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Full Length Research Paper

No HIV infections despite high numbers of hepatitis B and C virus infections in Dutch prisoners

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International studies show high prevalences of blood-borne infections in prisoners but little is known about infectious diseases in Dutch prisoners. This study assessed the prevalence of HIV, hepatitis B and hepatitis C virus infections in Dutch prisoners and contributing risk factors. A cross-sectional serosurvey was conducted among male prisoners, using blood samples and questionnaires. Overall, 229 prisoners participated (77%). No prisoner was HIV seropositive. Nineteen prisoners (8.3%) were anti-hepatitis B core (anti-HBc) positive, three of whom were hepatitis B surface antigen (HBsAg) positive. Fifty (22%) were anti-HBs positive, either after vaccination or previous infection. The prevalence of antibodies to Hepatitis C virus (HCV) was 7.4%, of whom 4.8% was HCV-RNA positive. Over half of the prisoners reported drug use, 36% reported drug use in prison. The predictor for HBV was IDU *(P<0.001)*; the predictors for HCV were higher age and injecting drug users (IDU) *(P<0.05)*. Prevalences among injecting drug users (IDUs) were significantly higher than among non-IDUs *(P<0.001)*. While we did not identify any HIV infected prisoners, the study showed that seroprevalences of Hepatitis B virus (HBV) and HCV infections among Dutch prisoners were up to twenty times higher than estimated for the Dutch general population. IDU was the most commonly reported route of transmission. Since only a minority of prisoners was immune to HBV, vaccination coverage in prisoners should be enhanced.

Key words: Epidemiology, blood-borne infection, hepatitis, HIV infection, injecting drug use, prison, seroprevalence.

INTRODUCTION

Worldwide, prison populations are at increased risk for infections with human immunodeficiency virus (HIV), hepatitis B virus (HBV) and hepatitis C virus (HCV) (EMCDDA, 2009; Long et al., 2004; Rotily et al., 2001; Weild et al., 2000). Injecting drug use (IDU) is the most commonly reported risk factor (Allwright et al., 2000; EMCDDA, 2009; Long et al., 2000; Weild et al., 2000). Identification of those infected enables initiation of appropriate care, and may reduce ongoing transmission. Prisons are a high risk environment for the transmission of blood-borne infections (BBI) because of high proportion of IDU, often with non-sterile equipment, and other risk behaviour such as tattooing, in particular while in prison, unprotected sex, the sharing of needles and syringe attributes, and limited access to health care

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(Long et al., 2001; Macalino et al., 2004; Poulin et al., 2007; Solomon et al., 2004; Weild et al., 2000).

European studies in prison settings in 2000 to 2007 have shown HIV prevalences around 3 and 5%, Hepatitis B virus (HBV) prevalences ranging between 10 and 35%, and HCV prevalences between 10 and 40% (Macalino et al., 2004; Poulin et al., 2007; Solomon et al., 2004; Weild et al., 2000). They have also shown high proportions of ever IDU among prisoners.

While in the Netherlands data on BBI in prison settings are lacking, such data have been collected among IDUs, showing a high prevalence of BBI and related high-risk behaviour (Berns et al., 1999; Beuker et al., 2001, 1999; de Boer et al., 2004). HIV prevalences in surveys among opioid drug users were found to be high, in particular in the southern part of the Netherlands: 22% in a street survey among IDUs in 1999, and 11% in a sample of opioid drug users in methadone treatment in 2010 (Beuker et al., 2001; Schreuder et al., 2010), compared to 1.9 and 2.5% in other areas in 1999 and 2010, respectively (Beuker et al., 2001; Schreuder et al., 2010). In 1999 and 2010, the seroprevalence of anti-HBc among IDUs varied between 35 and 68% and the HCV antibody seroprevalence between 35 and 74%, with the highest values again in the southern part of the Netherlands (Berns et al., 1999; Beuker et al., 2001, 1999; de Boer et al., 2004). For HBV, a nationwide vaccination program targeted at risk groups such as drug users, sex workers and men who have sex with men (MSM) was initiated in 2003 (van Houdt et al., 2009).

The aim of this cross-sectional study was to assess the prevalence of markers of HIV, HBV and HCV infections and related demographics and risk behaviour among prisoners in a penitentiary in the southern part of the Netherlands, incarcerating a population representative for general male prisoners in our country with respect to demographic characteristics (Ministry of Justice, 2009).

MATERIALS AND METHODS

Study setting

Due to the high burden of BBI in particular in the South of the Netherlands, this study was conducted in a penitentiary in Sittard, in the Southern Netherlands, where 317 male prisoners reside. The population in this male penitentiary is representative of Dutch prisons in general with respect to demographic characteristics, such as age distribution and ethnicity (Ministry of Justice, 2009). As in other Dutch penitentiaries, the study setting exists of different types of correctional facilities; the house of custody, the prison department, and a psychiatric department. Since spring 2009, all new incoming prisoners in the penitentiary are offered an STI screening by the medical department, including HIV testing. Uptake so far has been only 10% and the screening is only offered to new prisoners.

Study design

To determine the prevalence of markers of HIV, HBV and HCV among prisoners in the selected penitentiary, a cross-sectional serosurvey was offered to all prisoners aged 18 years and older in the period from 10 January to 8 February 2010 using a probability random sampling method. Prisoners from the psychiatric department were excluded (n = 22). All other prisoners (n = 295) were invited collectively per block by the research team for a twenty-minute briefing about the study. A few days later, the prisoners were asked whether they wanted to participate in our study. All documents were provided with a study number and results were kept coded.

The consent forms were provided by personal identifiers and the same study number, and they were stored separately at the regional Public Health Services. Written informed consent was required from all individuals before inclusion into the study. The medical department of the penitentiary reported test results and in case they were positive, the medical department referred the prisoners for further care and treatment to the hospital.

Approval for the study was obtained from the Medical Ethics Committee at Erasmus Medical Centre, Rotterdam (MEC-2009-310) and conforms to international and national legislation. As a token of appreciation, a telephone card worth €10 was distributed to prisoners who completed participation.

Questionnaire

Consenting prisoners completed a self-administered questionnaire and provided a blood sample. Questionnaires were used to collect data on various factors that may affect the prevalence of HIV, HBV or HCV, including socio-demographic characteristics such as date of birth, country of birth, residence history and education level. The questionnaires also collected data on sexual and drug related (risk) behaviour, both outside and inside prison, and testing and treatment history for infectious diseases. Hard drugs were defined as heroin, cocaine, opium, methadone, LSD, ecstasy or amphetamines; soft drugs as any other drug, such as cannabis, hashish, etc. The 75-item questionnaire was based on questionnaires used in similar previous surveys (Berns et al., 1999; Beuker et al., 2001, 1999; van den Berg et al., 2007; van Veen, 2007). The questionnaire was developed in Dutch and translated into the most common languages spoken in the target population as English, German, French, Russian and Turkish. To investigate whether the questions were understandable and clearly formulated the questionnaire was pre-tested among prisoners.

Sample selection and collection

Consenting prisoners provided a venous blood sample, or if not possible, a finger prick sample. After blood collection, blood samples were transported the same day to the laboratory of the department of virology at Erasmus Medical Centre in Rotterdam. Serum of prisoners were screened for antibodies to HIV, hepatitis B-surface antigen (HBsAg), hepatitis B-core antigen (anti-HBc), hepatitis B-surface antigen (anti-HBs) hepatitis C (HCV), all using the Architect® (Abbott Diagnostics, Chicago, USA). Those who were positive for HBsAg were confirmed with Architect® (Abbott Diagnostics, Chicago, USA) and those with antibodies against HCV with the western blot Inno Lia® (Innogenetics, Gent, Belgium). HCV positive samples were further tested for presence of an active HCV infection with a HCV-RNA PCR using the Cobas Taqman® (Roche Diagnostics, Basel, Switserland). Being protected against HBV was defined as having ≥ 10 IU hepatitis B-surface antibodies per litre of plasma. Finger prick samples were tested only for HCV-RNA with similar assays.

Statistical analysis of data

Data from the questionnaires were double entered and validated.

Statistical analyses were performed with SPSS version 18.0 statistical software. Associations between outcomes and explanatory variables were assessed using Chi-square or Fisher's exact test in univariate analyses. Variables were included into a multivariate logistic regression model if they showed a significant association at $p<0.05$ in univariate analyses. We checked for confounders and correlations.

RESULTS

Characteristics of the study population

In total, 229 prisoners were included in the study, of which 226 had completed the questionnaire (response rate 77%). Drug use behaviour of the non-responders did not differ from the drug use behaviour of the responders. Venous blood samples were available from 223 prisoners, and a finger prick sample was taken from six persons. The mean age of the study participants was 32 years (range 18 to 61 years) and all were male. An overview of other demographic characteristics of the study population is shown in Table 1.

Sexual behaviour

One in five prisoners (19%) reported more than 50 lifetime sex partners. Nearly all partners were women (98%). Condoms inconsistently used with steady and casual sex partners (87 and 77%, respectively).

Drug use and tattooing

Nineteen prisoners (8%) indicated ever injecting drugs (Table 1). Of these, 11 participants had ever shared drug equipment. The mean age of starting injecting drug use was 21 years and the average duration was 16 years (range 2 to 31 years). A total of 123 prisoners (54%) had ever used hard drugs, of whom 43 recently. More than half of the participants had been tattooed (124/226), of whom one quarter while in prison. Prisoners were often tattooed with self-developed systems (e.g. guitar strings, lighter springs). The median number of tattoos that were made in prison was two (range 1 to 20).

Prevalence of blood-borne infections

None of the participants tested HIV positive (Table 2). Nineteen prisoners (8.3%) were anti-HBc positive. Three tested HBsAg positive; none were aware of their infection. In addition, 50 persons were protected against HBV, either after vaccination (70%) or following a previous infection (30%). The reported risk behaviour was high among prisoners susceptible to HBV infection (anti-HBs negative); 54% ever used hard drugs, 14% recently used hard drugs, 2% had ever injected drugs, and 18% received methadone in the last 12 months. Seventeen participants were HCV positive (7.4%), of whom 11 participants had an active HCV infection (4.8%). Of those with an active HCV infection, six (55%) were unaware and none were put on treatment.

None of the active HBV infections were coinfected with HCV. Six of the 19 anti-HBc positive prisoners also had antibodies to HCV (32%), of whom two had an active HCV infection.

Prisoners who had ever injected drugs were significantly more likely to have antibodies to both HBc and HCV than those who had never injected drugs ($P<0.001$, Table 2). This is also applicable to prisoners with an active HCV infection.

Determinants of positive anti-HBc status

In univariate analyses, a positive anti-HBc test was significantly associated with age above 37 years; ever injecting drugs; methadone care; being tattooed in prison; having blood transfused; and MSM sexual contact ($P<0.05$, Table 3).

Methadone care was excluded from multivariate analyses due to its strong correlation with our main variable of interest; ever using hard drugs (correlation ≥0.6). The only significant determinant left was ever injected drugs (aOR 24).

Determinants of positive HCV status

In univariate analyses (Table 4), the presence of HCV antibodies was significantly associated with injecting drug use; the duration of injecting; drug use in prison, referring to both soft and hard drugs; and not having a steady partner ($P<0.05$, Table 4). Again, methadone care and the duration of injecting were excluded from multivariate analyses. These analyses showed that persons who ever injected drugs were more likely to test positive for HCV than persons who never used drugs (aOR 167) (Table 4). In addition, prisoners aged younger than 38 years were less likely to test positive (aOR 12).

DISCUSSION

In an area where the highest HIV prevalence among IDUs in the country has been measured, unexpectedly, no prisoners were tested positive for HIV. Moreover, 8.3% had antibodies against hepatitis B-core antigen and 7.4% had HCV antibodies. The most likely route of transmission for HBV and HCV was injecting drug use. The proportion of undiagnosed HBV and HCV infections was relatively high. In addition, only a minority of prisoners was immune to HBV.

Since our study prison is located in a geographical area with relatively high HIV prevalence rates among IDU, it

Table 1. Socio-demographic characteristics of 226 prisoners of PI, the Geerhorst.

Variable	N (n = 226)	Percentage	IDU (n = 19)	Non-IDU (n = 207)
Age tertiles (Years)				
18-26	82	36	2	80
27-37	67	30	5	62
> 37	77	34	12	65
Education level				
None/low	81	36	7	74
Middle	133	59	11	122
High	12	5	1	11
Country of birth				
The Netherlands	154	68	16	138
Other EU country	11	5	1	10
Turkey / Morocco	19	8	-	19
Suriname/Dutch Antilles	15	7	-	15
Other	27	12	2	25
Duration current prison stay (Months)				
0-2	58	26	4	54
3-6	59	26	5	54
7-18	56	25	5	51
≥ 19	53	24	5	48
Prison history**				
1 time	74	33	1	73
2-5 times	104	46	3	101
6-15 times	41	18	12	29
> 15 times	7	3	3	4
Blood transfusion (<1992)	5	2	1	4
Tattoo				
No	102	45	7	95
Yes, only outside prison	91	40	5	86
Yes, while in prison	33	42	7	26
Drug use in prison				
No	145	64	2	143
Yes, using (hard and soft) drug in prison	76	34	12	64
Yes, injecting drugs in prison	5	2	5	-
Ever drug use				
Never	102	46	-	102
Yes, ever using hard drugs	105	46	-	105
Yes, ever injecting drugs	19	8	19	-
Recent drug use (< 12 months)				
Never used drug	102	45	-	102
No recent drug use	81	36	6	76
Yes, recently used hard drugs	39	17	9	30
Yes, recent injected drug	4	2	4	-

Table 1. Contd.

IDU duration (Years)				
1-16	7	3	7	-
17-31	11	5	11	-
No IDU	208	92	1	207
Sharing needles				
No	8	3	8	-
Yes	11	5	11	-
Never IDU	207	92	-	207
Methadone use				
No	189	84	1	188
Yes, ever	8	3	4	4
Yes, recent	29	13	14	15
Sex partners ever (partners)				
1-10	81	36	6	75
11-50	94	42	9	85
> 50	42	19	4	38
MSM	4	2	2	2
Steady partner (sp)	132	58	6	126
Condom use sp				
Never	99	86	4	95
Not always	11	9	1	10
Always	6	5	-	6
No steady partner	110	49	14	96
Casual partner(cp)	80	35	5	75
Condom use cp				
Never	28	13	3	25
Not always	34	15	2	32
Always	19	8	-	19
No casual partner	145	64	14	131

** Including present prison stay, # Low: elementary school, middle: primary and secondary school, high: bachelor/master, recent: previous 12 months

was unforeseen that no HIV infection was diagnosed within this study. Our findings are contrary to findings in similar international studies conducted in other high-income countries. The burden of HIV infections among prisoners in these studies is higher, ranging from 0.3 to 5.1% (Long et al., 2001 Poulin et al., 2007Rotily et al., 2001). A study by Dolan in 2007 among prison populations in 18 countries worldwide even showed HIV prevalences of at least 10% (Dolan et al., 2007). A reason for the zero-prevalence in our study might be that the number of injecting drugs users has decreased substantially over the last decades. At present, past and current injecting behaviour in Dutch drug users in treatment settings is among the lowest in Europe (EMCDDA, 2009). Our results suggest that the potential for HIV transmission in Dutch prisons is probably low.

Concerning the prevalence of anti-HBc and HCV, these were also lower than previously reported by studies in prison settings worldwide, with percentages of both anti-HBc and HCV, ranging between 10 and 25% (Solomon et al., 2004). Nevertheless, the prevalences we found were higher than the current estimations for the general population in the Netherlands, that is 3.2% for HBV and 0.2% for HCV (Leemrijse et al., 2010; National coordination for infectious diseases control, 2005; Vriend et al., 2010) (Pieter studies RIVM, personal communication, 2010). In line with our study results, a recent inventory of 3062 patient files of Dutch prisoners estimated HCV

Table 2. Seroprevalence of HIV, hepatitis B and hepatitis C infections among 22 prisoners by awareness of seroprevalent status and by injecting drug use status.

	Positive {N (%)}	CI (95%)	Negative, {N (%)}	Unknown {N (%)}	Unaware, {N (%)}	NA, {N(%)}	IDU (n = 19)	Non-IDU (n = 207)	P-value**
HIV	0	0.0-1.6	222 (97%)	7 (3%)	-	-	0	0	-
Anti-HBc**	19 (8.3%)	5.2-12.4	203 (88%)	7 (3%)	16/19 (84%)	-	8 (42%)	11 (5%)	<0.001
HBsAg	3 (1.3%)	0.3-3.5	219 (95%)	7 (4%)	3/3 (100%)	-	1 (5%)	2 (1%)	0.180
Anti-HBs** >10 IU/l	50 (21.8%)								
-Vaccination	35/50 (70%)	16.8-27.5	172 (74%)	7 (4%)		-	10 (53%)	40 (19%)	<0.001
-Past infection	15/30 (30%)								
HCV**	17 (7.4%)	4.5-11.4	205 (90%)	4 (2%)	8/17 (47%)	-	11 (58%)	6 (3%)	<0.001
HCV-RNA**	11 (4.8%)	2.6-8.2	9 (4%)	1 (1%)	6/11 (55%)	205 (90%)	6 (32%)	5 (2%)	<0.001

*Unknown: Persons with either a finger prick sample or not enough material from venous sample, NA: Prisoners with a negative HCV test result where no HCV-RNA test was conducted. Anti-HBs: Antibodies to hepatitis B-surface antigen; anti-HBc: Antibodies to hepatitis B-core antigen; HBsAg: Hepatitis B-surface antigen; HCV-RNA: PCR to detect the genome of HCV. ** Chi-square test for difference in prevalence of IDU compared to non-IDU.

Table 3. Determinants of anti-HBc test results with risk factors of 226 prisoners.

Variable	Participant		Univariate analysis		Multivariate analysis		p-value
	Total, {N (%)}	Positives, {N (%)}	Unadjusted odds ratio	95% CI	Adjusted odds ratio	95% CI	
Age tertiles (Years)							
18-26	82(36)	4 (21)	1	-	1	-	0.887
27-37	67(30)	4 (21)	1.2	0.3-5.2	0.9	0.2-4.2	
> 37	77(34)	11 (58)	3.5	1.1-11.4	2.4	0.6-8.8	0.188
Cell							
Alone	168 (74)	16 (84)	1	-	-	-	
Together	58(26)	3 (16)	0.5	0.1-1.8	-	-	
Tattoo							
No	102 (45)	7 (37)	1	-	-	-	
Yes, only outside prison	91(40)	6 (32)	0.9	0.3-3.0	-	-	
Yes, also in prison	33(42)	6 (32)	3.4	1.0-10.9	-	-	
Blood transfusion <1992							
No	219 (98)	17 (89)	1	-	-	-	
Yes	5(2)	2 (11)	7.7	1.2-48.9	-	-	

Table 3. Contd.

Ever drug use							
No	102 (45)	5(5)	1	-	1	-	
Yes, hard drugs	105 (46)	6(6)	1.2	0.4-4.0	1.3	0.4-4.5	0.677
Yes, IDU	19 (9)	8 (62	25.6	6.4-102.6	23.7	5.6-99.6	<0.001
Methadone use							
No	189 (84)	11(58)	1	-	-	-	
Yes, ever	8(3)	2 (10)	6.4	1.1-36.8	-	-	
Yes, recent	29(13)	6 (32)	5.1	1.7-15.2	-	-	
MSM contact							
No	222 (99)	17(89)	1	-	-	-	
Yes	4(1)	2 (11)	11.7	1.5-87.9	-	-	

DU, Drug use; IDU; injecting drug use; Recent: < 12 months.

Table 4. Determinants of HCV test results with risk factors of 226 prisoners.

Variable	Participant		Univariate analysis		Multivariate analysis		p- value
	Total, {N (%)}	Positive, {N (%)}	Unadjusted odds ratio	95% CI	Adjusted Odds ratio	95% CI	
Age tertiles (years)							
18-26	82(36)	1 (6)	1	-	1	-	0.483
27-37	67(30)	3 (18)	3.8	0.4-37.5	2.4	0.2-29.1	
> 37	77(34)	13 (76)	16.8	2.1-131.7	11.8	1.2-113.2	0.032
Cell							
Alone	168 (74)	15 (88)	1	-	-	-	
Together	58(26)	2 (12)	0.4	0.8-1.6	-	-	
Drug use in prison							
No	145 (64)	6 (35)	1	-	-	-	
Yes, DU	76(34)	9 (53)	3.2	1.1-9.3	-	-	
Yes, IDU	5(2)	2 (12)	23.0	2.8-192.3	-	-	
Tattoo							
No	102 (45)	6 (36)	1	-	-	-	
Yes, only outside prison	91(40)	5 (30)	0.9	0.3-3.2	-	-	
Yes, also in prison	33(42)	6 (35	3.8	1.1-12.9	-	-	

Ever drug use							
No	102(45)	1 (6)	1	-	1	-	
Yes, hard drugs	105(46)	5 (29)	5.1	0.6-44.0	6.1	0.7-54.6	0.106
Yes, IDU	19 (9)	11 (65	183.3	20.2-1665.6	167.2	16.9-1655.5	<.0001
IDU duration (Years)							
1-16	7(3)	2 (12)	1	-	-	-	
16-31	11(5)	9 (53)	18.0	1.24-260.9	-	-	
Never IDU	208(92)	6 (35)	0.1	0.0-0.4	-	-	
Methadone use							
No	189(84)	3 (18)	1	-	-	-	
Yes, ever	8(3)	2 (12)	24.5	3.3-180.8	-	-	
Yes, recent	29(13)	12 (70)	46.0	11.8-180.0	-	-	
Sharing needles							
No sharing	8(3)	4	1	-	-	-	
Yes	11(5)	2	3.5	0.4-28.5	-	-	
No IDU	207(92)	199	0.0	0.0-0.2	-	-	
MSM contact							
No	222(99)	15 (88)	1	-	-	-	
Yes	4(1)	2 (12)	13.5	1.8-102.9	-	-	
Steady partner							
No	94(42)	11 (65)	1	-			
Yes	132(58)	6 (35)	0.4	0.1-1.0			

DU, Drug use; IDU, injecting drug use; recent: < 12 months.

antibody prevalence in the range of 2.0 to 10.7%. Although, that study was based on patient files only, and may have been subject to selective reporting (Leemrijse et al., 2010).

For HBV and HCV markers, we found univariate risk factors similar to those previously reported in literature, such as IDU, increasing age and tattooing (Allwright et al., 2000; EMCDDA, 2009; Poulin et al., 2007; Solomon et al., 2004; Weild et al., 2000). It is surprising that multivariate analyses did not show any association with tattooing. Furthermore, the prevalence of antibodies to hepatitis C increased with age. Similar studies have shown similar associations between higher age and HCV infection (Allwright et al., 2000; EMCDDA, 2009; Solomon et al., 2004; Weild et al., 2000).

Lastly, it is of note that we found rather low levels of risk behaviour like injecting drugs, sharing needles and syringes and male-to-male sex. Among prisoners who had ever injected drugs, prevalences were high and in line with those from previous surveys among IDUs (van den Berg et al., 2007).

Over half of the prisoners had ever used hard drugs and as only one in 5 were anti-HBs positive (>10 IU/L of plasma), vaccination against HBV would be beneficial for many prisoners. For hepatitis B-core antibody prevalences below 20%, vaccinating all inmates is cheaper than screening and subsequently vaccinating (Pisu et al., 2002). Vaccination could also be considered for those who are imprisoned for a short period (Pisu et al., 2002). While effort must be taken to ensure all three doses are received if people leave prison prior to completion of the vaccination schedule; other studies showed that even a limited set of hepatitis B vaccinations is likely to provide significant protection as well (Pisu et al., 2002; van der Sande et al., 2007). Finally, the need to increase the vaccination coverage in prison is underscored by the fact that the vaccination coverage was too low to show a protective association with HBV infection in our analyses.

In the Netherlands, IDUs are provided with a range of services that aims to reduce the harmfulness of their drug use. Opioid substitution treatment in the penitentiary in the southern part of the Netherlands is provided since 2003/2004 (Ministry of Justice, 2009). In the Netherlands, harm reduction interventions have proven to be effective (van den Berg et al., 2007).

Access to hepatitis C treatment remains low among Dutch prisoners. None of the HCV-RNA positive prisoners in our study were put on treatment. Reasons for this may include insufficient screening and treatment capacity, lack of information about treatment options, or low prioritisation of treatment of prisoners (EMCDDA, 2009). From both the individual and the public health perspective, it is important to reduce the burden of HCV infection. It is therefore essential to promote and expand access to testing and treatment for chronic carriers of the virus, since up to 30% of patients with untreated chronic hepatitis C infection will develop liver cirrhosis within 30 years (EMCDDA, 2009; National coordination for infectious diseases control, 2005).

Our study is one of the first Dutch cross-sectional studies that assessed the seroprevalence of blood-borne viruses among prisoners. While performed in a complex setting, the response rate was high. Although presenting results from a single-centre study limits generalisability, by selecting a prison in the previously identified epicentre of the HIV epidemic among IDUs, it is unlikely BBI are a larger problem in other prisons in the country. The study population in this prison was representative for general male prisoners in the Netherlands as demographics concerning age, ethnicity and the type of correctional facilities of our study population are comparable with the characteristics of all Dutch prisoners (Ministry of Justice, 2009). And, the majority (92%) of Dutch prisoners in general is male (Ministry of Justice, 2009). However, to get a completer picture of the burden of BBI among prisoners in the Netherlands, it is recommended to conduct future studies in other Dutch prison settings as well. Another limitation is the relatively low number of positive cases resulting in limited power to show statistically significant associations. Since we were not able to conduct phylogenetic analyses, we cannot judge whether infections where acquired and possibly transmitted inside prison. Finally, data was collected using self-administered questionnaires, which may have influenced the reliability. Though, several studies among drug users have underscored the trustworthiness of self-reported data, in particular on MSM and other sexual behaviour (Rotily et al., 2001; Upchurch et al., 1991; Weinhardt et al., 1998), and most have shown that drug use self-reporting is generally reliable (McElrath et al., 1994; Rotily et al., 2001).

In conclusion, while in our study no prisoners were tested HIV seropositive, the prevalences of HBV and HCV infections among these Dutch male prisoners were up to twenty times higher than in the general population. Infection rates among IDUs were significantly higher than among non-IDUs. This study indicated also high drug use and tattoo risk behaviour among prisoners. The predictors for both HBV and HCV were IDU, and older prisoners seem to be at higher risk of acquiring an HCV infection than the younger ones. Since many prisoners remained susceptible to HBV infection, vaccination coverage for HBV in prisoners should be further increased. In the light of the still relatively high prevalence of HBV and HCV infections, the prison setting may be especially appropriate for further preventive measures, such as HBV vaccination and case finding for HCV treatment in hidden populations. Reinforcing the control of BBI in prison would serve both the individual and society and is therefore of public health importance.

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Abbreviations: BBI, Blood-borne infections**; EMC,** Erasmus Medical Centre; **EMCDDA,** European monitoring Centre for Drugs and Drug Addiction; **HBV**, hepatitis B virus; HBsAg , hepatitis B-surface antigen; HBc, hepatitis B-core antigen; **HBs,** hepatitis B-surface antigen; **HCV**, hepatitis **C** Virus**; HIV,** human immunodeficiency virus; IDU, injecting drug use; **IDUs**, injecting drug users; **MSM**, men who have sex with men; **RIVM**, Rijksinstituut voor Volksgezondheid en Milieu (National institute for public health and the environment)

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