

## Prevalence, genotypes and factors associated with HCV infection among prisoners in Northeastern Brazil

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### Abstract

**AIM:** To determine hepatitis C virus (HCV) seroprevalence and its genotypes, and to identify the factors associated with HCV infection.

**METHODS:** This cross-sectional study, conducted in two prisons (one male and one female) in the State of Sergipe, Brazil, comprised 422 subjects. All of the prisoners underwent a rapid test for the detection of HCV antibodies. Patients with a positive result were tested for anti-HCV by enzyme linked immunosorbent assay and for HCV RNA by qualitative polymerase chain reaction (PCR). The virus genotype was defined in every serum sample that presented positive for PCR-HCV. In order to determine the factors independently associated with positive serology for HCV, multivariate logistic regression was used.

**RESULTS:** HCV seroprevalence was 3.1%. Of the 13 subjects with positive anti-HCV, 11 had viremia confirmed by PCR. Of these, 90.9% had genotype 1. A total of 43 (10.2%) were injecting drug users, and HCV seroprevalence in this subgroup was 20.6%. The variable most strongly associated with positive serology for HCV was use of injecting drugs [odds ratio (OR), 23.3; 95%

confidence interval (CI), 6.0-90.8]. Age over 30 years (OR, 5.5; 95%CI, 1.1-29.2), history of syphilis (OR, 9.8; 95%CI, 1.7-55.2) and history of household contact with HCV positive individual (OR, 14.1; 95%CI, 2.3-85.4) were also independently associated with HCV infection.

**CONCLUSION:** Most of the HCV transmissions result from parenteral exposure. However, there is evidence to suggest a role for sex and household contact with an infected subject in virus transmission.

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**Key words:** Hepatitis C; Prisoners; Drug abusers; Cross sectional analysis; Brazil

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### INTRODUCTION

Hepatitis C virus (HCV) is one of the main causes not only of chronic viral hepatitis, but also of cirrhosis and end-stage liver disease in the world<sup>[1]</sup>. Hepatitis C, given its treatment costs, high morbidity and mortality, generates a significant burden in healthcare systems. According to the World Health Organization, there are over 170 million people with chronic hepatitis C and approximately 3 to 4 million new cases each year<sup>[2]</sup>.

HCV seroprevalence in the general population has wide geographical variation. Studies performed in Brazil have shown an anti-HCV prevalence of 5.9% in the

Amazon region, 0.9% in the State of Rio de Janeiro and 0.34% in the State of Santa Catarina<sup>[3]</sup>.

There are six HCV genotypes, with several subtypes. For each genotype, there is a different pattern of treatment response and, consequently, a distinct therapeutic approach<sup>[4,5]</sup>. There is a wide geographical variation when it comes to genotype distribution, so that genotypes 1, 2 and 3 are more frequent in Europe, the USA and Japan; genotype 4 in central Africa, Egypt and the Middle East; genotype 5 in South Africa; and genotype 6 in Asia. Brazil in general has a higher prevalence of genotype 1, followed by genotype 3<sup>[6]</sup>.

Most HCV transmissions are due to parenteral exposure. It has been estimated that HCV is 10 times more infectious than HIV, per unit of blood, requiring less exposure to reach high prevalence<sup>[1]</sup>. Other routes have been described, such as sexual and vertical transmission, but these are less common than the parenteral one. Risk factors already proposed include use of injecting drugs (ID), tattoos, occupational blood exposure and hemodialysis<sup>[4,5]</sup>. It is important to highlight that HCV prevalence is higher in certain groups, such as prisoners<sup>[4]</sup>. Although these subjects represent only 0.8% of the American population, approximately 39% of the cases of chronic HCV infection have a history of imprisonment<sup>[7]</sup>. There are several international studies which determined hepatitis C prevalence in prisons, but studies in Latin America are scarce.

The following factors are related to higher prevalence of HCV in prisoners: duration of incarceration, use of ID, adverse socioeconomic situation and poor health care. Therefore, there is a potential public health issue, since the prison system works as a concentrator of hepatitis C subjects and a dissemination center of this infection. Risk behavior may precede imprisonment and continue afterwards<sup>[8,9]</sup>.

A large number of HCV carriers are asymptomatic and remain undiagnosed for a long time, resulting in further complications, such as liver cirrhosis, liver failure and hepatocellular carcinoma. These asymptomatic patients also represent a natural reservoir of the disease, and a source of dissemination<sup>[2]</sup>.

Prisons in the State of Sergipe, Brazil, do not currently screen for HCV and there are no statistics concerning HCV status of the prisoners incidentally diagnosed. Given the regional variation of HCV prevalence among prisoners, the lack of data in Sergipe and its importance in order to implement effective strategies to prevent HCV transmission, we conducted a study of the prevalence of HCV infection among prisoners, as well as HCV genotypes in viremic subjects, and factors associated with positive serology for HCV.

## MATERIALS AND METHODS

### Study population

This was a cross-sectional study performed in two prisons (one male and one female) in the State of Sergipe, Brazil. The study was conducted in the male prison in September

2009 and in the female one in February 2010. Subjects eligible for this study included all prisoners who agreed and signed the consent form.

### Data collection

Structured and individual interviews were privately conducted. Before the interview, it was explained that any collected information would be kept confidential. Subjects' names were not collected. Each questionnaire received a code number, in order to allow further connection to its respective blood sample, and was formed by closed questions, including sociodemographic characteristics and risk behaviors, such as the ones involving drug use and sexual practices, before and during the imprisonment.

### Blood sample collection

After the interviews, the subjects underwent a rapid test for the detection of HCV antibodies (kit HCV Rapid Test Bioeasy). Peripheral blood from those with a positive result in the rapid test was collected by a finger prick with a single use lancet. Then, six blood spots (two to confirm serology and four for molecular biology) were blotted onto high-quality filter paper (Schleicher & Scheull 903). For each circle, approximately three drops of blood were used. Afterwards, filter paper was left to dry at room temperature for 30 min or until the blood spot was completely dry. The material was kept in aluminum envelopes, along with a bag containing silica gel, and posted to Genoma Center. Only patients with positive anti-HCV had their results confirmed by qualitative polymerase chain reaction (PCR). Those with positive qualitative PCR had the HCV genotype determined.

### Statistical analysis

Continuous variables are reported as mean  $\pm$  SD, and analyzed using the Mann-Whitney *U* test. Categorical variables are presented as percentages and analyzed using Chi-square ( $\chi^2$ ) or Fisher's exact tests.  $P < 0.05$  were considered to be statistically significant. In order to identify parameters independently associated with positive serology for anti-HCV, a logistic regression model was determined. Variables with  $P < 0.1$  in univariate analysis were included in the multivariate analysis. Before indicating which variables would be inserted in the initial model, multicollinearity issues were solved. Backward selection of variables was performed, with entry and retention set at a significance level of 0.05. The discrimination capability of the final model was evaluated through the area under the ROC curve (AUC), and the goodness-of-fit of the logistic model was verified by the Hosmer-Lemeshow test ( $P > 0.05$ ). Variables that continued in the model were tested for possible interaction among them. Each interaction (between two variables) was individually tested and then added to the final model if they showed statistical significance. Statistical analyses were performed using the Statistical Package for the Social Sciences, version 17 (Chicago, IL, USA).

This study was approved by the Research Ethics Committee of the Federal University of Sergipe in April 2009

**Table 1** Characteristics of prisoners with positive serology for hepatitis C virus in Sergipe, Brazil

	<i>n</i> (total = 13 <sup>1</sup> )	%
Viremia (RNA)	11	84.6
Genotype		
1a	6	54.5
1b	1	9.1
1	3	27.3
3	1	9.1

<sup>1</sup>One patient refused to provide a blood sample for polymerase chain reaction.

**Table 2** Characteristics of 422 prisoners in Sergipe, Brazil

	<i>n</i> (total = 422)	%
Gender		
Male	303	71.8
Female	119	28.2
Age (yr)		
Mean (SD)	32.7 (8.8)	21.1
≤ 25	89	28.4
25-30	120	19.4
30-35	82	14.5
35-40	61	16.6
> 40	70	
Education level		
Uneducated	45	10.7
Less than high school	312	73.9
High school or more	65	15.4
Religion		
Catholic	238	56.4
Protestant	86	20.4
Other	98	23.2
Race		
White	141	33.5
Black	106	25.2
Multiracial	160	38.0
Other	14	3.3
Marital status		
Single	167	39.6
Married	117	27.7
Widowed	15	3.6
Stable union	111	26.3
Divorced	12	2.8
HCV seropositivity	13	3.1

HCV: Hepatitis C virus.

(N° CAAE 0038.0.107.000-09). Prison authorities did not have access to any questionnaires or blood samples.

## RESULTS

### Prevalence and genotypes

Of 382 men, 303 (79%) agreed to participate in the research, and of 137 women, 119 (87%) participated. All included subjects underwent the rapid test for the detection of antibodies to HCV, but one of the subjects with a positive result for this test did not provide a blood sample for qualitative PCR. HCV seroprevalence was 3.1%. From the 13 subjects with positive anti-HCV, eleven had confirmed viremia by PCR. Of these, 10 (90.9%) had genotype 1 (Table 1).

**Table 3** Characteristics of injecting drug users in prisoners in Sergipe, Brazil

	<i>n</i> (total = 43)	%
Drug		
Cocaine	21	48.8
Heroin	2	4.7
Benzylamine	12	27.9
Other	11	25.6
Duration of use (mean in years)	5.05 (5.7)	
Use in the last 2 mo	5	11.6
Started to use during imprisonment	3	7.0
Uses inside the prison	5	11.6
Needle sharing	14	32.6
Anti-HCV (+)	9	20.9

HCV: Hepatitis C virus.

### Subject characteristics

The mean age of the subjects was 32.7 ( $\pm$  8.8) years, and the most frequent age group was 25-30 years (28.4%). A total of 303 (72%) were men (recruited in the State Penitentiary of Arica Branca); and 119 (28%) were women (recruited in the Female Penitentiary of Sergipe). Seventy-two (60.5%) women and 39 (12.8%) men had drug dealing or drug use as the reason for imprisonment. Many of the subjects were multiracial (38%) and single (39.6%). More than half of the population declared themselves as Catholics (56.4%) (Table 2).

### Sexual practices and drug use

A total of 150 (35.5%) subjects reported previous sexually transmitted disease (STD), of which gonorrhea was the most frequently declared. Two hundred and forty-seven (58.5%) participants affirmed that they had paid or been paid for sex, and 109 (25.8%) rarely or never used condoms. Regarding drug use, 311 (73.7%) subjects had used illegal drugs, while 10.2% stated that they had used ID. Among ID users (IDU) ( $n$  = 43), 32.6% shared needles and syringes or other injecting equipment, 7% started injecting in prison and 11.6% continued injecting at the time of the interview. HCV seroprevalence among IDU was 20.6% (Table 3).

### Univariate analysis

As shown in Tables 4 and 5, we studied the association between serologic HCV status and sexual practices, drug use, sociodemographic and behavioral characteristics. Positive serology for HCV was significantly associated with the following characteristics: previous imprisonment; household contact with a HCV carrier; history of tattooing, though there was no significance considering only tattooing inside prison; previous syphilis; and use of illegal drugs, including inhaled cocaine, marijuana and ID. However, use of crack was not associated with HCV infection. Moreover, those with positive anti-HCV presented significantly higher mean age, higher mean CAGE score and higher mean duration of use of inhaled cocaine, marijuana and ID. There was no significant association between HCV and marital status (data not shown), gender, ethnicity, religion and sexual orientation. Rarely or never having

**Table 4** Socio-demographic and behavioral characteristics of 422 prisoners by serologic hepatitis C virus status, Sergipe, Brazil

Variable	HCV (-)	HCV (+)	P-value
Gender (male)	295 (72.1%)	8 (61.5%)	0.531
Mean age (yr)	32.56 (8.8)	36.77 (6.4)	0.019
Ethnicity (white)	137 (33.6%)	4 (30.8%)	0.833
Christian religion	314 (76.8%)	10 (76.9%)	0.990
Family income (R\$)	777 (1205)	684 (472)	0.923
Years of schooling (mean)	6.5 (5.4)	6.4 (2.9)	0.565
Mean incarcerated time (mo)	43.5 (40)	30.6 (30)	0.253
Previous imprisonment	139 (34.0%)	11 (84.6%)	< 0.001
History of alcohol use	298 (73.0%)	10 (73.9.0%)	0.756
CAGE (mean)	1.00 (1.2)	1.69 (1.2)	0.033
Household contact with HCV carrier	17 (4.2%)	4 (30.8%)	0.002
History of tattooing	244 (59.7%)	13 (100%)	0.003
Tattooing inside prison	110 (27.0%)	6 (46.2%)	0.202
History of piercing	39 (9.5%)	-	0.620
Previous blood transfusion	39 (9.5%)	-	0.620
Previously shared razors, toothbrushes, nail trimmers or scissors	241 (58.9%)	8 (61.5%)	0.850
Getting wounded by a sharp weapon in a struggle	129 (31.5%)	3 (23.1%)	0.762
Total	409 (96.9%)	13 (3.1%)	

HCV: Hepatitis C virus; CAGE: Cut down, Annoyed by criticism, Guilty e Eye-opener.

**Table 5** Sexual practices and drug use of 422 prisoners by serologic hepatitis C virus status, Sergipe, Brazil

Variable	HCV (-)	HCV (+)	P-value
Never or rarely used condom	103 (25.3%)	6 (46.2%)	0.109
Sexual orientation (Heterosexual)	315 (77.2%)	13 (100%)	0.081
Number of partners in the last year (mean)	2.44 (8.1)	2.54 (5.3)	0.594
Age at first sexual intercourse (mean in years)	14.54 (2.3)	15.00 (1.7)	0.456
Sexually transmitted diseases	144 (35.2%)	6 (46.2%)	0.557
History of genital herpes	6 (1.5%)	1 (7.7%)	0.198
History of syphilis	17 (4.2%)	3 (23.1%)	0.019
History of gonorrhea	109 (26.7%)	2 (15.4%)	0.528
Partner			
HCV (+)	4 (1.0%)	2 (15.4%)	0.012
Illegal drug user	223 (54.5%)	10 (76.9%)	0.110
Injecting drug user	24 (5.9%)	1 (7.7%)	0.553
Previous imprisonment	124 (30.3%)	5 (38.5%)	0.548
Ever paid or been paid for sex	242 (59.2%)	5 (38.5%)	0.136
History of illegal drug use	298 (72.9%)	13 (100%)	0.025
Inhaled cocaine	194 (47.4%)	11 (84.6%)	0.008
Duration of inhaled cocaine (mean in mo)	107.6 (273.1)	86.1 (80.3)	0.006
Marijuana	277 (67.7%)	13 (100%)	0.012
Duration of marijuana use (mean in mo)	129.5 (220.5)	198.5 (101.4)	0.002
Crack	129 (31.5%)	5 (38.5%)	0.561
Duration of crack use (mean in mo)	77.9 (254.1)	162.0 (371.9)	0.369
History of injecting drug use	34 (8.3%)	9 (69.2%)	< 0.001
Duration of injecting drug use (mean in mo)	26.1 (148.0)	261.2 (445.7)	< 0.001
Use of injecting drugs inside prison	5 (1.2%)	-	0.855
Ever shared needles and syringes or other injecting equipment	11 (2.7%)	3 (23.1%)	0.007
Total	409 (96.9%)	13 (3.1%)	

HCV: Hepatitis C virus.

used a condom, and a history of paying or being paid for sex were not associated with a higher HCV seroprevalence. An association was not observed between STD and HCV, except for syphilis. Regarding partner characteristics, the only variable that was significantly associated with HCV was a positive anti-HCV partner. Both groups (positive and negative anti-HCV) had similar mean duration of imprisonment, mean number of sexual partners in the last year, mean age at the time of the first sexual intercourse, mean family income and average years of education.

### Multivariate analysis

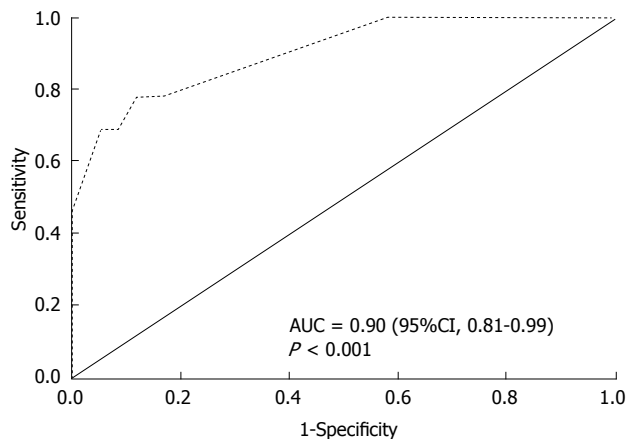
Multivariate logistic regression was performed using HCV status as the dependent variable. Among variables that presented collinearity issues (data not shown), the ones with greater clinical impact were chosen. Continuous variables were turned into dichotomous ones, using the receiver operating characteristic (ROC) curve to choose the cut-off point that presented the best discrimination capability. Table 6 shows the variables independently associated with positive serology for HCV, and the strongest



**Table 6** Multivariate logistic regression of characteristics associated with positive serology for anti-hepatitis C virus

Characteristic	Crude odds ratio	Adjusted odds ratio	95%CI	P-value
Injecting drug user	24.8	23.3	6.0-90.8	0.0000
History of household contact with HCV carrier	10.2	14.1	2.3-85.4	0.004
Previous syphilis	6.9	9.8	1.7-55.2	0.009
Age > 30 yr	5.6	5.5	1.1-29.2	0.043

Hosmer-Lemeshow test ( $P = 0.420$ ). HCV: Hepatitis C virus; CI: Confidence interval.



**Figure 1** Multivariate model receiver operating characteristics curve. AUC: Area under the curve; CI: Confidence interval.

association verified was between positive serology for HCV and use of ID (OR, 23.3; 95% confidence interval (CI), 6.0-90.8). The chance of presenting with positive anti-HCV was 14 times higher among subjects that had lived with an HCV carrier compared with those without this history, even after adjusting for other variables, such as use of ID. Age over 30 years and previous syphilis were also independently associated with positive serology for HCV. None of the tested interactions was statistically significant (data not shown). The Hosmer-Lemeshow test had  $P = 0.420$ , so the final model was considered to be adequate. Moreover, the area under the ROC curve was 0.90 (95%CI, 0.81-0.99;  $P < 0.001$ ), and the discrimination capability of the final model was considered to be good (Figure 1).

## DISCUSSION

To our knowledge, this is the first study to determine HCV seroprevalence, and factors associated with this infection in inmates in Northeastern Brazil. HCV seroprevalence observed in this research was 3.1%, which is higher than that found in the general population (1.14%)<sup>[4]</sup>. Nevertheless, this percentage is below expectation, especially if we consider the following aspects: the prevalence among prisoners described in other regions of Brazil or even in other countries; the absence of damage control programs in the evaluated prisons; and higher prevalence is expected in an already imprisoned population<sup>[10]</sup>. In Brazil, the studies conducted by Guimarães *et al.*<sup>[5]</sup>, Burattini *et al.*<sup>[8]</sup> and Coelho *et al.*<sup>[11]</sup> verified positive serology for HCV in 41%, 34% and 9% of inmates, respectively. Catalan-Soares *et al.*<sup>[12]</sup>,

in a study involving 63 prisoners, observed lower HCV seroprevalence (6.3%), but it was still twice that found in the present study. Moreover, Strazza *et al.*<sup>[9]</sup>, in a study in a Brazilian female prison, found an HCV seroprevalence of 16.2%. In the USA, in an incarcerated population, 16%-41% presented serological evidence of HCV infection, and approximately 12%-35% had chronic hepatitis C<sup>[7]</sup>. Experiences in Spain, England and France reported a prevalence of 48%, 30% and 30%, respectively<sup>[13]</sup>.

It is important to point out that, depending on the studied region, even inside one country, HCV seroprevalence presents a wide variation. HCV seroprevalence seems to increase along with the proportion of IDU. Vescio *et al.*<sup>[10]</sup>, in a meta-analysis, concluded that the most important source of heterogeneity among studies is the different proportion of IDU in each population. In addition, according to the same study, HCV seroprevalence among IDU also has an important influence on this heterogeneity. In our research, 10.2% of the inmates declared that they had already used ID. This proportion varies from 3% to 69% throughout the world<sup>[10]</sup>. Perhaps the explanation for the proportion of IDU not being as high as expected in our population is linked to the low percentage of imprisonments motivated by drug dealing or drug use, and also to other social and cultural characteristics not assessed in the present investigation.

It has been reported that HCV-RNA may be detected in 40%-90% of subjects with positive anti-HCV<sup>[2]</sup>. In our population, there was a high proportion of positive HCV-RNA-84.6% of the inmates with positive anti-HCV-that is, subjects capable of infecting others. This information corroborates the hypothesis that prisoners are important carriers of HCV and a potential source of transmission<sup>[7,13]</sup>, especially when many of them will return to society.

Genotyping of hepatitis C provides not only epidemiological data, but also information from the perspective of the therapeutic response. Treatment offers better results for genotypes 2 and 3<sup>[14]</sup>. Genotyping was performed in all 11 cases in which HCV-RNA was detected. We only identified genotypes 1 and 3, and genotype 1 was the most frequent (90.9%). Other studies also showed genotype 1 as the most frequent<sup>[14-18]</sup>, but always with a higher frequency of genotype 3 when compared with that in the present study.

There was no significant difference in HCV seroprevalence with respect to gender. Previous results in the medical literature are conflicting, in spite of one meta-analysis demonstrating a discreet predominance of positive anti-HCV among women<sup>[10]</sup>. However, this meta-analysis did not consider confounding variables that could be respon-

sible for such an association. One proposed confounding factor is the higher proportion of women incarcerated for drug dealing or drug use<sup>[19]</sup>. Regarding ethnicity, previous studies showed that Caucasians had a higher chance of presenting positive for anti-HCV<sup>[20,21]</sup>, but race did not influence the serological status in our population.

Age over 30 years was independently associated with positive serology for HCV, which was also observed in other studies<sup>[11,16,20]</sup>. This finding may be explained by a higher risk of exposure to HCV over the years. Guimarães *et al.*<sup>[5]</sup> found a different result, in which younger subjects had a higher chance of infection, but this finding might represent a local peculiarity.

Self-reported use of drugs, including ID, has been shown to be both valid and reliable<sup>[22]</sup>. Despite statistical significance in univariate analysis, inhaled cocaine did not remain in the final model. In the medical literature, HCV transmission through sharing materials used for inhaling cocaine remain controversial<sup>[23]</sup>. Use of ID remained in the final model and it was the factor most strongly associated with positive serology for HCV. This finding is consistent with those of other studies<sup>[9-11,20,24-28]</sup> and supports the effectiveness of HCV parenteral transmission. Use of ID during imprisonment has been reported by 3%-28% of inmates<sup>[7]</sup>. In the present study, only a minority of IDU (11.6%) referred to injecting inside prison. As previously mentioned<sup>[10]</sup>, difficulty in obtaining equipment for use of ID can lead to sharing, making HCV transmission easier. In our population, 32.6% declared that they shared needles, so a needle exchange program might be effective.

It has been demonstrated that HCV seroprevalence was three times higher in prisoners who had tattoos, when compared to those who did not<sup>[10]</sup>. In spite of observing an association between tattoos and HCV in univariate analysis, we did not identify an independent effect of this variable in HCV seroprevalence. In accordance with Hellard *et al.*<sup>[29]</sup>, in this study tattoos were strongly associated with use of drugs, presenting multicollinearity issues in multivariate analysis. However, it is important to point out that tattooing inside prison was not associated with positive anti-HCV, unlike previous findings<sup>[29]</sup>. Therefore, this might not be an important route of transmission in the studied population.

Other proposed routes of transmission do not seem to be relevant in the studied population. All of the subjects with positive anti-HCV denied a history of blood transfusion. Sharing personal care items and a history of getting wounded by a sharp weapon in a struggle occurred equally in prisoners in both groups-positive and negative anti-HCV.

It has been suggested that previous imprisonment would be associated with HCV infection<sup>[5]</sup>. Despite its significance in univariate analysis, this variable was not independently associated with a positive serology for HCV. Subjects with previous imprisonment, when compared to those without this background, had a higher proportion of IDU, and for this reason would present higher HCV seroprevalence. For IDU, imprisonment is a fairly com-

mon event, due to the illegality of their behavior or to crimes committed because of the high cost of drugs on the black market<sup>[30]</sup>.

Sexual transmission of HCV is controversial<sup>[10]</sup>. Some authors consider this route of transmission ineffective<sup>[31,32]</sup>, which is corroborated by the fact that use of condoms did not seem to protect the studied prisoners from HCV infection. An association between HCV and syphilis has been described<sup>[5,33,34]</sup> and we observed that a history of previous syphilis was independently associated with positive serology for HCV, even after adjustment for ID use and other confounding factors. Syphilis may be a marker of sexual promiscuity, but variables that evaluate this aspect, such as number of partners in the last year, other previous STD and having already paid or been paid for sex, were not associated with HCV infection. We suggest that HCV is not associated with STD in general, but with genital ulcers, inherent in syphilitic infection. As previously suggested<sup>[35]</sup>, blood containing HCV would penetrate more effectively through injured genital skin. Other studies corroborate the hypothesis of genital ulcers influencing HCV transmission<sup>[23,35]</sup>. Therefore, in spite of not being the main route, sexual transmission seems to have a role in this population.

Some studies<sup>[25,35]</sup> stated that homosexuality would lead to a higher chance of HCV infection. This association was not confirmed in our study. All the subjects with positive anti-HCV denied homosexual practices. This finding demonstrates that perhaps the association found in other studies might be related to risk behaviors, instead of homosexuality itself, which is in accordance with Fox *et al.*<sup>[26]</sup> and Mahfoud *et al.*<sup>[15]</sup>.

A previous partner infected by HCV and household contact with an HCV carrier were associated with positive serology for HCV. However, only household contact with an infected subject was retained in the final model. One possible explanation would be that, although both groups referred equally to sharing personal care items, household contact may lead to blood to blood contact by common use of such objects sporadically or in an unobserved manner.

Most HCV infections are acquired before imprisonment<sup>[10,36]</sup>, but transmission inside prisons has been reported<sup>[22,37]</sup>, which justifies implementation of prevention programs, especially in populations with a high proportion of susceptible subjects, such as the one in this study.

Our study has some limitations. This research included populations from two institutions, which makes external validity difficult for other populations in the world or even in other institutions in Northeastern Brazil. Some prisoners may not have answered some questions correctly, especially the ones concerning STD, chronological aspects and with legal implications, such as the use of ID inside prison. Strengths of the study include: a short period of data collection, showing the real HCV prevalence at that moment; interviews were conducted before test results were available, minimal ascertainment bias; and high sensitivity of the rapid test used, which avoids underestimation of HCV seroprevalence. It has been described that this test has both sensitivity and specificity close to 100%<sup>[38,39]</sup>.

The data shown corroborate the hypothesis that, in the studied prisoners, parenteral HCV transmission is the main route. However, there is evidence to suggest a role for sex and household contact in HCV transmission. This study demonstrated low HCV seroprevalence, with a high proportion of subjects having genotype 1. The large number of susceptible individuals in the studied population, the poor response of genotype 1 to antiviral treatment and the progress of chronic infection make prevention programs more important. It has been shown that treatment is cost-effective<sup>[40]</sup>, even in an imprisoned population<sup>[41]</sup>. Entering the prison system could be an opportunity to treat and break the transmission cycle. In addition, treatment adherence and side effects could be closely monitored.

Data on hepatitis C in Brazil are still scarce, so more epidemiological studies are necessary in order to guide and monitor prevention programs. We defend the offer of anti-HCV tests for those with a higher chance of infection, such as those with a previous history of syphilis, those aged over 30 years, IDU, or those who had lived with an HCV carrier, to improve the positive predictive value of the tests. This active research should be guided, if possible, by local studies. Even the ones not eligible for treatment may reduce transmission and progress to end-stage liver disease after receiving counseling.

## COMMENTS

### Background

Most studies have shown that hepatitis C virus (HCV) prevalence is higher in certain groups, such as prisoners. Duration of incarceration, use of injecting drugs, adverse socioeconomic situation and poor health care are related to higher prevalence of HCV in this population.

### Research frontiers

There is a wide regional variation of HCV prevalence among prisoners and studies that aimed to determine HCV prevalence in prisoners in Latin America are scarce. Most HCV transmission results from parenteral exposure, but other routes have been described. Sexual transmission is still controversial. There is a potential public health issue, since the prison system works as a concentrator of hepatitis C and a dissemination center of this infection. Many HCV carriers are asymptomatic and represent a natural reservoir of the disease, and a source of dissemination.

### Innovations and breakthroughs

The data shown corroborate the hypothesis that parenteral transmission is the main route. There is evidence to suggest the role of sexual and household contact in HCV transmission. Household contact may lead to blood to blood contact, by common use of personal objects sporadically or in an unobserved manner. This study also demonstrated a low HCV seroprevalence, probably due to the low proportion of injecting drug users.

### Applications

Since this study describes HCV prevalence in a regional prison, it may allow the development of strategies to guide and monitor prevention programs. Household contact with an infected subject must not be neglected, and, in the future, may be a risk factor to be considered in routine evaluation.

### Peer review

The obtained results show that most of the HCV transmissions are due to parenteral exposure and that transmission through sex and household contact with an infected subject play an important role. The paper is well written and the results appear to be well described and critically discussed (also in consideration of other studies).

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