

High Prevalence of Hepatitis C Virus Infection Among Immigrants From the Former Soviet Union in the New York City Metropolitan Area: Results of a Community-Based Screening Program

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BACKGROUND: Inadequate sterilization and reuse of medical equipment likely contributed to hepatitis C virus (HCV) transmission in the former Soviet Union (FSU). Although New York leads the nation in the number of immigrants from the FSU, the epidemiology of HCV infection has not been evaluated in this population. The aims of this study were to determine the prevalence of and risk factors for HCV infection among immigrants from the FSU in the New York metropolitan area.

METHODS: We conducted a 3-day community-based HCV screening program in the two boroughs of the New York metropolitan area with the highest density of FSU immigrants (Brooklyn and Queens). Russian cable television was used to invite subjects to come in for free HCV testing. In the last 2 days of screening, each person also completed an HCV risk factor questionnaire.

RESULTS: The overall prevalence of HCV seropositivity among the 283 subjects was 28.3% (95% confidence interval [CI] 23.0–33.5%). The prevalence of HCV infection was similar in men and women (30.3% vs 26.5%, $P = 0.48$) and was highest in subjects ≥ 70 yr old (35.0%). HCV seropositivity was 11.1% in immigrants from Russia, 29.0% from Uzbekistan, 31.0% from the Ukraine, and 36.8% from other regions. Intramuscular injections (odds ratio 9.1, 95% CI 2.0–42.4) and blood transfusions (odds ratio 3.2, 95% CI 1.2–9.0) were the only variables that were significantly associated with HCV infection in the multivariable analysis.

CONCLUSIONS: In this community-based screening program we found a high prevalence of HCV infection among immigrants from the FSU, and these infections likely resulted from inadequately sterilized medical equipment and blood transfusions. Universal HCV testing should be strongly considered for all FSU immigrants.

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INTRODUCTION

Hepatitis C virus (HCV) infection is a major public health problem worldwide. The World Health Organization estimates that approximately 3% of the world population is infected with HCV, and there are more than 170 million individuals with chronic HCV infection who are at risk for developing liver cirrhosis, decompensated liver disease, and hepatocellular carcinoma (1). According to the 1999–2002 National Health and Nutrition Examination Survey, an estimated 4.1 million of the U.S. civilian population have been infected with HCV, of whom 3.2 million have chronic HCV infection (2).

Injection drug use is the most common cause of HCV transmission in the United States (2, 3). In contrast, it is likely that inadequate sterilization and reuse of medical equipment contributed to HCV transmission in less developed countries

such as the former Soviet Union (FSU). Diagnostic and treatment procedures in hospitals were implicated as the source of HCV transmission in up to 59% of cases in certain regions of the FSU (4).

Immigrants from the FSU are increasing in number in the United States, and Census 2000 estimated that there are approximately 2.9 million immigrants from the FSU living in this country (5, 6). New York leads the nation in the number of FSU immigrants, with about 1.6 million residing in the New York City metropolitan area (5, 6). Despite the large number of immigrants from the FSU in the United States, the epidemiology of HCV infection has not been evaluated in this population. Therefore, we conducted a 3-day community-based study to evaluate the prevalence of and risk factors for HCV infection among FSU immigrants in the New York City metropolitan area. We hypothesized that the prevalence of HCV infection would be significantly higher in

immigrants from the FSU than in the general population of the United States.

METHODS

Study Population

We conducted a 3-day community-based HCV screening program in the two boroughs of the New York City metropolitan area with the highest density of FSU immigrants (Brooklyn and Queens). Russian cable television was used to invite subjects to come in for free HCV counseling and testing.

Subjects were excluded from this study if they refused HCV testing or if they were not an immigrant from the FSU. All persons provided written informed consent to undergo HCV testing. The study was reviewed and approved by the institutional review board at our medical center.

Study Design

Screening day 1 was conducted in Queens, NY. All eligible subjects seen on that day had HCV antibody testing performed (Ortho HCV ELISA version 3.0; Ortho-Clinical Diagnostics, Inc., Raritan, NJ). In addition, data were collected on age and sex.

Screening day 2 was conducted in Queens, NY, whereas screening day 3 was conducted in Brooklyn, NY. Similar to screening day 1, all participants seen on screening days 2 and 3 had HCV antibody testing performed. In addition, subjects with a positive HCV antibody test had alanine aminotransferase (ALT) levels measured, and viremia was confirmed by a quantitative HCV RNA assay that has a lower limit of detection of 615 IU/mL (VERSANT HCV RNA 3.0 Assay [bDNA], Bayer Diagnostics, Tarrytown, NY).

To evaluate risk factors for HCV infection among FSU immigrants, all subjects seen on screening day 2 and 3 also completed a self-administered demographic and HCV risk factor questionnaire. The questionnaire was designed by the investigators and was professionally translated into Russian. Data collected included age, sex, place of residence in the FSU, the year that they came to the United States, and alcohol use. Data were also collected on whether they were previously told that they had HCV infection and potential risk factors for HCV infection, including having a career as a health-care professional, hospitalizations, intramuscular injections, blood transfusions, hemodialysis, surgery, injection or other drug use, tattoos, body piercing, and number of lifetime sexual partners. All questionnaires were reviewed for completeness prior to the subjects leaving the testing site.

Study Outcomes

The primary outcome being evaluated was the prevalence of HCV antibody positivity in immigrants from the FSU in the New York City metropolitan area. The secondary outcomes of this study included risk factors for HCV infection, the proportion of HCV antibody positive subjects who were viremic,

and the proportion of HCV antibody positive individuals who had elevated ALT levels (≥ 40 U/L). For all secondary outcomes, only subjects seen on screening day 2 and 3 were included because these data were not collected on screening day 1.

Statistical Analysis

Continuous variables were compared using the unpaired 2-tailed *t*-test or the Mann-Whitney U test. Data are expressed as mean \pm SD for those variables that were normally distributed and median and interquartile range (25th–75th percentile) for those with a nonnormal distribution. Categorical variables are expressed as proportions and were compared using the χ^2 test or Fisher's exact test.

Univariate analyses were utilized to identify those variables that were significantly associated with HCV seropositivity. Subsequently, a backwards stepwise multivariable logistic regression model was created using all statistically significant variables that were identified in the univariate analyses. For each variable that was associated with HCV seropositivity in the multivariable models, the odds ratio (OR) and 95% confidence interval (CI) were calculated. Statistical analysis was performed using SPSS software version 15.0 for Windows (SPSS Inc., Chicago, IL) and a 2-tailed *P* value of <0.05 was considered statistically significant.

RESULTS

Demographic Characteristics

In total, 283 subjects were eligible for this study, including 186 seen on screening day 1, 30 seen on screening day 2, and 67 seen on screening day 3. The mean age of the 283 subjects was 51.9 ± 15.7 yr, and 116 (41.0%) were less than 50 yr of age. Overall, 151 (53.4%) of the 283 participants were female.

Prevalence of HCV Infection

The overall prevalence of HCV antibody seropositivity among the 283 subjects was 28.3% (95% CI 23.0–33.5%). The frequency of HCV antibody seropositivity was 28.5% on screening day 1, 30.0% on screening day 2, and 26.9% on screening day 3 ($P = 0.95$).

As shown in Figure 1, the prevalence of HCV antibody seropositivity was highest in the 40 individuals who were 70 yr of age and older (35.0%), although the age-specific difference was not statistically significant. In addition, we found that there was no difference in the prevalence of HCV infection between men and women (Fig. 1).

Among the 97 subjects seen on the second and third screening days, seven individuals reported that they were told that they had HCV infection in the past. Of these seven individuals, four were HCV antibody positive and three were HCV antibody negative when they were tested for this study. Exclusion of the seven individuals who were told that they had HCV infection in the past from the analysis slightly lowered

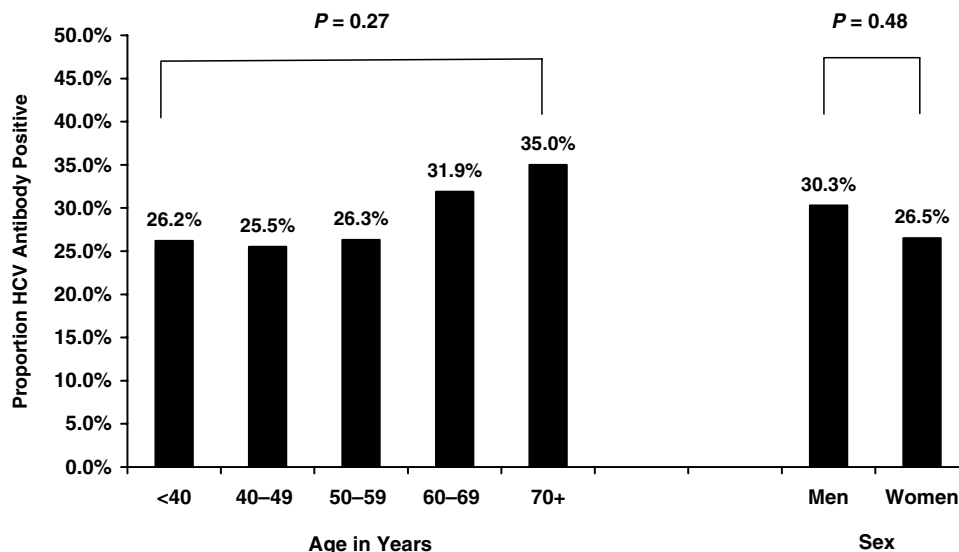


Figure 1. Prevalence of HCV antibody seropositivity among the 283 study subjects stratified according to age and sex.

the combined prevalence of HCV seropositivity on day 2 and 3 from 27.8% to 25.6%.

Risk Factors for HCV Infection

Detailed demographic and risk factor data were obtained from the 97 subjects seen on the second and third screening day (Table 1). There were slightly more women than men who were tested on these days, and a majority of individuals were from the Ukraine or Uzbekistan. There was a high frequency of prior hospitalizations, intramuscular injections, blood transfusions, and surgical procedures while in the FSU. In contrast, drug use was very uncommon.

To determine factors that were associated with HCV seropositivity, we evaluated the proportion of subjects who were HCV antibody positive according to select demographic and clinical characteristics (Table 2). In the univariate analysis, prior hospitalizations, intramuscular injections, blood transfusions, and surgeries were significantly associated with being HCV antibody positive. However, intramuscular injections (OR 9.1, 95% CI 2.0–42.4) and blood transfusions (OR 3.2, 95% CI 1.2–9.0) were the only variables that remained independently associated with HCV infection in the multivariable analysis.

Prevalence of HCV Viremia and Elevated ALT Levels

Among the subjects seen on screening day 2 and 3 who were HCV antibody positive, 66.7% (95% CI 47.7–85.7%) were viremic by bDNA assay and had chronic HCV infection. Therefore, the overall prevalence of chronic HCV infection among the 97 individuals who were seen on the second and third screening days was 18.6% (95% CI 10.7–26.4%). Among viremic subjects, the median HCV RNA level was 525,994 IU/mL (interquartile range 153,920–1,458,660 IU/mL).

Of the HCV antibody positive subjects who were seen on screening day 2 and 3, the median ALT level was 39.0 U/L (interquartile range 16.0–64.0 U/L), and ALT levels were elevated in 48.1% (95% CI 28.0–68.3%) of individuals. Of the HCV antibody positive subjects, elevated ALT levels were significantly more common in viremic subjects than in those who were not viremic (66.7% vs 11.1%, $P = 0.01$).

Table 1. Demographic and Clinical Characteristics of the 97 Subjects Who Were Seen on Screening Day 2 and 3

Characteristic	Value
Age (yr)*	50.0 ± 17.2
Male	48.5%
Place of origin	
Russia	18.6%
Ukraine	29.9%
Uzbekistan	32.0%
Other	19.6%
Number of years in the United States [†]	10.0 (6.0–14.0)
Health-care professional [‡]	10.3%
Ever hospitalized [‡]	59.8%
Ever had intramuscular injections [‡]	63.9%
Ever had a blood transfusion [‡]	28.9%
Ever had hemodialysis [‡]	2.1%
Ever had surgery [‡]	63.9%
Ever used drugs	2.1%
Ever had a tattoo [‡]	9.3%
Ever had a body piercing [‡]	48.5%
Number of lifetime sexual partners	
0–1	39.2%
2–9	38.1%
10 or more	22.7%
Current alcohol use	
None	53.6%
1–2 drinks/day	36.1%
3 or more drinks/day	10.3%

*Data expressed as mean ± SD.

[†]Data expressed as median (25th–75th percentile).

[‡]Subjects were asked to respond to these questions for the time period when they were living in the former Soviet Union or any of the post-Union Republics.

Table 2. Frequency of HCV Antibody Seropositivity in the 97 Subjects Who Were Seen on Screening Day 2 and 3 According to Select Demographic and Clinical Characteristics

Characteristic	Number of Subjects Tested	Number of Subjects HCV Antibody Positive (%)	P Value
Age (yr)			0.87
<40	32	28.1	
40–49	16	31.3	
50–59	19	21.1	
60–69	16	25.0	
70 and older	14	35.7	
Sex			0.39
Women	50	24.0	
Men	47	31.9	
Place of origin			0.33
Russia	18	11.1	
Ukraine	29	31.0	
Uzbekistan	31	29.0	
Other	19	36.8	
Number of years in the United States			0.49
<10	45	24.4	
≥10	52	30.8	
Health-care professional*			0.72
No	87	28.7	
Yes	10	20.0	
Ever hospitalized*			0.007
No	39	12.8	
Yes	58	37.9	
Ever had intramuscular injections*			<0.001
No	35	5.7	
Yes	62	40.3	
Ever had a blood transfusion*			0.002
No	69	18.8	
Yes	28	50.0	
Ever had hemodialysis*			0.48
No	95	27.4	
Yes	2	50.0	
Ever had surgery*			0.03
No	35	14.3	
Yes	62	35.5	
Ever used drugs			0.48
No	95	27.4	
Yes	2	50.0	
Ever had a tattoo*			0.26
No	88	26.1	
Yes	9	44.4	
Ever had a body piercing*			0.35
No	50	32.0	
Yes	47	23.4	
Number of lifetime sexual partners			0.67
0–1	38	28.9	
2–9	37	21.6	
10 or more	22	36.4	
Current alcohol use			0.44
None	52	32.7	
1–2 drinks/day	35	20.0	
3 or more drinks/day	10	30.0	

*Subjects were asked to respond to these questions for the time period when they were living in the former Soviet Union or any of the post-Union Republics.

DISCUSSION

The principal finding of this community-based screening study was the extraordinarily high prevalence of HCV infection among FSU immigrants in the New York City metropolitan area. The 28.3% prevalence of HCV infection in our subjects is over 17 times greater than the 1.6% prevalence reported among the general population of the United States (2). Furthermore, the high prevalence of HCV infection in this population is striking, given the low frequency of prior injection drug use. These findings have important public health implications for the large number of immigrants from the FSU who reside in the United States.

The prevalence of HCV infection in the FSU is not clearly established and varies considerably among different populations and geographic regions. High seroprevalence rates of HCV infection in Uzbekistan were reported by Ruzibakiev *et al.* (7), with prevalences of 6.4% among blood donors, 25.4% in high-risk patient groups, and 62.7% in injection drug users. A recent report of serological screening in 1,269 subjects in Uzbekistan also revealed a HCV prevalence of 6.5% in the general population, 27.1% in patients (subjects with acute and chronic liver diseases, tuberculosis, and hematological disorders), and 51.7% among injection drug users (8). A high prevalence of HCV infection in the FSU and marked regional differences in HCV seroprevalence rates have also been noted by other investigators (9–12).

However, significantly lower HCV prevalence rates were reported by Naoumov (4) in volunteer blood donors in the Ukraine (2.3%) and Russia (1.6%), and even lower seroprevalence rates (0.93%) were reported among 10,682 volunteer blood donors in the Russian Republic of Dagestan (13).

In the present study, we found that the prevalence of HCV infection varied according to geographic region, with the prevalence being highest in immigrants from the Ukraine (31.0%), Uzbekistan (29.0%), and other regions of the FSU (36.8%), and lowest in those from Russia (11.1%). The reasons for the wide variability in the prevalence of HCV infection in different regions of the FSU is unknown but is likely because of regional differences in the quality of health-care services provided (14).

In contrast to the large number of studies that have evaluated HCV infection in the FSU, very little is known about the epidemiology of HCV infection among immigrants from this region. Among blood donors in Israel, the highest prevalence of HCV infection was found among those born in the FSU and Eastern Europe (15). A study by Glikberg *et al.* (16) evaluated the prevalence of HCV infection among 102 immigrants from the Asian Republics of the FSU in Israel. The HCV seropositivity rate in that study was 26.5%, and this was remarkably similar to the 28.3% that we found among our 283 FSU immigrants in the New York City metropolitan area.

In addition to the high prevalence of HCV infection, we also found that intramuscular injections and blood transfusions were independently associated with HCV seropositivity. Intramuscular injections are currently not a major risk factor for HCV transmission in developed countries such as the United States, although they may have been a risk factor for transmission of viral hepatitis in developed countries many decades ago. For example, a 1945 memorandum from the United Kingdom Ministry of Health concluded that hepatitis following injection treatment was “communicated by traces of blood transferred on syringes and needles from patient to patient” (17). After decades of awareness of the risks related to nonsterile injections, the policy of “one sterile syringe and needle for each patient” was eventually adopted widely by the medical community in industrialized countries, and the subsequent introduction of disposable syringes reduced HCV transmission even further (14).

In contrast to developed nations, the general population in developing countries continues to be at a high risk of acquiring blood-borne diseases from nonsterile medical injections, and medical injections have been identified as a major risk factor in outbreaks of blood-borne infectious diseases (14, 18–22). The World Health Organization estimates that the annual worldwide incidence of infections that are attributable to nonsterile medical injections is an astounding 8.0–16.0 million for hepatitis B virus infection, 2.3–4.7 million for HCV infection, and 80,000–160,000 for human immunodeficiency virus infection (18). The strong association between intramuscular injections and HCV infection among our subjects is not surprising because of the high prevalence of blood-borne infections (*e.g.*, hepatitis B virus, HCV, and human immunodeficiency virus), the tremendous popularity and overuse of injectable therapy, and the high proportion of these injections that are nonsterile in developing countries (14, 18–22).

The strengths of our study include the prospective study design, the community-based setting, and the collection of detailed demographic and risk factor data. Although HCV infection has been identified by public officials and administrators in New York City as a major public health problem among immigrants from the FSU (23), we are unaware of any previous studies that have evaluated the prevalence of and risk factors for HCV infection among FSU immigrants in New York City or elsewhere in the United States.

Nonetheless, there are several important limitations of this study that should be considered when interpreting our findings. First, the study was conducted in Brooklyn and Queens in New York, and the immigrant population in these boroughs may differ from immigrants from the FSU who reside in other geographic locations. Second, there is the potential for selection bias because subjects identified in an advertised screening program may not reflect the population as a whole. Therefore, our findings may not be generalizable to all FSU immigrants in the United States.

Third, there is the possibility that some individuals who suspect or know they are infected with HCV may volunteer for testing, and this may overestimate the prevalence of HCV

infection in this population. Although a small number of our subjects did report that they were told that they had HCV infection in the past, this did not have a substantial impact on the seroprevalence of HCV infection.

Fourth, we only collected risk factor data on subjects seen on the second and third screening days, and therefore the number of individuals with risk factor data was relatively small. Fifth, data on HCV viremia were only available on HCV antibody positive subjects seen on the second and third screening days and we did not perform genotype testing because of financial constraints. Finally, the VERSANT HCV RNA 3.0 Assay, which is a bDNA assay, was used to determine viremia in those subjects with positive HCV antibody. Since the lower limit of HCV detection of this assay is 615 IU/mL, it is possible that we may have underestimated the number of HCV antibody positive subjects who were viremic because subjects with very low HCV RNA levels could have been misclassified as nonviremic. Although our findings have important public health implications, these limitations highlight the need for large, well-designed studies to evaluate the epidemiology of HCV infection in this population.

In conclusion, this community-based HCV screening program identified a high prevalence of HCV infection among FSU immigrants in the New York City metropolitan area, and it is likely that the use of inadequately sterilized medical equipment and blood transfusions were the primary modes of HCV transmission in this population. Given the high prevalence of HCV infection among immigrants from the FSU, our findings suggest that universal HCV testing should be strongly considered in this population. Finally, the increased availability of sterile injection equipment, routine HCV testing of blood products, and strict adherence to aseptic techniques in developing countries should help to reduce the worldwide public health epidemic of HCV infection.

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STUDY HIGHLIGHTS

What Is Current Knowledge

- The prevalence of hepatitis C virus (HCV) infection is greater in developing countries than in industrialized nations.
- Inadequate sterilization and reuse of medical equipment likely contributed to HCV transmission in the former Soviet Union.

- Although New York leads the nation in the number of immigrants from the former Soviet Union, the epidemiology of HCV infection has not been evaluated in this population.

What Is New Here

- The prevalence of HCV seropositivity among immigrants from the former Soviet Union who reside in the New York City metropolitan area is 28.3%.
- Intramuscular injections and blood transfusions while living in the former Soviet Union were the only independent risk factors for HCV seropositivity.
- The findings of this study suggest that universal HCV testing should be considered for all immigrants from the former Soviet Union.

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CONFLICT OF INTEREST

Guarantor of the article: Edmund J. Bini, M.D., M.P.H.

Specific author contributions: Steven Batash: conception and design of the study, analysis and interpretation of data, critical revision of the article for important intellectual content, final approval of the article, provision of patients, obtaining of funding, administrative and logistic support, collection and assembly of data; Inessa Khaykis: analysis and interpretation of data, drafting of the article, critical revision of the article for important intellectual content, final approval of the article, collection and assembly of data; Robert F. Raicht: conception and design of the study, analysis and interpretation of data, critical revision of the article for important intellectual content, final approval of the article, obtaining of funding; Edmund J. Bini: conception and design of the study, analysis and interpretation of data, drafting of the article, critical revision of the article for important intellectual content, final approval of the article, statistical expertise, obtaining of funding, collection and assembly of data.

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