
Number of new eligible arrivals identified through reception testing as HCV antibody positive (%)†	1,053 (4.7)	1,320 (5.6)	966 (5.6)	3,339 (5.3)

BBV, blood-borne virus; HCV, hepatitis C virus.
* Percentage calculated from number of new arrivals offered a test during reception process.
† Percentage calculated from number of new arrivals tested for HCV antibodies.

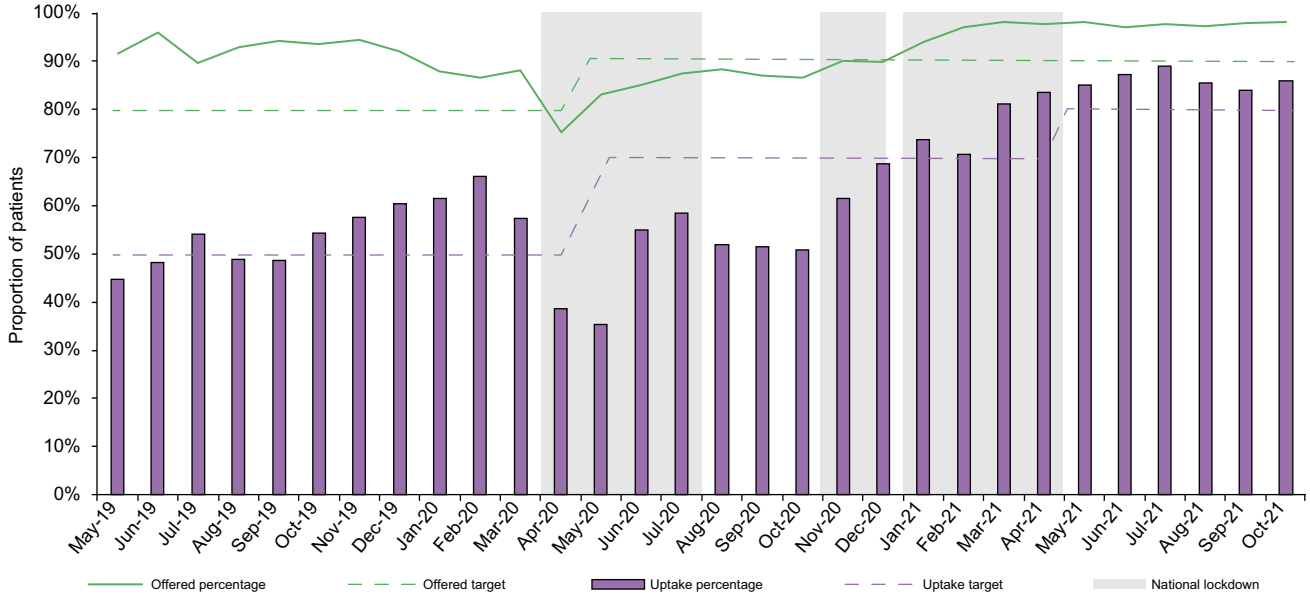

Fig. 2. Monthly reception testing offer and uptake. HCV testing offer (solid green line) and uptake (purple bars) for each month of the initiative compared to the offer (dashed green line) and uptake (dashed purple line) targets for each year. The grey zones correspond to lockdown periods during the COVID-19 pandemic in England. HCV, hepatitis C virus.

2020, comprising those newly diagnosed and those already known to be HCV infected but not treated. The beginning of the COVID-19 pandemic in the UK reduced the number of referrals and treatment initiations. Despite this, between May 2020 and October 2021, 940 residents were diagnosed as HCV RNA positive, giving an HCV RNA prevalence of 2.3% across all prison categories (Table 3). Of these, 915 (97.3%) patients started DAA treatment (Table 3).

Discussion

This initiative was developed to improve HCV screening of new residents arriving at prisons in England. Across the whole initiative, 63,137 prison residents were tested for HCV antibodies and 1,848 residents were treated for HCV. In the period between May 2020 and October 2021, 40,727 residents in prisons with healthcare provided by PPG were tested for HCV antibodies. Of these, 2,286 residents were found to be positive for HCV antibodies and 940 residents were positive for HCV RNA. Across all prisons, this equates to an HCV antibody prevalence of 5.6% and an HCV RNA prevalence of 2.3%, equating to 41% of those identified as antibody positive. It is important to note that the HCV RNA prevalence presented here is the proportion of all HCV antibody-positive residents and not just those who were identified through the reception testing initiative. The prevalence of HCV antibodies increased from 4.7% in Year 1 to 5.6% in both Year 2 and 3. This is likely due to increased positive engagement with the more vulnerable residents from Year 1 to Year 2 onwards. The antibody prevalence of 5.6% seen in this initiative is lower than previous estimates.[2] Between 2014 to 2018, the proportion of individuals identified as positive for HCV in English prisons declined from 11% to 6.2%.[2] This was due to an increase in generalised testing rather than targeted testing of high-risk groups.[2] A study investigating screening in 2,376 residents in eight prisons in Italy reported an HCV antibody prevalence of 10.4% among whom HCV RNA prevalence was 41.0%, a level similar to that reported in this initiative.[21] The high rates of testing seen in the later periods of this initiative has led to a more accurate understanding of HCV antibody prevalence in English prisons without the bias of risk-based screening. As HCV antibody prevalence remained consistent across the initiative while HCV RNA prevalence declined, we believe the low HCV RNA prevalence seen in this initiative, compared with that previously reported,[2] reflects progress towards HCV elimination in England (personal communication from Andy Jones). This initiative also demonstrated the effectiveness of the introduction of regional BBV teams on linkage to care. Over the 2.5 years of this initiative, 1,502 HCV-positive patients were treated with DAAs. Across the same period in England, 20,529 patients with HCV were treated, meaning this initiative accounted for 7.3% of those HCV patients (NHSE personal communication). Between July and September 2021, 15 out of 20 prisons in England that were awarded micro-elimination status by NHSE were those with healthcare provided by PPG (personal communication from Georgia Threadgold). In 2020, NHSE defined HCV micro-elimination as ≥95% of prison residents tested within the previous 12 months, ≥90% of HCV RNA-positive patients treated or initiated on treatment and a robust system to review ongoing testing and treatment performance to ensure these targets are maintained (personal communication from Georgia Threadgold).

Modern DAA therapeutic regimens are usually 8 to 12 weeks in duration and are highly effective, with over 95% of patients treated achieving SVR12.[3,22–24] Previous HCV elimination efforts in prisons have demonstrated that similar SVR rates can also be achieved with DAA treatment in these settings,[19] and that scaling up DAA therapies in prisons can reduce HCV incidence.[26] During the second year of this initiative, 96.4% of patients diagnosed with chronic HCV were initiated on treatment. One challenge of treating HCV in prisons is that residents are often released or transferred before treatment can be initiated or

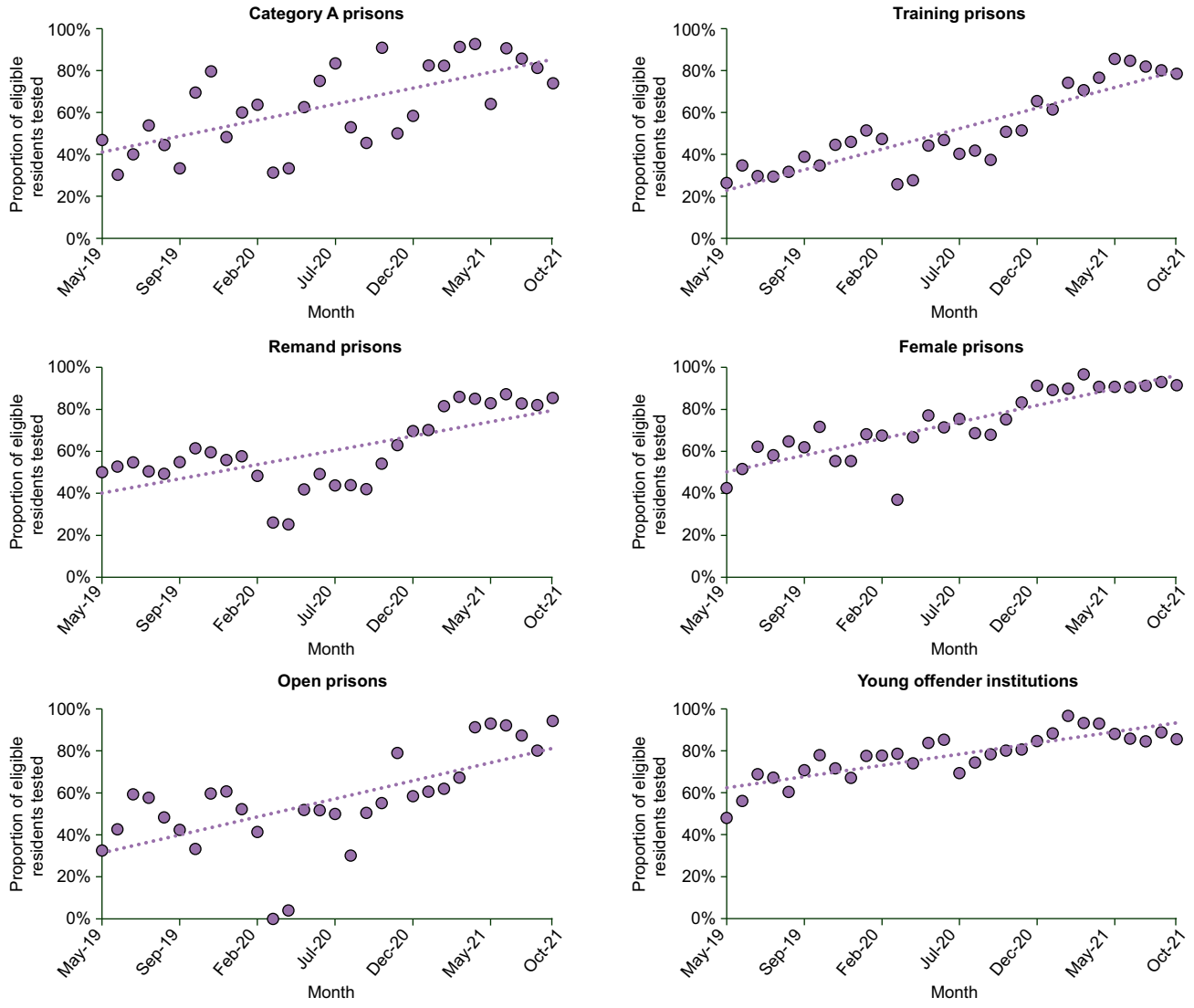

Fig. 3. Testing uptake across all prison categories. Trends of the mean testing uptake in each prison category throughout the initiative. YOI, young offender institution.

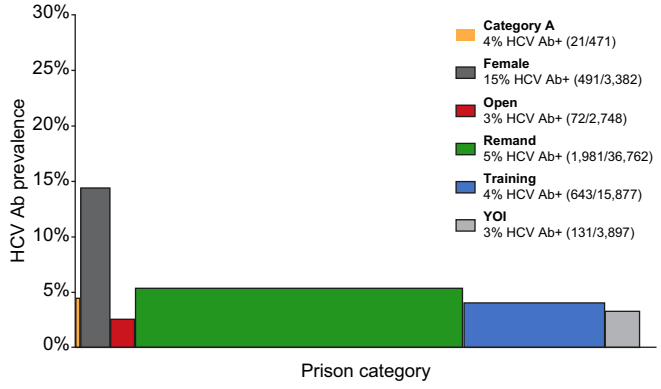

Fig. 4. Relative patient numbers, and HCV antibody prevalence rates, by prison category. Bar chart showing the prevalence of positive HCV antibody results obtained during the reception period, stratified by prison category. The width of the bar relates to the number of patients tested per prison category. Ab, antibody; HCV, hepatitis C virus; YOI, young offender institution.

completed. Due to this, obtaining an SVR12 for patients who were treated, which can take 20–24 weeks from treatment initiation, was not deemed achievable during this initiative. However, based on the demonstrated effectiveness of DAAs in this population, an estimated 90% of residents are likely to have achieved SVR12.[27,28] The short duration of DAA therapeutic regimens may assist with overcoming barriers such as short length of stay and inter-prison transfers, and reduce the resources needed for treatment monitoring.[25] Medicine in-possession was the recommended method of treatment, which also helped to overcome the challenge presented by short sentence durations as DAAs stayed with patients regardless of unexpected prison release.

During this initiative, the COVID-19 pandemic led to the disruption of HCV services globally.[29–32] On 24 March 2020, all prisons in England and Wales were put into immediate lockdown.[33] This resulted in significant restrictions to prison regimes, including confining residents to their cells for over 22 hours per day and excluding all but essential staff from entering

Table 3. Referral and treatment of residents in Years 2 and 3 (May 2020–Oct 2021).

Category	Total (May 2020–Oct 2021)
Total number of residents screened	40,727
Number of new HCV antibody-positive diagnoses	2,286
HCV antibody prevalence*	5.6%
Number of new HCV RNA-positive diagnoses	940
HCV RNA prevalence*	2.3%
Number of HCV RNA-positive patients referred for treatment	921
Number of new DAA treatment initiations	915
Treatment initiation rate†	97.3%

DAA, direct-acting antiviral; HCV, hepatitis C virus; RNA, ribonucleic acid.
* Calculated from total number of residents screened.
† Calculated from new HCV RNA-positive diagnoses.

prisons.[34] Numbers of staff also declined due to self-isolation and those having to shield due to health conditions.[35] The pandemic also reduced the activity of courts in the UK, which reduced the number of new prisoners entering prisons.[36] The disruption caused by COVID-19 also had a significant impact on the reception test and treat pathway, which is reflected in the observed decrease of HCV antibody testing uptake in the second quarter of 2020. However, the testing of new residents for HCV antibodies within 7 days of arrival increased from 35.3% in May 2020 to 88.8% in July 2021, despite many prisons included in the initiative remaining in lockdown. This trend highlights that the reception test and treat pathway presented here is adaptable to changing circumstances within the prison system. This was due to the regional BBV team adapting test and treatment pathways and rapidly developing remote assessment processes. With the expectation of further COVID-19 waves, COVID-19-resilient pathways were implemented and a national lockdown in January 2021 did not impact HCV testing and treatment rates. The increase in testing rate observed in Year 3 was largely due to the loosening of restrictions after the pandemic. Had the pandemic not occurred, it is anticipated that this increase would have been achieved earlier. For prisons that were not achieving their expected monthly testing targets, senior managers were brought in to ensure pathway optimisations were being implemented.

The uptake of HCV antibody testing increased in every prison category across the whole analysis period. However, the increase in testing uptake in remand prisons was less pronounced than in other prison categories. Remand prisons are a challenging category as residents stay only a short time due to awaiting court appearances, being transferred between prisons and having different lengths of sentences.[37,38] The average length of stay of a resident in a remand setting is often short,[37,38] providing a small window of time for completion of HCV testing and treatment despite most DAA treatment regimens being 8 to 12 weeks in duration.[3] Peer support provided by The Hepatitis C Trust was vital for ensuring treatment adherence and following patients on treatment either to new prisons after transfer, or into the community after release. The peers have a lived experience of HCV and incarceration, meaning they are more trusted by, and can better communicate with, residents. Studies evaluating test and treat pathways in a small number of prisons in Italy and Spain reported high rates of testing uptake and SVR, showing that these initiatives are effective and feasible.[39,40] The prison reception test and treat pathway presented here is the largest of its kind conducted to date, having been implemented in 47 prisons across England. While other initiatives have been one-off projects in a small number of prisons, this initiative is ongoing, overseen by dedicated staff (*e.g.* BBV nurses) but delivered by prison healthcare with continued peer support.

Despite the success of this initiative at screening and linking HCV-positive residents to care, a small percentage of residents in each year of the initiative were not offered HCV antibody testing. The methods of data collection can explain why some residents were not offered tests. Reception testing templates for data collection on SystmOne were altered several times during the initiative, leading to the 'test offer' template not being included during one period of the initiative. While these adaptations led to more accurate data reporting as the project continued, it also meant that data collection and the sources of data did not stay consistent throughout the project. This affected the reporting of the number of patients who were RNA positive, reducing the accuracy of the measurement of HCV RNA-positive patients before 2020. The shortage of HCV testing training for staff also contributed to low rates of testing offers and uptake at the beginning of the initiative, and to address this, six regional BBV lead nurses were employed to oversee structured training for staff. It is important to note that these changes did not impact the assessment, diagnosis or access to treatment for patients during this initiative. Patient referrals in this initiative varied by site, with prisons referring using phone, email or SystmOne. All referrals also required the relevant SystmOne template to be completed. A lack of robust structure for referrals during this initiative resulted in underreporting as data were not recorded for some patients who were referred and/or treated. Data reporting alone did not account for all patients who were not referred. Some patients who were HCV RNA positive were not referred as they refused to engage with the ODN specialists, and some patients were released from prison before blood results were returned due to short sentences. The Hepatitis C Trust's 'follow me referral' initiative helped to ensure that most of the consenting patients who were released early were followed up within the community and linked to treatment.[20] Peer support for people with HCV in England has been shown be effective.[41] Patients with HCV in peer groups were significantly more likely to initiate treatment (relative ratio 1.12; 95% CI 1.02–1.21; p <0.01) and complete their treatment course (odds ratio 2.45; 95% CI 1.49–3.84; p <0.01) compared with those without peer support.[41] These data suggest that residents who consented to peer support during this initiative had a high likelihood of completing treatment after release.

Over the course of the initiative, PPG altered the POC testing protocol and switched to the InTec Rapid Anti-HCV Test from venous blood or dried blood spot testing in the majority of

prisons.[42,43] The InTec Rapid Anti-HCV Test allowed for HCV antibody test results to be available within 15 minutes,[42] meaning that patients received their results during the initial reception healthcare assessment, minimising delays to blood collection for HCV RNA testing and improving patient engagement. The availability of rapid HCV antibody testing led to an increase in testing uptake as more residents agreed to be tested with the knowledge that the result would come back in 15 minutes. Finger-prick testing also reduced the requirement for venepuncture when testing for HCV antibodies. As venepuncture requires trained staff and is more invasive than finger-prick testing, this could have also contributed to the lower rates of testing seen before the switch to the InTec Rapid Anti-HCV Test. Venepuncture is also a challenge with PWID due to poor venous access from injection drug use.[44] As a large proportion of residents in the prison system are PWID,[12] finger-prick testing allows for easier detection of HCV antibodies in this population. The increase in engagement with POC testing seen in this initiative mirrors data previously reported from a single-centre study in France which showed 98% of participants in the POC group received a test result, compared with 71% of participants who were offered a serological test.[45] POC testing has also been shown to be preferable over serological testing in residents in young offender institution prisons.[46]

To achieve the WHO global elimination targets for HCV by 2030, there is a need to focus on populations with high HCV prevalence, which includes those in prison.[4] The reception test and treat pathway discussed here has been successful at identifying HCV-positive patients entering prison and linking these patients to care. It is also a priority to test and treat residents who are already in the prison system to lower overall HCV prevalence and prevent onward transmission. Strategies to address this have been described elsewhere,[39,40] and a high intensity test and treat strategy for established prison populations in England is underway, the results of which are eagerly anticipated.

Presented here are interim data from halfway through the 5-year reception test and treat initiative. The ongoing efforts have shown that reception testing can be rolled out on a large scale to successfully identify individuals with HCV as they enter prison and link them to care, and can be adapted to address challenges such as the COVID-19 pandemic. Maintaining high rates of screening and treatment referrals at reception over the next half of the initiative, in conjunction with high-intensity test and treat initiatives to identify individuals with HCV who are already in prison, will provide a robust strategy to achieve HCV micro-elimination in prisons.

This initiative was created with the intention of increasing HCV testing and treatment across entire prison networks using a partnership approach and being adaptable to changing environments. These data show that it is feasible to identify HCV-positive individuals entering the prison system and link them to treatment at-scale. This reception test and treat strategy could be applicable to many prisons globally, and a rollout of similar methods will be useful in ensuring the WHO HCV elimination goals become a reality.

Abbreviations

BBV, blood-borne virus; DAA, direct-acting antiviral; GT, genotype; HCV, hepatitis C virus; NHS, National Health Service; NHSE, NHS England; ODN, operational delivery network; POC, point-of-care; PPG, Practice Plus Group; PWID, people who inject drugs; SVR, sustained virological response; WHO, World Health Organization.

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Conflict of interest

Iain Brew has received consulting fees and honoraria from Gilead Sciences. Andrew Milner, Andy Jones and Kate Dorrington are employees of, and own stock in, Gilead Sciences. Louise Missen is an employee of Gilead Sciences, and owns stock in Gilead Sciences and GSK. Philip Troke was an employee of Gilead Sciences at the time of engagement in this project; he is now an employee of GSK and owns shares in both Gilead Sciences and GSK. Arran Ludlow-Rhodes was an employee of Practice Plus Group at the time of engagement in this project; he is now an employee of Gilead Sciences and owns shares in Gilead Sciences and holds an unpaid role as an HCV Action Ambassador. Julia Waldron, Nichola Royal, Hannah Alexander, Emily Mongale, Samantha Allen and Lee Christensen have nothing to declare.

Please refer to the accompanying ICMJE disclosure forms for further details.

Authors' contributions

All authors were involved in the design and implementation of this initiative, reviewed the data, contributed to the writing of this manuscript and approved the final version. All authors had access to the data and final responsibility for the decision to submit for publication.

Data availability statement

Patient data included in this manuscript are considered sensitive and will not be shared. Detailed information on the design of the reception testing protocol is provided in the methods and appendices.

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Supplementary data

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Author names in bold designate shared co-first authorship

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