

# Prevalence of hepatitis C in prisons: WASH-C surveillance linked to self-reported risk behaviours

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## Summary

We used cross-sectional willing anonymous salivary hepatitis C (WASH-C) surveillance linked to self-completed risk-factor questionnaires to estimate the prevalence of salivary hepatitis C antibodies (HepCAbs) in five Scottish prisons from 1994 to 1996. Of 2121 available inmates, 1864 (88%) participated and 1532/1864 (82%) stored samples were suitable for testing. Overall 311/1532 (20.3%, prevalence 95%CI 18.3–22.3%) were HepCAbs-positive: 265/536 (49%, 95%CI 45–54%) injector-inmates but only 27/899 (3%, 95%CI 2–4%) non-injector-inmates. Among injectors, HepCAbs positivity was only slightly higher ( $p=0.03$ ) in those who had injected inside prison (53%, 162/305) than in those who had not (44%, 98/224). Those who

began injecting in 1992–96 were much less likely to be HepCAbs-positive than those who started pre-1992 (31%, 35/114 vs. 55%, 230/422;  $p<0.001$ ). Even with injectors who began in 1992–96 but had never injected inside prison, the prevalence of hepatitis C carriage was 17/63 (95%CI 16–38%). The prevalence and potential transmissibility of hepatitis C in injector-inmates are both high. Promoting 'off injecting' before 'off drugs' (both inside and outside prison), methadone prescription during short incarcerations, alternatives to prison, and support of HepCAbs-positive inmates in becoming eligible for treatment, all warrant urgent consideration.

## Introduction

Willing Anonymous Salivary HIV and hepatitis C (WASH-C) surveillance studies were conducted at five adult prisons in Scotland during 1994–96, with results on HIV prevalence already published.<sup>1,2</sup> All inmates were invited to take part by giving a saliva sample to be tested immediately for HIV antibodies, and eventually for hepatitis C, and to self-complete an anonymous behavioural risk-factor questionnaire. Saliva sample and questionnaire were linked by sealed numerical codes, and were thus unattributable to individual prisoners.

The five studies had high volunteer rates (overall 88%, 1864/2121; lowest 70%, 304/434 at Perth

Prison) and took place as follows: in 1994, at Barlinnie Prison in Glasgow, Scotland's largest prison (985 participants); in 1995, at Perth Prison, Scotland's oldest and the local prison for Dundee (304 participants) and at Cornton Vale for female prisoners (136 participants); in 1996, at Lowmoss Prison, near Glasgow (293 participants) and at Aberdeen Prison (146 participants). Questionnaires by 95% of respondents (1771/1864) passed all logical checks. Over a third of inmates with a valid questionnaire (36%: 636/1749) reported a history of injecting drug use. Nineteen HIV-antibody-positive saliva results were found, predominantly in injectors (16/19).

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AGB and SMG anticipated that validated hepatitis C tests would become available,<sup>3,4</sup> and from the Barlinnie study on, had sought permission at the time, both from local ethics committees and from the prisoners themselves, for the saliva samples to be tested eventually for hepatitis C when suitable assays had been developed.

By early January 1998, Cameron *et al.*<sup>3</sup> had completed blind evaluation of an hepatitis C antibody assay on saliva samples from hepatitis-C-antibody-positive patients, mostly injectors, 84% of whom (97/115) were serum-hepatitis-C-RNA-positive by polymerase chain reaction. The saliva test classified as hepatitis-C-antibody-positive in saliva (HepCAbs): 96/97 individuals who were serum-hepatitis-C-RNA-positive but only 2/18 who were serum-RNA-negative. A further 26 serum/saliva pairs were collected from hepatitis-C-antibody-negative patients, all of whom tested hepatitis-C-antibody-negative in saliva. We inferred from these data that specificity would not be a problem, and so sanctioned the testing of prisoners' saliva samples.

The saliva test that Cameron *et al.* had developed was, in effect, a surrogate marker for hepatitis C RNA or hepatitis C carrier status. In meta-analysis of the role of polymerase chain reaction in defining infectiousness among people infected with hepatitis C virus, Dore *et al.*<sup>5</sup> found that among 1148 people exposed to sources positive by polymerase chain reaction, 148 cases of transmission occurred, compared with no definite case among 874 people exposed to negative sources.

As a surrogate marker for hepatitis C carriage, the saliva test was thus ideal for application to our prisoners' samples. The risk to novice injectors<sup>6,7</sup> of hepatitis C transmission through shared injecting during incarceration depends critically upon the proportion of inside-injectors with hepatitis C carrier status, their frequency of injection, and on the transmission rate for hepatitis C after needlestick exposure to persons positive by polymerase chain reaction, which Dore *et al.*<sup>5</sup> have estimated as 6% (95%CI 2–10%). Tattooing<sup>8</sup> during incarceration,<sup>9,10</sup> fights or other trauma in which there is blood-to-blood contact are other potential transmission routes for hepatitis C, as are blood transfusions prior to 1992<sup>11–13</sup> and occupational exposure.<sup>13–15</sup> Sexual transmission of hepatitis C can also occur but is uncommon; the rate of maternal transmission has been quantified.<sup>16,17</sup>

International data, including from Scotland, suggest that between 60% and 90% of injectors might have hepatitis C antibodies,<sup>18–34</sup> with between 50% and 90% of them being also RNA positive.<sup>3,5,18,23,33,35</sup> Based on these ranges and 36% of our adult prisoners having a history of injecting drug use, we expected that between 11% and 29% of prisoners would have

hepatitis C antibodies in saliva, with 20% as a central estimate:  $0.36 * 0.80^{19,34} * 0.70^{18,23,33}$

We estimated the number of adult inmates across Scottish prisons with hepatitis C antibodies in saliva (HepCAbs, a marker for hepatitis C carrier status), and associated risk behaviours, including the role of injecting inside prisons. Geographical and temporal variation were also of interest, particularly the period in which injecting careers began (pre-1989, 1989–1991, 1992 or later). Sterilization tablets were made available to all Scottish prisoners during the latter period, namely from December 1993 following an outbreak of HIV and hepatitis B seroconversions in Glenochil prison earlier in that year.<sup>36,37</sup> The Scottish Prison Service's 1998 calendar for prisoners highlighted: 'What you should know about hepatitis'.

## Methods

We used the recently validated method for detecting antibodies to hepatitis C in saliva (HepCAbs)<sup>3</sup> which had been shown to correlate with the presence of hepatitis C RNA in blood, and thus with hepatitis C carrier status. The laboratory method for identifying hepatitis C carriage by saliva testing, its blind validation against 115 paired blood/saliva samples, and against behavioural data for 649 of our Barlinnie and Lowmoss prisoners with large-volume residual saliva samples have been described more fully elsewhere.<sup>3</sup> Briefly, salivary antibody was detected by using a modified ELISA assay (Monalisa antiHCV new antigen: Sanofi Pasteur, France). The reverse of the serum ratio was used, namely: four volumes saliva (80 µl) to one volume of diluent (20 µl). The incubation period was increased to overnight (approximately 20 h) at room temperature instead of 60 min at 40°C for serum. The test was otherwise carried out according to the manufacturer's instructions. The cutoff was altered to optical density of 0.2 to enable the assay to be used to detect RNA-positive patients. All negatives and reactivities in the optical density range 0.2–0.4 were retested for confirmation.

Cameron *et al.*<sup>3</sup> had no access to the behavioural database. Pilot (Stage 1) results on 649 samples were reported to AGB, SMG and SJH who checked them against prisoners' self-reported history of injecting drug use. Alignment was excellent: 120 samples were positive out of 241 from injectors with valid questionnaires (50%) but only 10/360 from self-reported non-injectors (3%). These preliminary results were discussed with the Scottish Prison Service in early February 1998. During February and March 1998, the testing was completed of sufficient-volume residual saliva samples from the Barlinnie and Lowmoss prisoners (Stage 2); and *de novo* testing

was done of saliva samples which were stored with SB at the Regional Virus Laboratory in Edinburgh and which had come from our 1995–96 studies. The latter samples were transferred to Glasgow for testing by SC to ensure homogeneity of laboratory method across prisons.

To the 1994 questionnaire,<sup>38</sup> a question was added in 1995 about having ever had a hepatitis C test; and in 1996 about having ever had a tattoo done in prison.

## Results

Table 1 shows for each prison the number (and test result) of sufficient-volume saliva samples that were testable for hepatitis C carriage from prisoners who had: (i) returned a valid behavioural questionnaire, or (ii) given an inconsistent prison or injecting history. The last column in Table 1 also shows the untestable rate separately for injectors (IDUs) and non-injectors.

Comparison of the untestable rate between stage 1 (high-volume samples: 8/649) and stage 2 testing of Barlinnie and Lowmoss samples (remainder 151/629) showed clearly that volume of residual saliva was the main determinant of testability. Overall, the untestable/non-assigned rate was 18% (332/1864), with some heterogeneity between prisons: reassuringly, much the lowest for inmates of Barlinnie Prison whose saliva samples had been stored longest. The untestable rate was lower, but not significantly so, at 16% (100/636) for injector-inmates than for non-injectors (19%: 218/1135).

Overall, 311/1532 (20.3%) samples from adult prisoners tested positive for hepatitis C antibodies in saliva. 95%CI for HepCAbS prevalence was from 18.3% to 22.3%. For prisoners with a valid risk-factor questionnaire, Table 2 shows the prevalence of hepatitis C carrier status for four important sub-

groups: (i) prisoners who had never injected; (ii) all injectors; (iii) injectors who had never injected inside prison; and (iv) inside-injectors.

From Table 2, half the adult injector-inmates of these five prisons had hepatitis C antibodies in saliva (265/536; 95%CI 45–54%), but only 3% had of the non-injectors (27/899; 95%CI 2–4%).

The prevalence of HepCAbS was only moderately higher (Mantel-Haenszel  $\chi^2=4.8$ ,  $p=0.03$ ) for inside-injectors (53%: 162/305) than for injector-inmates who had never injected inside prison (44%: 98/224). As the former may be characterized by a greater intensity than the latter of injecting outside as well as inside prisons, inside-injecting cannot be indicted as the cause of their higher prevalence of hepatitis C carriage. Indeed, among injectors who began their injecting career most recently, in 1992–96, and so had been injecting for a maximum of 4 years 10 months prior to study, the absolute difference in prevalence of HepCAbS was only 7%: 17/63 (27%) of those who had never injected inside prison vs. 17/50 (34%) for inside-injectors.

Table 3 shows injectors' prevalence of HepCAbS according to the calendar period in which they began their injecting career (pre-1989, 1989–91 or 1992–96).

Injectors who began injecting in 1992–96, having accumulated an estimated total of 203.5 injection-years, were very significantly less likely to have HepCAbS (31%: 35/114) than were injectors who had started pre-1992 (55%: 230/422,  $p<0.001$ ). Recent injectors' estimated incidence of HepCAbS during 1992–96 was thus 17 per 100 injection-years (35/203.5 \* 100).

Only 96/265 (36%) injectors with HepCAbS were sentenced to serve more than 1 year, namely: 13/35 (37%) hepatitis C carrier injectors who began their injecting career in 1992–96 and 83/129 (64%) whose injecting career began before 1992.

**Table 1** Numbers of sufficient-volume saliva samples, and number positive for hepatitis C antibodies in saliva: by prison

Prison and year of study	Prevalence of hepatitis C antibodies in saliva (%)		Number (%) of untestable or unassigned saliva samples		
	Prisoners with valid questionnaires	Prisoners who gave inconsistent prison or injecting history	Total rate	In IDUs	In non-IDUs
Lowmoss, 1996	29/ 203 (14%)	1/ 4	86/ 293 (29%)	31/116	52/ 170
Aberdeen, 1996	19/ 112 (17%)	1/ 2	32/ 146 (22%)	10/ 53	21/ 90
Perth, 1995	39/ 203 (19%)	3/15 (20%)	86/ 304 (28%)	21/ 82	58/ 200
Cornton Vale, 1995	22/ 79 (28%)	1/ 2	55/ 136 (40%)	19/ 58	34/ 74
Barlinnie, 1994	184/ 856 (21%)	12/56 (21%)	73/ 985 (7%)	19/327	53/ 601
Totals	293/1453 (20%)	18/79 (23%)	332/1864 (18%)	100/636 (16%)	218/1135 (19%)

**Table 2** Prevalence of hepatitis C antibodies in saliva by self-reported injector status

Prison and year of study	Prevalence of hepatitis C antibodies in saliva (%)			
	Prisoners who had never injected	All injectors	Injectors who had never injected inside prison	Inside-injectors
Lowmoss, 1996	2/115	27/ 85 (32%)	9/ 34 (26%)	18/ 51 (35%)
Aberdeen, 1996	0/ 69	19/ 43 (44%)	7/ 13 (54%)	12/ 30 (40%)
Perth, 1995	4/139	35/ 61 (57%)	4/ 9	31/ 51 (61%)
Cornton Vale, 1995	1/ 37	21/ 39 (54%)	7/ 17 (41%)	12/ 20 (60%)
Barlinnie, 1994	20/539	163/308 (53%)	71/151 (47%)	89/153 (60%)
Totals	27/899 (3%)	265/536 (49%)	98/224 (44%)	162/305 (53%)

**Table 3** Injectors' prevalence of hepatitis C carrier status by calendar period in which they began injecting

Prison	Injecting career began:			
	Pre-1989 Prevalence of hepatitis C carrier status (%)	1989–91 Prevalence of hepatitis C carrier status (%)	1992–96 Prevalence of hepatitis C carrier status (%)	1992–96 Estimated number of injection-years for injectors who began injecting in 1992–96
Lowmoss, 1996	19/ 46 (41%)	3/12 (25%)	5/ 27 (19%)	25.3 * 3 years 4 months +
Aberdeen, 1996	7/ 9	4/ 8	8/ 26 (31%)	27.7 * 11 months = 109.7 injection-years
Perth, 1995	21/ 32 (66%)	10/16 (62%)	4/ 13 (31%)	22 * 1 year 9 months = 38.5 injection-years
Cornton Vale, 1995	15/ 26 (58%)	2/ 4	4/ 9	39 * 1 year 5 months = 55.3 injection-years
Barlinnie, 1994	126/222 (57%)	23/47 (49%)	13/ 39 (36%)	
Totals	188/335 (56%)	42/87 (48%)	35/114 (31%)	203.5 injection-years

Zero out of three first-time prisoners in 1994–96 who reported that they had started to inject inside tested positive for HepCAbS (according to start of injecting career only, an upper bound for the expected number might be:  $0.31 * 3 = 0.93$ ).

Twenty-seven non-injectors with valid risk-factor questionnaires had hepatitis C antibodies in saliva. None was known to have ever taken a blood test for hepatitis C or to have been tattooed in prison, but not all were asked these questions. Three of the 27 reported having had an acute attack of hepatitis, compared to 18/880 (2%) of all non-injectors with valid questionnaire and testable saliva sample, markedly higher than the 0.6 expected. Other risk factors were not significantly over-represented in the 27 non-injectors with positive HepCAbS, as follows: five had ever been treated for a sexually transmitted disease (compared to 9% of all non-injectors (78/889), somewhat higher than expected number of 2.4); two prisoners reported having paid money for sex (compared to 7% of all non-injectors (58/882), and so in line with expected: 1.8); and 13 of the 27 had been in prison five or more times before this sentence (compared to 35% of all non-injectors

(312/893), or 9.4 expected out of non-injectors with hepatitis C antibodies in saliva).

## Discussion

Two in 10 of our stored residual saliva samples were insufficient in volume for testing. There was some heterogeneity between prisons but this did not appear to be attributable to length of storage or location of samples, see Table 1. Since our method for detection of hepatitis C antibodies in saliva closely correlates with hepatitis C RNA, and thus hepatitis C carriage, we are able in this study to quantify the hepatitis C carrier-related health issues which are relevant to prisons.

The prevalence of hepatitis C carrier status was 49% among 536 prisoners with a history of injecting drug use (95%CI 45–54%) and 3% only among 899 self-reported non-injectors (95%CI 2–4%). These new data thus attest to the frankness of prisoners' answers about injector status in anonymous, self-completion risk behaviour questionnaires. The only risk factor that significantly distinguished the 27 non-

injectors who were hepatitis C carriers from other non-injectors was a history of acute hepatitis. They were not exceptional in terms of their multiplicity of past imprisonments.

The prevalence of hepatitis C carriage was significantly lower at 31% (35/114) among inmates who began their injecting career in 1992–96, at most 4 years 10 months prior to study, than among those who started injecting pre-1992 (55%: 230/422). It is possible that the establishment of harm minimization interventions for injectors in the late 1980s, particularly needle or syringe exchange, has led to a reduction in needle sharing, and thus in hepatitis C transmission. We note, however, that because calendar period of initiation defines length of injecting career, it is likely to be confounded with the number of exposures to hepatitis C infection.

It is extremely worrying that 31% of injectors (35/114) became carriers of hepatitis C within a maximum of 4 years 10 months after starting to inject: that is, within an estimated 203.5 cumulative injection-years. Since, as described above, the sensitivity of the saliva test for hepatitis C antibodies was 96/97 for viral carriage but 98/115 (95%CI 79–92%) for ever infected, two-fifths of these injectors may have been infected with hepatitis C (31%/0.79) giving an estimated hepatitis C infection incidence in the range 18.7–21.8 per 100 injection-years, in close agreement with van Beek *et al.*<sup>39</sup> Furthermore, as in Australia, these infections occurred during a time when community-based interventions to prevent needle sharing were well established. Half (17) of the above 35 hepatitis C carriers indicated that they had never injected inside prison and so, at least for these, transmission almost surely occurred in the community setting.

Harm minimization measures will have benefits for both the prisons and the outside community to which inmates soon return. Immunization against hepatitis A and B<sup>2</sup> and methadone substitution, to assist opiate-dependent injectors to come 'off injecting', need to be more readily available to injectors, both outside and inside prisons. Scottish prisoners have superior access to sterilization tablets compared with England and Wales,<sup>2</sup> but continuation of methadone prescriptions during incarceration is rare,<sup>40</sup> which risks a return to shared injecting during incarceration for opiate-dependent prisoners with a history of injecting drug use. The high prevalence, and transmissibility,<sup>5</sup> of hepatitis C carriage in injector-inmates are a strong argument for 'off injecting' before 'off drugs' as an important harm reduction message. Safe continuance of methadone prescriptions during short incarcerations, or the evaluation of options other than prison for drug-dependent offenders, are urgent public and prisoners' health considerations.

Only 96/265 (36%) of injectors with hepatitis C carriage had been sentenced to serve more than 1 year in prison. A sensible division of treatment responsibilities may be for prisons to concentrate effort on assisting longer-term injector-inmates with hepatitis C carrier status to surmount the hurdle of eligibility for treatment of their viraemia. Treatment with interferon<sup>41</sup> can cause serious side-effects and is expensive. For treatment to be cost-effective, eligibility is restricted, whether the patient is a prisoner or not:<sup>42</sup> patients must typically be 'off injecting' (to avoid re-infection), cautious in their use of hypnotics or depressants such as benzodiazepines (because of potential for liver damage), and have minimal alcohol intake.<sup>43</sup>

Wider availability of drugs-free wings would assist other injectors with hepatitis C carriage who are serving shorter sentences to begin, or to maintain, during incarceration their effort at establishing eligibility for outside treatment of their viraemia.

The five adult prisons where prisoners gave consent for eventual hepatitis C testing of their stored saliva samples held approximately half (47%: 2481/5244) the adult prisoners in Scotland in 1996–97,<sup>42</sup> accounting for two thirds of prisoners (66%: 1827/2788) in the west of Scotland but just over a quarter (27%: 654/2456) of the north-east prison directorate. Taking this differential representation into account (data not shown), we estimate that between one in five and one in six adult prisoners in Scotland in 1998 may be hepatitis C carriers, or around 1000 inmates, of whom some 360 are likely to have been sentenced for at least 1 year. Even if only half of the latter, mainly injectors, wanted help to become eligible for treatment of their hepatitis C carriage, and at most half of them succeeded in achieving eligibility and accepted treatment,<sup>44</sup> the Scottish Prison Service may need to anticipate adult treatment costs of up to £180 000 on an annual basis for a few years to come. There will be additional costs for young offenders, for whom we have no data but 8% of whom we would expect *a priori* to be hepatitis-C-RNA-positive.

More generally, the health service in Scotland can anticipate that about half the survivors out of 20 000 injectors, as estimated by the Scottish Affairs Committee in its report on Drug Abuse in Scotland,<sup>46</sup> may have hepatitis C carrier status. To help in future planning, a non-nominal register of confirmed hepatitis C cases is being established by the Scottish Centre for Infection and Environmental Health in association with virology laboratories.

Similar considerations apply elsewhere. In England and Wales, Bacchus *et al.*<sup>46</sup> estimated that 22% of adult prisoners had a history of injecting drug use but only 24/1009 interviewees reported injecting in prison this time, much lower than in Scotland.<sup>2</sup>

Based on injectors alone, and the international data cited in the Introduction, the Prison Service in England and Wales may expect between  $0.22 * 60\% * 50\% = 6\%$  and  $0.22 * 90\% * 90\% = 18\%$  of adult prisoners to have hepatitis C carrier status with  $0.22 * 80\% * 70\% = 12\%$  as a central prior estimate. Definitive hepatitis C prevalence results for prisoners in England and Wales are due to be reported later in the year; as also are those from Europe-wide WASH-C surveillance studies in Belgium, France, Germany, Italy, Portugal and Spain.

The higher rate of hepatitis C carriage in inside-injectors cannot be ascribed to inside injecting *per se*, because the intensity of injecting outside, and inside, prison are likely to be highly confounded. We have not demonstrated hepatitis C carrier status in any of three first-time prisoners who started to inject inside on this sentence. Our data, combined with those from forthcoming studies which involve three times as many prisoners, should generate an estimate ( $x/20$ ) based on a denominator of 20 for inside transmission(s) of hepatitis C carriage to first-time prisoners who started to inject inside Europe's prisons in the mid-1990s. Other research designs to measure hepatitis C seroconversions during incarceration—for example, by anonymous linkage of paired samples and off-study questionnaire about risk behaviours during this incarceration<sup>7,39,48</sup>—need to be correspondingly large.

We have shown that non-injector inmates and prison staff live or work in a prison community in which the prevalence of hepatitis C carriage is higher at 20% than they typically encounter on the outside; higher, for example, than haemodialysis staff members encounter in their working environment<sup>49</sup> but lower than drug treatment centre staff would meet with. Prisoners, as well as officers, should be made aware of the importance of universal precautions for avoidance of blood-to-blood contacts; and should follow these precautions carefully. Risk to non-injector prisoners and to officers depends upon the frequency of exposure-prone contacts, for which the rate within the Scottish Prison Service is reportedly low, as well as on the prevalence of hepatitis C carrier status in sources. Officers' concern has been documented in the Third Prison Survey:<sup>50</sup> 49% of officers in the Scottish Prison Service had worried in the last 6 months about catching hepatitis B/C.

To our knowledge, the prevalence of hepatitis C antibodies in saliva, a marker for hepatitis C carrier status, has not been reported in prison officers, but could be estimated by officers' anonymous participation in WASH-C surveillance studies with linked self-completion questionnaire on occupational (and other behavioural or iatrogenic) risks and precautions;<sup>51</sup> or, if feasible, by unlinked, anonymized hepatitis C testing of stored blood samples which had been

taken for measuring hepatitis B surface antibody levels<sup>14</sup> in prison staff after hepatitis B immunization. The Communicable Disease Surveillance Centre and the Scottish Centre for Infection and Environmental Health collaborate on surveillance of healthcare workers occupationally exposed to blood-borne viruses:<sup>52–54</sup> this could be extended to include prison officers.

Finally, consideration needs to be given to prisoners' access to confidential hepatitis C testing, as available in Scottish prisons, and to appropriate specialist follow-up and treatment, if desired,<sup>45</sup> for prisoner-patients who are hepatitis-C-RNA-positive and have abnormal liver function tests. Prisoner-patients should have parity of access with other patients to a high standard of clinical follow-up.

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