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, 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, inter-
Table 1. Prevalence of markers for blood-borne viruses in returned syringes.

<table>
<thead>
<tr>
<th>Marker</th>
<th>Unshared syringes (n = 130)</th>
<th>Shared syringes (n = 29)</th>
<th>All syringes (n = 159)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIV</td>
<td>72 (55.7)</td>
<td>18 (62.1)</td>
<td>90 (56.6)</td>
</tr>
<tr>
<td>HCV</td>
<td>66 (50.8)</td>
<td>18 (62.1)</td>
<td>84 (52.8)</td>
</tr>
<tr>
<td>HBcAg</td>
<td>39 (30.0)</td>
<td>8 (27.6)</td>
<td>47 (29.6)</td>
</tr>
<tr>
<td>HBsAg</td>
<td>23 (17.8)</td>
<td>7 (24.1)</td>
<td>30 (19.0)</td>
</tr>
</tbody>
</table>

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 blood-borne infection, using residual material testing from returned syringes (n = 159).

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

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