Incidence of Hepatitis C Virus Infection and Associated Risk Factors among Scottish Prison Inmates: A Cohort Study

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Received for publication January 22, 2003; accepted for publication September 9, 2003.

To gauge the incidence of hepatitis C virus (HCV) infection and associated risk factors among inmates during their imprisonment, the authors recruited adult males in a long-stay Scottish prison into a cohort study between April 1999 and October 2000. On two occasions (at 0 and 6 months), saliva was collected for anonymous HCV antibody testing and risk behavior data were obtained through a self-administered questionnaire. The participation rate was 85% at both initial recruitment (612/719) and follow-up (375/441; 171 men were ineligible for follow-up). For inmates who reported never having injected drugs, ever having injected drugs, having injected drugs during follow-up, and having shared needles/syringes during follow-up, HCV incidences per 100 person-years of incarceration risk were 1, 12, 19, and 27, respectively. Ever having injected drugs (relative risk = 13.0, 95% confidence interval: 1.5, 114.3) and having shared needles/syringes during follow-up (relative risk = 9.0, 95% confidence interval: 1.1, 71.7) were significantly associated with HCV seroconversion. The effectiveness of existing interventions, including the provision of bleach tablets for sterilizing injection equipment, was suboptimal. The development of methadone maintenance programs in prisons and the creation of drug courts to keep offending drug injectors out of prison might help to reduce transmission in this setting.

hepacivirus; hepatitis C; incidence; prisoners; prisons; risk-taking; substance abuse, intravenous

Abbreviations: CI, confidence interval; HCV, hepatitis C virus; HMP, Her Majesty’s Prison.

The World Health Organization estimates that 170 million persons are infected with hepatitis C virus (HCV), an agent that can cause considerable morbidity and mortality (1). Accordingly, the World Health Organization recommends that “each country should define the relative contribution of various sources of infection through epidemiologic studies. Such studies would enable countries to prioritize their preventative measures and to make the most appropriate use of resources” (1, p. 146).

In Western countries, HCV is most commonly transmitted among injecting drug users who share injecting equipment (2). It is well recognized that the prevalence of HCV among prison inmates, especially those who inject drugs, is high (3) and that most drug injectors eventually become incarcerated (4). Five cases of HCV infection occurring during incarceration have been reported in Australia (5, 6), and a few cohort studies (7–12) have examined the incidence of HCV among prison inmates, though not all could categorically exclude transmission occurring during the period just prior to prison entry; all but one involved the use of attributable HCV testing. This report presents the findings of a cohort study conducted, using a novel recruitment and testing approach, to gauge the incidence of HCV infection and associated risk factors among inmates during their imprisonment.
MATERIALS AND METHODS

Study design and eligibility

We carried out a cohort study of inmates that involved collection of saliva for anonymous HCV antibody testing on two occasions at 0 and 6 months. These samples were linked, by a unique identifier, to risk behavior data collected through a self-administered questionnaire.

To ensure that any HCV antibody seroconversions observed were the result of transmission in prison, we required inmates to have been incarcerated for at least 6 months before providing their first sample; it is estimated that 97 percent of persons seroconvert within 6 months of acquiring HCV (11). Only those inmates who did not leave prison, for any reason, during their sentence were eligible for inclusion. Ethical permission was granted by the local Health Board Ethics Committee. Inmates were told that separate, additional arrangements would be made if they wanted a named HCV test.

Setting

The study was undertaken at Her Majesty’s Prison (HMP) Shotts in central Lanarkshire, Scotland, a large (460 inmates), maximum-security, long-stay (all sentences exceeding 4 years) male prison serving all of Scotland.

Recruitment

The participants were recruited between April 1999 and October 2000. The first of five cohorts was accessed from all existing inmates as of April 1999. Cohorts 2–5 comprised new entrants to the prison, and these inmates were enlisted at 3-month intervals. Participation was voluntary and anonymous, thus allowing inmates who would not have participated if they had had to undergo named testing to participate; consent was verbal.

Prior to the first day of data and saliva collection for each cohort, the principal researcher held study briefings and question/answer sessions attended by over 70 percent of eligible inmates and by prison staff. A team of assistants, independent of the prison service, was trained to help with recruitment, the collection and labeling of saliva samples, and administration of the questionnaire. Fifteen inmate “volunteer overseers” were recruited to ensure that the agreed-upon study procedure was adhered to, to publicize the study, and to encourage fellow inmates to attend talks and participate. The prison officers were not directly involved in the study, and at all times the research team’s independence from the Scottish Prison Service was emphasized.

Questionnaire

The first questionnaire inquired about demographic factors and risk behaviors engaged in before and during the inmate’s current sentence. The follow-up questionnaire asked about behaviors in the previous 6 months. The questionnaire was pilot-tested on 40 inmates in HMP Edinburgh.

HCV antibody testing

We chose saliva as the body fluid for HCV antibody testing (3) to avoid venipuncture. Samples were tested at the West of Scotland Regional Virus Laboratory using an assay that has 85 percent sensitivity and 100 percent specificity (13).

Procedure for collecting and linking samples

On data collection days, the assistants and volunteer overseers distributed the questionnaires to the participants, who completed them in the privacy of their own cells. Inmates were then escorted to a recreation hall, where they provided a saliva sample by chewing on a swab that was then returned to its container.

We adopted the following design to link two sets of saliva samples and questionnaires that were anonymous. On the first data collection day, the participant was asked to choose an envelope that contained two smaller envelopes—one marked “open first visit” and the other marked “open second visit.” Inside each of these smaller envelopes was a pair of numbered stickers. The numbers on all four stickers were identical, but those in the first envelope were printed in red and those in the second were printed in black. The participant attached one red sticker to his saliva sample container and one to his questionnaire. He then wrote his prisoner number across the edge of the sealing flap of the large envelope, with the “open second visit” envelope still inside, and resealed it. Transparent cellophane tape was then placed over the written number, thus ensuring that it could not be altered. The envelope was kept in a safe until the second study day, when the participant repeated the above process with the black stickers. Thus, corresponding saliva samples and questionnaires for both occasions could be linked via the numbered labels. The study components were then rendered anonymous by destroying, in his presence, the participant’s study envelope on which was written his prisoner number.

Statistical analysis

Analysis was confined to inmates who were negative for HCV antibody in their saliva at recruitment and who had a 6-month follow-up HCV saliva test result. Data were analyzed using Stata software (14). The incidence of HCV infection was calculated using the person-years method (15), where the date of seroconversion was taken as the midpoint of the follow-up period. Confidence intervals for incidences were calculated using an exponential error factor (16). Binomial regression was used to assess risk factors for HCV seroconversion.

RESULTS

Initial recruitment and participation

On the initial study days, 85 percent (612/719) of the prison population was recruited (cohorts 1–5: 356/424 (84 percent), 67/77 (87 percent), 89/90 (99 percent), 24/45 (53 percent), and 76/83 (92 percent), respectively). Because of the anonymous nature of the study, it was not possible to
identify the reasons why 107 of the inmates did not participate; however, there was no difference between the average age of this group and that of the total prison population.

**HCV antibody prevalence**

Of the saliva samples taken from the 612 inmates recruited, 17 were insufficient for HCV antibody testing and four generated inconsistent results. Of the remaining 591 inmates, 93 (16 percent; 95 percent confidence interval (CI): 13, 19) had HCV antibodies in their saliva.

**Six-month follow-up and participation**

Of the 612 inmates recruited, 171 (28 percent) were ineligible to participate in the 6-month follow-up interview for reasons of liberation, transfer to another prison or a court, or a hospital visit. Eighty-five percent (375/441) of the eligible inmates participated in the second stage of data collection; consistent questionnaire information and sufficient saliva samples, generated on the first study day, were available for 362 of the 375 inmates.

**Characteristics of the follow-up group**

The characteristics of the follow-up group (n = 362) were compared with those of inmates who similarly provided consistent questionnaire information and sufficient saliva samples on the first day of the study but were not followed up because of either nonparticipation or eligibility (n = 229 (i.e., 591 – 362)). The former group had shorter sentences (83 percent and 74 percent of those followed up and not followed up, respectively, were incarcerated in 1995 or later; p = 0.009) and were younger (24 percent and 35 percent of those followed up and not followed up, respectively, were over age 35 years; p = 0.01); however, no other significant demographic or behavioral differences—particularly injection-related differences (32 percent and 26 percent of those followed up and not followed up, respectively, were ever injectors; p = 0.1)—between the two groups were evident.

**HCV antibody incidence**

Of the 362 inmates followed up, 53 had a first saliva specimen that was positive for antibodies to HCV; all corresponding second specimens tested positive. Of the remaining

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309 inmates, two of the second saliva specimens were insufficient. Five of the 307 inmates who were initially negative for antibodies to HCV seroconverted to positive. Thus, the cumulative exposure time for all 307 inmates was 152.25 years ([(307 – 5) × 0.5 years] + [5 × 0.25 years]). Hence, the incidence was 3.3 per 100 person-years of incarceration risk (5 × 100/152.25) (table 1).

Of the five seroconverters, 1) one reported having injected drugs, shared needles/syringes, and been involved in a bloody fight during the 6-month follow-up period and had a methadone maintenance prescription discontinued upon entry into prison; 2) three had ever injected drugs but responded “no” to the questions asking, at recruitment, whether they had injected drugs during their current sentence and, at follow-up, whether they had injected in the previous 6 months; and 3) one reported no history of injecting drugs.

For participants who reported having shared needles/syringes during follow-up (3 percent), having injected drugs during follow-up (4 percent), having ever injected drugs (24 percent), and having never injected drugs (76 percent), the respective incidences per 100 person-years of incarceration risk were 26.7 (95 percent CI: 3.8, 100), 19.1 (95 percent CI: 2.7, 100), 11.9 (95 percent CI: 4.5, 31.8), and 0.9 (95 percent CI: 0.1, 6.3) (table 1). In univariate analyses, inmates who reported having ever injected drugs (relative risk = 13.0, 95 percent CI: 1.5, 114.3) and having shared needles/syringes during follow-up (relative risk = 9.0, 95 percent CI: 1.1, 71.7) were at significantly increased risk of incident HCV infection compared with those who had never injected and never shared, respectively. Upon adjustment for other factors, ever having injected drugs was the only independent significant risk factor. Other risk behaviors that applied to the 6-month period of follow-up—being involved in a bloody fight (reported by 14 percent), being stabbed with a needle (1 percent), having one’s body pierced (1 percent), being tattooed (2 percent), and engaging in anal sex (1 percent)—were not associated with HCV seroconversion.

### TABLE 1. Continued

<table>
<thead>
<tr>
<th>Demographic factor or risk factor</th>
<th>Total No.</th>
<th>%</th>
<th>Seroconverters No.</th>
<th>%</th>
<th>Incidence rate/100 person-years</th>
<th>95% CI</th>
<th>Unadjusted relative risk</th>
<th>95% CI</th>
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<td>96</td>
<td>4</td>
<td>80</td>
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<td>Engaged in anal sex without a condom during follow-up¶</td>
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* CI, confidence interval.
† Upon adjustment for other factors in the table, ever having injected drugs was the only independent significant risk factor for hepatitis C virus seroconversion.
‡ Referent.
§ Includes 6-month follow-up period.
¶ Relates to 6-month follow-up period.
# “Other equipment” includes filters, spoons, or water.
DISCUSSION

In this cohort study, we evaluated risk factors for incident HCV infection among inmates during their incarceration. Five inmates who were hitherto negative for antibodies to HCV developed HCV antibodies in their saliva, thus generating an incidence of 3.3 per 100 years of incarceration risk. This incidence may have been an underestimate, because the salivary antibody test used, while 100 percent specific, is only 85 percent sensitive; it is thus possible that one new infection went undetected as a consequence of the suboptimal sensitivity of the assay. The observation that none of the 53 inmates initially found to be antibody-negative became antibody-positive became antibody-negative 6 months later supports the view that the five apparent seroconversions were real, and not artifacts of either the procedure for collecting and linking samples or fluctuation in viral load among persons already infected. The possibility of a seroconverter having acquired his infection outside the prison is extremely unlikely, since 97 percent of people exposed to HCV will have seroconverted by 6 months (17).

The potential to identify the exact means through which the five inmates became infected was limited by our study design, which depended on self-reporting of risk behaviors. The use of self-completed questionnaires should have minimized socially desirable responding (18); the validity of self-reported drug use outside, though not within, the prison setting has been demonstrated to be satisfactory (19, 20). Nevertheless, risk behavior data should be interpreted with caution. Four of the five seroconverters had ever injected drugs; only one admitted to injecting during his current sentence. Since those who had ever injected drugs, but not those who had ever injected, had no additional significant risk factors (tattooing, body piercing, bloody fights, anal sex) over their noninjector counterparts, injection in prison seems the most likely explanation for infection occurring in at least four of the five cases.

A community study of drug injectors conducted in nearby Glasgow during 1999 (A. Taylor, University of Paisley, personal communication, 2000) confirmed that the great majority of HCV-infected drug injectors acquire their infection outside of prison (21, 22). What this study has demonstrated, however, is that HCV can be transmitted within a prison, most likely as a consequence of injecting drug use. Following an outbreak of human immunodeficiency virus infection at HMP Glenclochil in 1993 (23), the Scottish Prison Service introduced several measures to prevent the transmission of bloodborne infections inside prison; these included the provision of bleach tablets for sterilizing injection equipment and drug counseling, detoxification, and drug behavior management programs. These interventions were unable to prevent the infections detected at HMP Shotts, though it is possible that more would have occurred if, for example, bleach tablets had not been available (24).

In late 2000, following the conclusion of the study, methadone maintenance programs began to be introduced in Scottish prisons, as advocated in the Scottish Prison Service strategy “Action on Drugs,” published that year (25). While this intervention has not been well evaluated in the prison environment, it is hoped that its effectiveness in reducing injectors’ need to inject drugs outside the prison (26) will be replicated inside. Indeed, one of the seroconversions in our study might have been prevented if such programs had been implemented earlier.

Another method of bloodborne virus prevention among drug injectors—needle/syringe exchange—has not yet been shown to prevent HCV in the community (27). Although a few prisons worldwide provide inmates with sterile needles and syringes (28), the concept is anathema to most prison officers and is unlikely to be adopted in this setting in the United Kingdom.

It is clear that drug injection equipment is shared inside prisons. The most effective way to prevent HCV transmission in prisons is to avoid, where possible, the incarceration of drug injectors. Drug courts, which offer injectors who have offended because of their drug use a treatment regimen as an alternative to imprisonment, are functioning in parts of some countries, including the United States and the United Kingdom. With prison populations in Scotland and throughout the rest of Europe continuing to increase in size (28, 29) and with these populations harboring reservoirs of HCV—as the prevalence of HCV infection (16 percent) at HMP Shotts indicates—the enormity of the challenge of curbing injecting drug use in prisons is evident.

ACKNOWLEDGMENTS

The authors thank the staff of HMP Shotts: Bill McKinlay (governor); Nick Cameron (deputy governor); prison managers Alec Stewart, Jim Younie, Paul Brennan, Sandy Paterson, and Craig Corkindale; and the prison supervisors and their staff. The authors are grateful to health-care manager Heather Gourlay and her staff for ensuring that requests for hepatitis C virus counseling were met promptly. The authors thank Linda MacDonald and Karen Wilson of the Regional Virus Laboratory, who processed the saliva samples. The support of Dr. David Joliffe, former chief medical officer of the Scottish Prison Service, is appreciated. The authors also thank the study assistants: Kieron Dempsey, Nicola McLelland, Nicki Kid, Saffron Dickinson, Peter Masterson, Anne Broderick, Ruth O’Sullivan, Donna Dorris, Carl Mills, David McHarg, Hannah Logie, Joan Johnson, Camille Warrington, Patricia Furlong, and Moyra Mackay.

REFERENCES


