Prevalence of antibodies to hepatitis B, hepatitis C, and HIV and risk factors in Irish prisoners: results of a national cross sectional survey

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Abstract

Objectives To determine the prevalence of antibodies to hepatitis B core antigen, hepatitis C virus, and HIV in the prison population of the Republic of Ireland and to examine risk factors for infection.
Design Cross sectional, anonymous, unlinked survey, with self completed risk factor questionnaire and provision of oral fluid specimen for antibody testing.
Setting Nine of the 15 prisons in the Republic of Ireland.
Participants 1366 prisoners, of whom 1205 (57 women) participated. In the smaller prisons all prisoners were surveyed, while in the three largest prisons one half of the population was randomly sampled. Three small prisons believed not to have a problem with injecting drug use were excluded.
Main outcome measures Prevalence of antibodies to hepatitis B core antigen, antibodies to hepatitis C virus, and antibodies to HIV. Self reported risk factor status.
Results Prevalence of antibodies to hepatitis B core antigen was 104/1193 (8.7%; 95% confidence interval 7.2% to 10.5%), to hepatitis C virus, 442/1193 (37%; 34.3% to 39.9%), and to HIV, 24/1193 (2%; 1.3% to 3%). The most important predictor of being positive for hepatitis B and hepatitis C was a history of injecting drug use. Thirty four women (60%) and 474 men (42%) reported ever injecting drugs. A fifth (104) of 501 injecting drug users reported first injecting in prison, and 347 (71%) users reported sharing needles in prison.
Conclusions Infection with hepatitis C secondary to use of injected drugs is endemic in Irish prisons. Better access to harm reduction strategies is needed in this environment.

Introduction

A high proportion of prisoners in many countries inject drugs.[1–5] In the Republic of Ireland it has been estimated that 40% of prisoners misuse drugs.[6] Given the association between injecting drug use and infection with hepatitis B virus, hepatitis C virus, and HIV, it is important to know both the prevalence of these infections and the pattern of risk behaviours in prison environments so that appropriate responses can be instituted.

We report the results of a national study examining the relations between self reported risk behaviour and the prevalence of antibodies to hepatitis B core antigen, hepatitis C virus, and HIV in the Irish prisoner population.

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Extra tables of results can be found on the BMJ's website

Methods

At the time of our study there were about 2680 prisoners in the Republic of Ireland in 15 prisons. On the basis of information from the Department of Justice, Equality and Law Reform, prisons were categorised according to expected prevalence for blood borne viral infections into low, medium, and high risk prisons. The three low risk prisons were excluded from the survey as the total number of prisoners concerned (275) was too small to provide accurate estimates of prevalence or to preserve confidentiality. We estimated that a sample of 1200 prisoners was required to measure the prevalence of antibodies to hepatitis C virus in the high and medium risk prisons. All five high risk prisons were selected for the survey, and four of the seven medium risk prisons were selected at random. In six prisons all inmates were surveyed, while in the three larger high risk prisons half the population was selected by using systematic random sampling. Prisoners who were absent from the premises at the time of the survey (n = 36) and prisoners considered to be a safety risk for the research staff (n = 9) were excluded.

The survey was carried out between September and November 1998. Staff and prisoners were briefed in advance. There were two parts to the survey: a questionnaire and collection of an oral fluid sample. Researchers met groups of 10 to 40 prisoners. The survey was explained, and prisoners were advised that the survey was voluntary, anonymous, and confidential. Ten prisoners who did not want to provide a sample of oral fluid were asked to complete the questionnaire. No inducements were offered and no negative sanctions were imposed on non-respondents. Prisoners who did not want to meet the researchers in a group setting were approached individually.

No identifier was recorded on either the questionnaire or the oral fluid specimen. Once completed, the questionnaire and specimen were placed in a sealed envelope. A number was later assigned to both, linking the two. On the day of the survey anonymised information on age and sex was gathered on the entire population of each prison to assess the representativeness of the sample.

Questionnaire—The questionnaire, derived from one used in several cross sectional prison surveys in the United Kingdom,[7–11] consisted of questions relating to demography, prison sentences, risk behaviours, self reported hepatitis and HIV testing, and hepatitis B vaccination. It was self administered and took about five minutes to complete. A researcher helped those who had literacy difficulties.

Oral fluid tests—Oral fluid samples were collected with a proprietary device (EpiScreen, Epitope, Beaverton, OR), refrigerated, and transported in batches by same-day courier to the laboratory. Processing (blind to demographic information) started the next working day. Each sample was tested for total IgG to check specimen quality. The sensitivity of the assay for antibodies to hepatitis B core antigen was estimated to be

82% and specificity greater than 99%. For the hepatitis C virus assay, sensitivity was estimated to be 80% and specificity 100%. For the HIV assay, both sensitivity and specificity were greater than 99%. (See the appendix for details of testing procedures and estimation of sensitivity and specificity.)

Statistical analysis—Data were entered with an automated procedure[12] and checked manually. Statistical analysis was carried out with JMP.[13] For categorical measures χ^2 tests were used to compare groups. Multiple logistic regression analysis was used to identify factors associated with positive test results.

Results

All nine prisons agreed to participate, and 1205 (88%) of the 1366 selected prisoners responded to the survey, representing 45% of the total Irish prison population at the time. Of the 72 women in prison on the survey days, 57 participated.

Analyses refer to the 1193 participants who provided oral fluid samples that could be analysed or, for analyses relating to injecting drug use, to the 1178 respondents who declared their injector status. Denominators vary because not all respondents answered all questions.

The median (range) age of respondents was 25 (16 to 67) years. The age distribution of respondents was similar to that of the total population of the surveyed prisons ($\chi^2 = 1.7$, df 7, $P = 0.98$).

Prevalence of viral antibodies

The prevalence of antibodies to hepatitis B core antigen was 104/1193 (8.7%; 95% confidence interval 7.2% to 10.5%), to hepatitis C virus, 442/1193 (37%; 34.3% to 39.9%), and to HIV, 24/1193 (2%; 1.3% to 3%); 459 prisoners (38.5%) had positive results for one or more of the infections. Antibody prevalence rates by selected risk factors are shown in table 1 separately for the 509 injecting drug users and 669 non-injectors. The prevalence of antibodies to all three viruses was higher in those who reported use of injected drugs.

Reported drug use

Of 1178 respondents, 509 (43.2%) reported ever injecting drugs; of these, 417 also smoked heroin; 119 smoked heroin but said they did not inject. Women prisoners were more likely than men to report ever injecting drugs (59.7% *v* 42.4%, $P = 0.01$) and heroin smoking in the past year (59.7% *v* 45.2%, $P = 0.03$).

One fifth of the injecting drug users (104) reported injecting drugs for the first time while in prison. Of 492 injecting drug users, 347 (70.5%) reported sharing needles while in prison compared with 225 (45.7%) in the month before imprisonment ($P < 0.0001$). Of 330 injectors who had been in prison for more than three months on the current sentence, 148 (44.9%) stated that they had injected drugs in the previous month (in prison).

Of 497 injectors, 185 (37.2%) reported being on a methadone programme before committal. Most of them (80%) reported injecting in the month before imprisonment.

Sexual activity

Of 1108 men, 28 (2.5%) reported having anal sex with another man before committal, 17 stating that they never used condoms. Twenty of the 1079 men who answered the question reported having had anal sex with another man while in prison.

Hepatitis B vaccination

Of the 1143 respondents who answered the question, 300 (26.2%) said they had completed a three dose

Table 1 Prevalence of antibodies to hepatitis B core antigen, hepatitis C virus, and HIV by selected risk factors in injecting drug users and in those who reported never injecting drugs (non-injectors). Figures are numbers (percentages) of prisoners; 95% confidence intervals

		Antibodies		
	Total*	Hepatitis B core antigen	Hepatitis C	HIV
Total sample	1193†	104 (8.7); 7.2 to 10.5	442 (37.0); 34.3 to 39.9	24 (2.0); 1.3 to 3.0
Injecting drug users	509‡	94 (18.5); 15.2 to 22.1	414 (81.3); 77.7 to 84.6	18 (3.5); 2.1 to 5.5
<30 years old	382	51 (13.4); 10.1 to 17.2	312 (81.7); 77.4 to 85.4	6 (1.6); 0.6 to 3.4
≥30 years old	102	38 (37.3); 27.9 to 47.4	81 (79.4); 70.3 to 86.8	11 (10.8); 5.5 to 18.5
Men	475	88 (18.5); 15.1 to 22.3	390 (82.1); 78.4 to 85.5	17 (3.6); 2.1 to 5.7
Women	34	6 (17.7); 6.8 to 34.5	24 (70.6); 52.5 to 84.9	1 (2.9); 0.1 to 15.3
High risk prison	410	81 (19.8); 16.0 to 24.0	347 (84.6); 80.8 to 88.0	17 (4.2); 2.4 to 6.6
Medium risk prison	99	13 (13.1); 7.2 to 21.4	67 (67.7); 57.5 to 76.7	1 (1.0); 0.02 to 5.5
Smoked heroin in past 12 months:				
Yes	417	74 (17.8); 14.2 to 21.8	341 (81.8); 77.7 to 85.4	15 (3.6); 2.0 to 5.9
No	87	19 (21.8); 13.7 to 32.0	68 (978.2); 68.0 to 86.3	3 (3.5); 0.7 to 9.8
Started injecting in prison:				
Yes	104	11 (10.6); 5.4 to 18.1	80 (76.9); 67.6 to 84.6	4 (3.9); 1.1 to 9.6
No	397	82 (20.7); 16.8 to 25.0	329 (82.9); 78.8 to 86.5	14 (3.5); 1.9 to 5.9
Times injected in past month:				
0	221	40 (18.1); 13.3 to 23.8	177 (80.1); 74.2 to 85.2	7 (3.2); 1.3 to 6.4
1 to 19	139	26 (18.7); 12.6 to 26.2	119 (85.6); 78.7 to 91.0	6 (4.3); 1.6 to 9.6
≥20	74	19 (25.7); 16.2 to 37.2	67 (90.5); 81.5 to 96.1	2 (2.7); 0.3 to 9.4
Shared needles in prison:				
Yes	347	68 (19.6); 15.6 to 24.2	314 (90.5); 86.9 to 93.4	12 (3.5); 1.8 to 6.0
No	145	26 (17.9); 12.1 to 25.2	90 (62.1); 53.6 to 70.0	6 (4.1); 1.5 to 8.9
Attended methadone programme before committal:				
Yes	185	46 (24.9); 18.8 to 31.7	150 (81.1); 76.7 to 86.5	8 (4.3); 1.9 to 8.3
No	312	48 (15.4); 11.6 to 19.9	259 (83.0); 78.4 to 87.0	10 (3.2); 1.6 to 5.8
Started or completed hepatitis B vaccine:				
Yes	298	49 (16.4); 12.4 to 21.2	NA	NA
No	178	38 (21.4); 15.6 to 28.1	NA	NA
Did not know status	23	5		
Non-injectors	669‡	10 (1.5); 0.7 to 2.7	25 (3.7); 2.4 to 5.5	6 (0.9); 0.3 to 1.9
<30 years old	404	1 (0.3); 0.01 to 1.4	13 (3.2); 1.7 to 5.4	2 (0.5); 0.1 to 1.8
≥30 years old	237	9 (3.8); 1.8 to 7.1	10 (4.2); 2.0 to 7.6	4 (1.7); 0.5 to 4.3
Men	646	9 (1.4); 0.6 to 2.6	25 (3.9); 2.5 to 5.7	6 (0.9); 0.3 to 2.0
Women	23	1 (4.4); 0.1 to 22.0	0; 0.0 to 14.8	0; 0.0 to 14.8
High risk prison	297	6 (2.0); 0.8 to 4.4	15 (5.1); 2.9 to 8.2	3 (1.0); 0.2 to 2.9
Medium risk prison	372	4 (1.1); 0.3 to 2.7	10 (2.7); 1.3 to 4.9	3 (0.8); 0.2 to 2.3
Smoked heroin in past 12 months:				
Yes	119	2 (1.7); 0.2 to 5.9	11 (9.2); 4.7 to 15.9	0; 0.0 to 3.1
No	546	8 (1.5); 0.6 to 2.9	14 (2.6); 1.4 to 4.3	6 (1.1); 0.4 to 2.4
Men ever had anal sex with men:				
Yes	12	2 (16.7); 2.1 to 48.4	2 (16.7); 2.1 to 48.4	3 (25.0); 5.5 to 57.2
No	617	7 (1.1); 0.5 to 2.3	23 (3.7); 2.4 to 5.5	3 (0.5); 0.1 to 1.4
Started or completed course of hepatitis B vaccine:				
Yes	201	5 (2.5); 0.8 to 5.7	NA	NA
No	360	5 (1.4); 0.5 to 3.2	NA	NA
Did not know status	83	0		

NA=not applicable.
*Numbers do not always add up to total because not all respondents answered all questions.
†Antibody prevalence estimated in 1193 respondents with analysable oral fluid samples (10 respondents did not provide sample and two samples were inadequate for laboratory analysis).
‡Antibody prevalence among injecting drug users (509) and in those who reported never injecting drugs (non-injectors, 669) estimated in those with analysable samples who also answered question "Have you ever injected drugs?" (1178); 15 respondents with analysable samples did not declare injecting drug use.

Table 2 Logistic regression models* to identify determinants of prevalence of antibodies to hepatitis B core antigen, hepatitis C virus, and HIV

	Total sample (n=1193)†	No (%) positive for antibodies	Odds ratio (95% CI)	P value‡
Antibodies to hepatitis B core antigen (n=104)				
Ever injected drugs:				
No	669	10 (1.5)	1	
Yes	509	94 (18.5)	21.6 (10.9 to 47.6)	<0.0001
Age (years):				
16-19	177	9 (5.1)	1	
20-24	367	26 (7.1)	1.5 (0.6 to 4.1)	0.41
25-34	399	37 (9.3)	2.3 (1 to 6.3)	0.07
⩾35	194	27 (13.9)	9.7 (3.8 to 28.6)	<0.0001
Ever treated for sexually transmitted infection:				
No	1011	75 (7.4)	1	
Yes	147	26 (17.7)	1.9 (1.1 to 3.3)	0.02
Antibodies to hepatitis C virus (n=442)				
Ever injected drugs:				
No	669	25 (3.7)	1	
Yes	509	414 (81.3)	80.8 (47.9 to 143)	<0.0001
Age (years):				
16-19	177	47 (26.6)	1	
20-24	367	175 (47.7)	2.8 (1.5 to 5.3)	0.002
25-34	399	158 (39.6)	1.8 (0.9 to 3.4)	0.08
⩾35	194	38 (19.6)	1.9 (0.8 to 4.5)	0.11
Months spent in prison over past 10 years:				
<3	136	20 (14.7)	1	
3-11	197	39 (19.8)	2.9 (1.2 to 6.9)	0.01
12-36	299	102 (34.1)	4.0 (1.9 to 8.6)	<0.001
>36	538	277 (51.5)	6.5 (3.2 to 13.3)	<0.0001
Smoked heroin in past 12 months:				
No	637	82 (12.9)	1	
Yes	540	353 (65.4)	2 (1.2 to 3.3)	0.007
Antibodies to HIV (n=24)				
Ever injected drugs:				
No	669	6 (0.9)	1	
Yes	509	18 (3.5)	3.4 (1.3 to 9.5)	0.01
Ever treated for sexually transmitted infection:				
No	1011	15 (1.5)	1	
Yes	147	9 (6.1)	3 (1.2 to 7.4)	0.02
Men ever had anal sex with men:				
No	1080	18 (1.7)	1	
Yes	28	5 (17.9)	8.4 (2.4 to 25.1)	0.001

*Initial models for hepatitis C and HIV included age, sex, time spent in prison in the past 10 years, injecting drug use, smoking heroin, ever had sex with a man inside or outside prison, ever treated for sexually transmitted infection, and use of condoms during heterosexual intercourse. Model for hepatitis B also included whether respondents had started or completed hepatitis B vaccination. Significant factors were retained in the final model.
†Numbers do not always add up to total because not all respondents answered all questions.
‡For whole model χ^2=142, P<0.0001 for hepatitis B core antigen; χ^2=848, P<0.0001 for hepatitis C virus, and χ^2=28, P<0.0001 for HIV.

course of hepatitis B vaccination; 199 (17.4%) received one or two doses, and 538 (47.1%) had not received any vaccine. Vaccination uptake was higher in injecting drug users than non-injectors (59.7% *v* 31.2%, P<0.0001) and in people in prison for more than three of the past 10 years (60.8% *v* 30.1%, P<0.0001).

Logistic regression

Logistic regression models were constructed to clarify the associations between prisoners' reported risk behaviours and other characteristics and the likelihood of being positive for antibodies to hepatitis B core antigen, antibodies to hepatitis C virus, and antibodies to HIV. Three groups of variables were considered for inclusion in each model: demographic and sentence characteristics; drug using and drug services; and sexual history. Significant factors were retained in the models.

In relation to both antibodies to hepatitis B core antigen and antibodies to hepatitis C virus the most important predictor of being positive was a history of injecting drug use (table 2). Those who reported injecting drugs were 81 times more likely to have antibodies to hepatitis C and 22 times more likely to have antibodies to hepatitis B than non-drug using prisoners. Although inferences from the antibodies to HIV regression model are limited by small numbers, those who reported a history of anal sex were eight times more likely to have positive results and those who reported injecting drug use three times more likely (table 2).

Separate models were constructed for respondents with and without a history of injecting drug use. Table 3 shows the model for hepatitis C in injecting drug users. Those in prison for more than three of the past 10 years, those who first injected three or more years ago, those who reported sharing needles in prison, and those who reported frequent current injecting were more likely to be positive for antibodies to hepatitis C virus. (Five tables of results of other models are shown on the *BMJ* website.) Antibodies to hepatitis B core antigen were more common in older injecting drug users, those who had been injecting longer, and those who reported having been treated for sexually transmitted infections. Antibodies to HIV were more common in older injectors and were associated with condom use.

In the models for respondents without a history of injecting drug use, positive results for antibodies to hepatitis B core antigen were more likely in older respondents and in men who reported taking part in anal sex. Smoking heroin and being positive for antibodies to hepatitis B core antigen were risk factors for hepatitis C. Reporting anal sex with men was a powerful predictor of HIV in non-injectors (odds ratio 56.0, 95% confidence interval 9.1 to 349.0).

Discussion

In this national representative survey two fifths of Irish prisoners reported a history of injecting drug use. A remarkable finding is that 21% of prisoners who use drugs reported that they had started to inject while in prison. Surveys in some Scottish prisons have reported similarly high figures,[9 11 14] but elsewhere the proportion who start injecting drug use in prison is much lower.[10 11 14] Clearly, providers of health care in Irish prisons need to focus preventive efforts in this area.

Nearly half of those with a history of injecting drug use reported continuing use while in prison, and almost three quarters had shared injecting equipment in prison. These figures confirm a previous Irish prison report.[4] Given the limited access to injecting equipment in prison and the high prevalence of infection, it is hardly surprising that sharing needles in prison emerged as a significant risk factor for hepatitis C in injectors (see table 3).

The prevalence of infection with HIV was 2%, and 8.7% of prisoners had evidence of non-vaccine induced antibodies to hepatitis B. The HIV prevalence is similar to that reported in prison studies from other developed countries.[8 9 15 16] The prevalence of antibodies to hepatitis B core antigen in Irish prisons is similar to that in the United Kingdom, despite the

higher proportion of injecting drug users in Irish prisons, and much lower than the 33% figure reported from Australia.[3] The policy in the Republic of Ireland is to offer vaccination to all prisoners with sentences of eight months or longer. Although there is room for improvement (26.2% of prisoners reported completed vaccination), vaccine uptake is higher than in other prison populations and in other populations of injecting drug users.[17] The unexpectedly low prevalence of hepatitis B suggests that the targeting of prisoners as a special group in Irish vaccination policy may be having some effect.

More than a third of all prisoners, and more than 80% of injecting drug users, were positive for antibodies to hepatitis C virus. Community surveys among Irish injectors have indicated a prevalence of between 52% and 76%.[18] The prevalence of antibodies to hepatitis C virus in Irish prisoners is similar to that found in Greek prisons[1] but higher than that reported for Scotland[19] and Australia.[20]

This cross sectional survey was not designed to provide direct evidence of transmission of infectious diseases in prison. Participants who spent more time in prison over the past 10 years, however, and those who shared needles while in prison were significantly more likely to be positive for antibodies to hepatitis C virus. This could be because the more chaotic users, who are more likely to be infected, spend longer in prison, but it also suggests that being in prison in Ireland may be an independent risk factor for contracting hepatitis C infection. In any case, it is clear that both injecting drug use and infection with hepatitis C virus are major problems that need to be examined by the healthcare system in Irish prisons. Community drug treatment services in Ireland have evolved considerably over the past decade and needle exchange and methadone maintenance are widely available. The Irish prison healthcare system has not kept pace with this change but is not unique in this as few prison healthcare services have implemented such measures.[5 21] Our survey suggests a need to consider increased provision of measures to reduce harm in Irish prisons. In addition, uptake of hepatitis B vaccination, although higher than in many countries, could still be improved.

In Ireland, as elsewhere, injecting drug use in prison is here to stay. The time has come for policy makers, researchers, and clinicians working in prisons to ensure that being in prison does not add unnecessarily to the health risks of this already disadvantaged population.

Table 3 Logistic regression model* to identify determinants of prevalence of antibodies to hepatitis C virus in injecting drug users

	Injecting drug users (n=509)†	No (%) positive for antibodies to hepatitis C virus (n=414)	Odds ratio (95% CI)	P value
Months spent in prison over past 10 years:				
<3	40	19 (47.5)	1	
3-11	49	36 (73.5)	2.3 (0. 8 to 7.1)	0.14
12-36	120	97 (80.8)	2.4 (0.9 to 6.6)	0.08
>36	296	260 (87.8)	2.9 (1.1 to 7.6)	0.03
Years since first injecting:				
<3	85	55 (64.7)	1	
⩾3	383	327 (85.40	2.9 (1.5 to 5.4)	0.001
Sharing needles in prison:				
No	145	90 (62.1)	1	
Yes	347	314 (90.5)	2.9 (1.5 to 5.7)	0.002
No of times injected in month before survey:				
0	221	177 (80.1)	1	
1-19	139	119 (85.6)	1.1 (0.5 to 2.1)	0.89
⩾20	74	67 (90.5)	3.0 (1.1 to 10.0)	0.05

Whole model χ^2=53, P<0.0001.
*Initial model included variables age, sex, time spent in prison in preceding 10 years, smoking heroin, length of time since first injection, started injecting in prison, sharing practices in prison and outside prison, injecting frequency in prison, taking methadone before committal, ever had sex with a man inside or outside prison, ever treated for sexually transmitted infection, and use of condoms during heterosexual intercourse. Significant factors were retained in final model. Interaction between length of time spent in prison in past 10 years and number of years since first injecting drugs was not significant.
†Numbers do not always add up to total because not all respondents answered all questions.

What is already known on this topic

Prisons are high risk institutions for the spread of hepatitis B, hepatitis C, and HIV; in Western countries the main risk factors are injecting drug use and men having sex with other men

In 1997, a study in a Dublin prison reported that two thirds of prisoners used heroin; over half of these injected the drug

What this study adds

Nine per cent of Irish prisoners are infected with hepatitis B, 37% with hepatitis C, and 2% with HIV

Among injecting drug users the prevalence of hepatitis C infection is 81.3%

The survey confirms the high rates of injecting drug use and sharing of injecting equipment within Irish prisons, and a fifth of injecting drug users reported starting injecting in prison

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Contributors: SA, JB, FB, and LT developed the protocol and tendered for funding. SA, JB, FB, JL, and LT were involved in fieldwork and contributed to the analysis plan. SA supervised the data collection and carried out the analysis with JL. LT negotiated the contract for oral fluid analysis with the Pubic Health Laboratory Service as principal liaison between the Dublin team and the service. JVP supervised the development of laboratory methods and the laboratory analysis and wrote the appendix. SA, JB, FB, JL, and LT contributed to the government report on which the paper is based. FB drafted the paper, with contributions from all authors. SA, FB, and JL wrote the revised version, with contributions from all authors. SA is guarantor for the paper.

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Competing interests: FB has contributed to policy development on prison health for the Labour party and, until recently, was a part time prison medical officer. JB is a member of the National Drugs Strategy Team. Though the study was funded by Department of Justice, Equality and Law Reform, Republic of Ireland, the research contract guaranteed freedom to publish results in a peer reviewed journal.

Appendix

Oral fluid testing procedures

Testing for antibodies to HIV was done with the Murex 1+2 GACELISA (VK61, Abbott Diagnostics, Maidenhead),[22 23] with positive results confirmed by using a modified Clonesystems enzyme immunoassay (EIA; Biostat Diagnostics, Stockport). Anti-HBC testing used Murex ICE (Abbott Diagnostics, Maidenhead), with positive results confirmed with an in-house radioimmunoassay.[24] Testing for antibodies to hepatitis C virus used a modified protocol for the Ortho HCV 3.0 SAVe enzyme linked immunosorbent assay (ELISA; product No 940982, Ortho Diagnostics, Amersham); borderline results were further investigated with a modified Chiron recombinant immunoblot assay (RIBA) HCV 3.0 (product No 930780, Ortho Diagnostics, Amersham).

Estimation of sensitivity and specificity of oral fluid tests

The Ortho HCV 3.0 eSAVE ELISA was selected for the development of an assay for antibodies to hepatitis C virus in oral fluid on the basis of its superior sensitivity on serum testing. Dilutions were prepared of well characterised serum specimens positive and negative for antibodies to hepatitis C virus in which the IgG content was similar to that found in oral fluid. These dilutions were used to optimise conditions for the assay such that the discrimination between positive and negative specimens was maximised. Specimen volume and the duration, temperature, and effect of agitation on incubation of the specimen, conjugate, and substrate were studied. By using the optimum conditions identified, oral fluid specimens collected by Orasure from 291 blood donors who were negative for antibodies to hepatitis C virus were tested to establish the cut off for the assay. Tests on Orasure specimens from 318 people serologically negative for antibodies to hepatitis C virus were all negative (specificity 100%; 95% confidence interval 98.8% to 100%). Of 216 Orasure specimens from serpositive subjects, 188 (sensitivity 87.0%; 82.6% to 91.5%) were positive. Of the 216 oral fluid specimens from seropositive patients, however, 126 had been collected from patients with liver disease, and 116 (92%; 85.9% to 96.1%) of these were positive. The remaining 90 seropositive specimens came from a randomly sampled population of injecting drug users from London. Of these, 72 (80.0%; 70.2% to 87.7%) yielded positive results. As this latter group probably better represents the population of prisoners at risk of hepatitis C infection, this observation was used as a guide to the sensitivity of oral fluid antibodies to hepatitis C virus testing in the population of prisoners described in this paper.

1 Malliori M, Sypsa V, Psichogiou M, Touloumi G, Skoutelis A, Tassopoulos N, et al. A survey of bloodborne viruses and associated risk behaviours in Greek prisons. *Addiction* 1998;93:243-51.
2 Rotily M, Galinier-Pujol A, Vernay-Vaisse C. Risk behaviours of inmates in south-eastern France. *AIDS Care* 1995;7(suppl 1):89-93.
3 Crofts N, Stewart T, Hearne P, Ping XY, Breschkin AM, Locarnini SA. Spread of bloodborne viruses among Australian prison entrants. *BMJ* 1995;310:285-8.
4 O'Mahony P. *Mountjoy prisoners: a sociological and criminological profile*. Dublin: Stationery Office, 1997.
5 Dolan K, Hall W, Wodak A. The provision of methadone within prison settings. In: Ward J, Mattick RP, Hall W, eds. *Methadone maintenance treatment and other opioid replacement therapies*. Amsterdam: Harwood Academic, 1998:379-95.
6 Ministerial Task Force on Measures to Reduce the Demand for Drugs. *Second report*. Dublin: Department of the Taoiseach, 1997.
7 Bird AG, Gore SM, Jolliffe DW, Burns S. Anonymous HIV surveillance in Soughton Prison, Edinburgh. *AIDS* 1992;6:725-33.
8 Bird AG, Gore SM, Burns SM, Duggie JG. Study of infection with HIV and related risk factors in young offenders' institution. *BMJ* 1993;307:228-31.
9 Gore SM, Bird AG, Burns SM, Goldberg DJ, Ross AJ, Macgregor J. Drug injection and HIV prevalence in inmates of Glenochill prison. *BMJ* 1995;310:293-6.
10 Bird AG, Gore SM, Cameron S, Ross AJ, Goldberg DJ. Anonymous HIV surveillance with risk factor elicitation at Scotlands largest prison, Barlinnie. *AIDS* 1995;9:801-8.
11 Gore SM, Bird AG, Burns S, Ross AJ, Goldberg D. Anonymous HIV surveillance with risk-factors elicitation: at Perth (for men) and Cornton Vale (for women) prisons in Scotland. *Int J STD AIDS* 1997;8:166-75.
12 Principia Products. *Remark office OMR—version 4*. Paoli, PA: Principia Products, 1997.
13 Sall J, Lehman A, (SAS Institute). *JMP start statistics: version 3.2*. Belmont, New York: Duxbury, 1996.
14 Bird AG, Gore SM, Hutchinson SJ, Lewis SC, Cameron S, Burns S. Harm reduction measures and injecting inside prison versus mandatory drugs testing: results of a cross sectional anonymous questionnaire survey. *BMJ* 1997;315:21-4.
15 Bellis MA, Weild AR, Beeching NJ, Mutton KJ, Syed Q. Prevalence of HIV and injecting drug use in men entering Liverpool prison. *BMJ* 1997;315:30-1.
16 Gaughwin MD, Douglas RM, Liew C, Davies L, Mylvaganam A, Treffke H, et al. HIV prevalence and risk behaviours for HIV transmission in South Australian prisons. *AIDS* 1991;5:845-51.
17 Lamgani TL, Davidson KL, Hope VD, Luutu JW, Newham JA, Parry JV, et al. Poor hepatitis B vaccine coverage in injecting drug users: England. *Commun Dis Public Health* 1999;2:174-7.
18 Smyth B, Keenan E, O'Connor JJ. Evaluation of the impact of Dublin's expanded harm reduction programme on the prevalence of hepatitis C among injecting drug users with short injecting histories. *J Epidemiol Community Health* 1999;53:434-5.
19 Gore SM, Bird AG, Cameron SO, Hutchinson SJ, Burns SM, Goldberg DJ. Prevalence of hepatitis C in prisons: WASH C surveillance linked to self reported risk behaviours. *Q J Med* 1999;92:25-32.
20 Butler TG, Dolan KA, Ferson MJ, McGuinness LM, Brown PR, Robertson PW. Hepatitis B and C in New South Wales prisons: prevalence and risk factors. *Med J Aust* 1997;166:127-30.
21 Farrell M, Howes S, Vester A, Davoli M. *Reviewing current practice in drug substitution treatment in Europe*. London: National Addiction Centre, EMCDDA, Osservatorio Epidemiologico, 1999.
22 Connell JA, Parry JV, Mortimer PP, Duncan J. Novel assay for the detection of immunoglobulin G anti-human immunodeficiency virus in untreated saliva and urine. *J Med Virol* 1993;41:159-64.
23 Connell JA, Parry JV. Detection of anti-HIV in saliva and urine at the time of seroconversion. *Clin Diag Virol* 1994;1:299-311.
24 Parry JV, Perry KR, Mortimer PP. Sensitive assays for viral antibodies in saliva: an alternative to tests on serum. *Lancet* 1987;ii:72-5.

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Corrections and clarifications

Smoking and dementia in male British doctors: prospective study

A formula was incomplete in this paper by Richard Doll and colleagues (22 April, pp 1097-102). In the last sentence of the statistical methods section the formula for the 95% confidence limit of the relative risk should have been given as: "exp (b ± SE×1.96) [not exp(b SE 1.96)], where b is the log relative risk and SE its standard error."

Editor's choice

Some errors in the *BMJ* lie dormant for quite some time before detection, as has happened with a reference cited in Editor's Choice from 10 April 1999 (vol 318). In the first paragraph the image of the "champagne glass of world poverty" was wrongly attributed to a World Bank report. In fact, it can be found in the United Nations Development Programme's *Human Development Report 1992* at www.undp.org/hdro/92.htm.

Medicine and the media

In the article entitled "The steady drip of biased reporting" (20 May, p 1414) we misquoted Claire Rayner in the last paragraph. The final sentence should have started: "If the NHS has been fatally flawed …"