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Surveillance of HIV, Hepatitis B Virus, and Hepatitis C Virus in an Estonian Injection Drug–Using Population: Sensitivity and Specificity of Testing Syringes for Public Health Surveillance

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Abstract

Surveillance of bloodborne infections among injection drug users (IDUs) can be accomplished by determining the presence of pathogen markers in used syringes. Parallel testing of returned syringes and venous blood from IDUs was conducted to detect antibodies to human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV). Syringe surveillance for HIV yielded a sensitivity and specificity of 92% and 89%, respectively, and provided a reasonable estimate of the prevalence of HIV among participants. Because sensitivity for HBV (34%) and HCV (55%) was low, syringe testing may be useful for surveillance of hepatitis over time but not for estimation of prevalence.

Injection drug use is a major risk factor for HIV infection worldwide and is the primary cause of eastern Europe's rapidly increasing rate of HIV infection [1]. The most dramatic expansion of the HIV/AIDS epidemic in the 1990s occurred in Estonia; during this period, this Baltic state had both the highest incidence of HIV infection in the world and the highest prevalence (1.5%) in the European region [2]. The expansion of Estonia's HIV/AIDS epidemic was primarily driven by an increase in injection drug use [3].

As is common in injection drug use–mediated HIV epidemics, the increase in the incidence of HIV infection in Estonia was preceded by an increased incidence of hepatitis B virus (HBV) and hepatitis C virus (HCV) infections. Between 1994 and 1997, there was an almost 5-fold increase in the number of people infected with HBV and HCV [3]. From a public health perspective, disease surveillance is particularly important among sentinel populations,

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such as injection drug users (IDUs), if one is to understand the patterns of transmission of bloodborne pathogens. Because existing HIV surveillance systems do not accurately report bloodborne infections in many countries, studies testing syringes used by IDUs have been conducted in regions where drug use is a major mode of transmission [4,5]. Additionally, residue from syringes has been analyzed to determine the effectiveness of prevention programs targeting drug users [6,7] and to assess the risk of acquiring the virus in injection venues [8]. Finally, the method has been evaluated in several studies, using a laboratory simulation approach: collecting blood from persons known to be positive for HIV, HBV, or HCV and aliquoting it to syringes for subsequent testing [7,9,10]. The purpose of the present study was to assess the validity of the syringe surveillance method by conducting parallel testing of returned syringes and venous blood from IDUs in harm-reduction programs.

Methods

Study activities took place at 2 syringe exchange programs in Tallinn, the capital of Estonia. Site 1 was NGO Convictus, located at the city center. In 2004, this program had >13,500 visits and distributed >92,800 sterile syringes. Site 2 was NGO AIDS Support Center, located in the northern part of the city. In 2004, this program had >4100 visits and distributed >33,000 sterile syringes [11].

Between February and August 2004, 200 IDUs aged ≥18 years who used the syringe exchange program's services were approached and asked to participate in the study; 162 (81%) participated in the study. Potential participants were approached at both sites on 2 days weekly during the first 3 h of operation. The study was described in private to each potential participant in that person's preferred language (i.e., Estonian or Russian), and the person was screened for eligibility (age ≥18 years, use of needle exchange, not previously enrolled). The study procedures were approved by the institutional review board at State University of New York Downstate Medical Center and by the ethics board at University of Tartu.

Consenting participants completed an anonymous, interviewer-administered questionnaire (based on the Family Health International Questionnaire for IDUs [12]); provided a blood sample for testing for HIV, HBV, HCV, and syphilis; and returned used syringes for testing. Information was collected about each returned syringe to determine who used the syringe (i.e., single use vs. shared). At the end of study, respondents were offered a direct referral to voluntary counseling and HIV testing. Additionally, participants received a food coupon worth approximately €7.

Residue from used syringes and needles was extracted using a 50-μL wash buffer solution pipetted into a microcentrifuge tube [9]. The procedure involved drawing the wash solution from the bottom of the microcentrifuge tube through the needle into the syringe and slowly expelling it. The process was repeated 3 times. If a study participant returned >1 syringe, the extracts from all syringes were pooled.

Material from the wash solution (residue from used syringes) and blood (serum) drawn from participants were tested by EIA. The following commercially available test kits were used to test for HIV, HBV, and HCV infection markers: hepatitis B surface antigen (HBsAg) (IMx HBsAg [V2]; Abbott), antibody to hepatitis B core antigen (HBcAg) (HBV CORE IgM; Abbott), HCV (HCV version 3.0; Abbott), and HIV (HIV-1/HIV-2 III Plus; Abbott). Nontreponemal rapid plasma reagin test for syphilis was used (Omega Diagnostics).

Descriptive statistics for the participants—mean and SD for continuous variables, percentages and frequencies for categorical variables—were computed. Sensitivity, specificity, and predictive value estimates of the residue from used syringes were calculated

relative to the results obtained by testing of serum. These values were calculated for all syringe extracts, including those from shared syringes. Approximate 95% confidence intervals for these characteristics were obtained using the normal approximation for binomial proportions. The software package R (version 2.0.1; available at: http://www.r-project.org/) for Windows was used for statistical analysis.

Results

The 162 participants ranged in age from 18 to 52 years (median, 23 years), with 67% of the entire sample <25 years old. The majority (84%) of the respondents were male, and 92.7% were not ethnic Estonians (82.2% were ethnic Russians, and 10.5% were members of other Russian-speaking ethnic groups). Almost all respondents (88.9%) were born in Estonia. The majority (70.4%) of participants had never been married. Close to the half of the respondents reported no monthly income (42.7%), and 6.7% earned less than the state-estimated subsistence minimum (approximately €93).

The majority of participants, 86% (139), reported using a sterile needle for injection, whereas 10.5% (17) indicated they used a shared syringe and 14.8% (24) used shared paraphernalia (such as water, cooker, or cotton). Syringe distribution was reported at a higher rate: 19.1% (31) reported giving away a used syringe, and 23.5% (38) passed along other paraphernalia.

Altogether, 289 syringes were provided by 162 participants: 1 syringe by 146 participants, 2 syringes by 9 participants, and ≥5 syringes by 5 participants. Three participants were excluded because they did not return a syringe or provide a blood sample. We used self-reports from IDUs to identify whether syringes were shared: 130 of 159 participants reported single use of the returned syringe(s).

The prevalence of HIV infection among participants was 56% (89/159). Results of serological testing for hepatitis were as follows: 85.1% (131/154) tested positive for antibodies to HBcAg, 21.3% (33/155) tested positive for HBsAg, and 96% (153/159) tested positive for antibodies to HCV.

Testing results for syringe extracts appear in table 1. Antibodies to HIV were found most often (56.6% of syringes), followed by antibodies to HCV (52.8%), antibodies to HBcAg (29.6%), and HBsAg (19.0%). When analysis was restricted to the extracts from the 130 unshared syringes, the percentage of positive results was generally lower but not significantly different from data for shared syringes. Results from pooled extracts were not significantly different from those of single-use syringes, and no pattern in terms of higher or lower prevalence was observed.

Sensitivity and specificity of all syringe extracts compared with blood drawn from IDUs were very good for HIV (92.1% and 88.6%, respectively) but poorer for HBV (34.4% and 86.1%, respectively, for HBsAg) and HCV (54.9% and 83.3%, respectively) (table 2). When the analysis excluded shared syringes, the results were similar (data not shown).

Discussion

Injection drug use plays a central role in HIV transmission in eastern Europe and central Asia. A viable surveillance system will provide the opportunity for ongoing monitoring of the epidemic and focused intervention efforts. Given the stigma associated with serological testing, syringe testing provides an opportunity for more-widespread public health monitoring of the HIV epidemic among IDUs. This study builds on previous studies by validating the use of syringe testing as part of an HIV surveillance system [13,14].

The prevalence of virus markers was generally higher in shared syringes, as might be expected given the higher risk of bloodborne viral infections. Because this study was not powered to measure the likelihood that sharing syringes increases one's risk of acquiring bloodborne viruses, the finding merits further investigation to understand its implications for monitoring infection trends.

The sensitivity for HBV and HCV was low. Previous work has demonstrated that EIAs for detecting HIV in syringe residues are much more sensitive than are those used to detect HBV and HCV [10]. Successful application of syringe surveillance techniques to HBV and HCV may be improved if the contents of single syringes are not divided to conduct multiple tests. Although a good surveillance system does not necessarily need to be highly sensitive [15], clearly delineated and consistent methods for case finding and diagnosis are particularly important when sensitivity is low. More work will need to be done if syringe testing for hepatitis surveillance is to become a reliable tool for public health professionals.

Sensitivity and specificity estimates for HIV were high, at ~90% for syringes exchanged at the study syringe exchange programs. Regardless of whether individual use or multiperson use of syringes was considered, the syringe testing method provided a reasonable estimate of HIV prevalence among participants. With a finding of a >90% positive predictive value for syringe surveillance, this study demonstrates that syringe testing may be used to unobtrusively monitor trends in the HIV epidemic and to determine the effectiveness of prevention programs such as syringe exchange.

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Table 1

Prevalence of markers for bloodborne viruses in returned syringes.

Marker	Unshared syringes (*n* = 130)	Shared syringes (*n* = 29)	All syringes (*n* = 159)
HIV	72 (55.7)	18 (62.1)	90 (56.6)
HCV	66 (50.8)	18 (62.1)	84 (52.8)
HBcAg	39 (30.0)	8 (27.6)	47 (29.6)
HBsAg	23 (17.8)	7 (24.1)	30 (19.0)

NOTE. Data are no. (%) positive. HBcAg, hepatitis B core antigen; HBsAg, hepatitis B surface antigen; HCV, hepatitis C virus.

Table 2

Sensitivity, specificity, and positive predictive value for detection of markers of bloodborne infection, using residual material testing from returned syringes (n = 159).

Measure	HIV	HBcAg	HBsAg	HCV
Sensitivity	92.1 (84.5–96.8)	33.6 (25.6–42.4)	34.4 (18.6–53.2)	54.9 (46.7–62.9)
Specificity	88.6 (78.7–94.9)	91.3 (72.0–98.9)	86.1 (78.6–91.7)	83.3 (35.9–99.6)
Positive predictive value	91.1 (83.2–96.1)	95.7 (85.2–99.5)	39.3 (21.5–59.4)	98.8 (93.6–100)

NOTE. Data are percentages (95% confidence intervals). HBcAg, hepatitis B core antigen; HBsAg, hepatitis B surface antigen; HCV, hepatitis C virus.