Discarded Needles Do Not Increase Soon After the Opening of a Needle Exchange Program

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This study examines the effect of a Needle Exchange Program (NEP) on the quantity and geographic distribution of discarded needles on the streets of Baltimore, Maryland, and presents methods to survey discarded needles in the community. A random sample of 32 city blocks located within high-drug-use census tracts, stratified by east and west sides of the city and by proximity to the NEP, was selected for survey. Three teams surveyed the number of needles and the number of drug vials and unbroken glass bottles ("trash") to control for practice effects. Surveillance was conducted prior to initiation of the NEP in August 1994 and 1 and 2 months thereafter. Over the three study periods, the absolute count of discarded needles was 106,130, and 128, respectively; the number of vials and bottles was 3,048, 3,825, and 3,796, respectively. The initial nonstatistically significant increase in needles (mean change = 0.38, 95% confidence interval (CI) −0.18 to 0.93) was offset by accounting for background trash. Regression models fitted with the generalized estimating equation method, which accounted for within-block correlation over time, showed no significant increase in the number of needles after adjustment for trash during the first 2 months of the NEP’s operation. These data suggest that the initiation of NEPs does not result in an increase in the number of discarded needles on the street. Am J Epidemiol 1997;145:730–7.

Injection drug users (IDUs) are at high risk for the acquisition of blood-borne pathogens, including human immunodeficiency virus (HIV) (1) and hepatitis B (HBV) and hepatitis C viruses (2, 3). The primary mode of transmission for these viruses is through the multiperson use of contaminated needles and syringes (referred to as "needles" in this paper). Despite education, HIV testing, and counseling, the spread of blood-borne infections among IDUs continues (4). In an effort to limit transmission of these pathogens, needle exchange programs (NEPs) have been designed to provide IDUs with sterile replacements for their used and potentially contaminated needles, typically on a one-for-one basis. Recent reports from NEP evaluation studies suggest that well-implemented programs can reduce the transmission of blood-borne pathogens and do not increase the frequency of drug injection (5, 6).

One concern about the implementation of NEPs is that large-scale distribution of free sterile needles might lead to an increased number of discarded and possibly contaminated needles on the street (5, 7). The anxiety regarding discarded needles is not only that they are unsightly to the community, but that they might be handled by citizens, particularly children, and could lead to needle-stick injuries and HIV or hepatitis infections (6). In fact, since the risk of a needle-stick is low and survivability of HIV within a syringe is brief (from 1 or 2 days to 28 days) (8, 9), seroconversion after a needle-stick injury is equally low (6). The risk of HTV transmission from a single needle-stick is estimated to be 0.3 percent per exposure (10). To avoid increasing the total number of discarded needles and needles in circulation, many NEPs have employed a one-for-one exchange policy (7). Since most IDUs do not have access to proper needle disposal containers, it can be reasoned that...
NEP utilization might lead to fewer discarded needles in the community.

In theory, NEPs that operate on a one-for-one exchange basis should not contribute to an increase in the total number of discarded needles since the number of distributed needles is intended to be equal to the number of needles being collected. In practice, the extent to which NEP participation alters needle disposal patterns, quantitatively or geographically, is not yet known. While the total number of discarded needles may remain constant, increases or decreases in specific neighborhoods may be observed. Additionally, many programs show some leniency in the one-for-one rule, especially for first-time participants (5). This is done to encourage IDUs to enroll and remain in these programs. A lenient exchange policy has been associated with a greater reduction in injections per needle among exchangers compared with programs that enforce a strict one-for-one algorithm (11). For example, some programs give a “starter” set of needles the first time a person comes to the exchange. Thereafter, the NEP becomes a one-for-one exchange. During the early period of a program in which starter needles represent a proportionately greater percent of needles distributed, the number of needles found discarded in the community should be monitored for potential changes. However, the potential for an increase in discarded needles is modest since the number of starter needles distributed is a very small proportion of the overall number of needles exchanged; this proportion will decrease over time (5).

Even if the total number of discarded needles remains stable after the opening of a one-for-one NEP, there is a potential for a shift in the geographic distribution of discarded needles related to the location of the NEP. On one hand, if IDUs who use the NEP tend to congregate at the exchange site, an increase in discarded needles might be observed in that vicinity. On the other hand, if NEP clients pick up discarded needles on their way to exchange, a decrease in the number of discarded needles near the exchange site might be observed.

There are few reports on the apparent number and distribution of discarded needles after the establishment of an NEP. NEP service providers in Tacoma, Washington, have offered anecdotal reports about a decrease in the number of discarded needles in the vicinity of their NEP (12). In Amsterdam, the Netherlands, the number of accidental needle-stick injuries reported to the surveillance system increased after the opening of the needle exchange. However, this trend most likely reflected a reporting bias related to an increased awareness of HIV transmission risks. During the same time period, there was a concomitant increase in the number of needle-stick injuries reported by health care workers (13). A surveillance study from the Toronto Department of Public Works, which collected discarded needles for 2 months prior to and 3 years after the NEP opened, reported a decrease in the collection of discarded needles over time (14). However, it was unclear whether this apparent decrease was the result of an actual decline in discarded needles or a decrease in public reporting and subsequent collection of the needles.

In the Discarded Needle Study in Portland, Oregon, the staff surveyed two blocks surrounding the NEP between three and five times per week starting three and one-half months before the opening of the NEP and for 2 years while the NEP was in service (15). They found a decrease in the number of needles in the vicinity of the NEP compared with before the start of the NEP. They also found a post-NEP reduction in the proportion of days that discarded needles were found in the vicinity. The Portland study did not report on discarded needles further away from the NEP. An observer bias may have affected the study results, or it is also possible that counts decreased because participants picked up discarded needles on the way to the NEP for the purpose of exchange (analogous to behaviors induced by the “bottle bill”).

In August 1994, an NEP was established in Baltimore, Maryland, to reduce HIV transmission among IDUs. During the first year, a mobile van operated by the Baltimore City Health Department was parked 4 days a week at two fixed locations on the east and west sides of the city. Within the first 2 months of operation, the program enrolled over 780 IDUs and exchanged more than 25,000 needles. Needle exchange clients receive new needles in exchange for their used ones, as well as risk reduction education, condoms, bleach, alcohol wipes, bottle tops (“cookers”), and a limited number of drug treatment referrals. On the initial visit to the NEP, new clients received two starter needles. Thereafter, the Baltimore NEP functioned as an unlimited one-for-one exchange. Clients were encouraged to return any needles to the van for exchange, whether they were program or nonprogram (“street”) needles. Program needles are distinguished by an adhesive bar code and a marking in indelible ink.

The purpose of this study was to assess how the introduction of the NEP might have changed the number and distribution of discarded needles on the streets of Baltimore. Prior to the opening of the program and then at set intervals thereafter, systematic surveys of discarded needles were performed to assess the possible impact of the NEP on the number and geographic distribution of discarded needles.
MATERIALS AND METHODS
Sampling design

The sampling frame and the survey units were determined in five steps:

1) 1990 census tract data on homicides and aggravated assaults were merged onto a Geographical Information System database (16). Forty census tracts with an identical range of crime events as the census tracts containing the two NEP sites were selected as potential survey areas.

2) Three expert panels of outreach workers, current and ex-drug users, and community police independently identified 78 street intersections with high drug use throughout Baltimore City. Fifty-three of these intersections were located within the 40 crimematched census tracts. Intersections that were independently mentioned more than one time by the experts were assigned a weight according to the number of times mentioned. If an intersection was named two separate times by different experts, the intersection was given two chances for selection.

3) The 53 intersections then were stratified by east and west sides of the city and by distance from the respective NEP sites. Distance strata were determined to be less than 0.5 mile (0.8 km), 0.5-1 mile (0.8–1.6 km), and greater than 1 mile (greater than 1.6 km) from the NEP site.

4) Thirty intersections (15 on the east side and 15 on the west side) then were randomly selected from among the 53 intersections. A quota was established to have an approximately equal number of intersections within each distance stratum. Intersections adjacent to both NEP sites also were included, yielding 32 intersections from which to select 32 survey blocks.

5) One city block abutting each of the 32 intersections was randomly selected as a block unit for the survey.

Data collection

Data collection procedures were standardized before training of surveyors occurred and before implementing the protocol in the field. Forms were designed to tally counts of the number of needles with intact barrels (plungers found alone were not counted), drug vials (small glass vials that typically are the size of perfume samplers), and unbroken glass beverage bottles.

Three teams of three persons each were trained in the following standard protocol: All surveying began in the northeast corner of the block, and teams walked clockwise until the perimeter of the block was covered. They returned to side streets and alleys within the block and surveyed these areas systematically and consistently over time. To increase consistency, the same teams returned to the same blocks on repeat visits. Teams consisted of one “recorder” and two “scouts”. Three authors (M. D., R. G., and B. J.) were members of the survey teams. One scout surveyed the outer edge of the sidewalk, the gutters, and up to 3 feet (92.1 cm) into the street, while the other scout surveyed the inside half of the sidewalk and three feet into a yard or an empty lot. The recorder surveyed the middle of the sidewalk and tallied the items counted. On the first six visits, teams counted the objects of interest, but left them untouched. Consequently, data might conceivably contain objects that had been there on the previous count day. This aspect of the survey methodology has been addressed by averaging the Saturday and Wednesday counts.

Although all nine surveyors knew the NEP locations, six were not told of the hypotheses regarding the survey. To limit potential observer bias, these surveyors were told that they were conducting a “hazardous materials” survey. Furthermore, surveyors were not given information regarding the results obtained on previous counts. However, each triad consisted of two trained community surveyors and one member of the research team. To reduce the possibility that the researchers might misrepresent the count, roles within the teams rotated. Overlapping of observation areas and internal checks among team members were encouraged.

Statistical analysis

Outcomes measured at each point in time included the number of needles (N), vials (V), and bottles (B) per block. The ratio of needles to the sum of vials and bottles (N/(V + B)) was then used to provide an estimate of how the needle count varied in relation to the vial and bottle counts. A value of 0.1 was substituted for zero needle counts. One observation with (V + B) equal to zero was excluded to construct exploratory graphics and to compute descriptive statistics (e.g., table 1). As often occurs with ratios and counts, the distribution of the needle-to-(vial + bottle) ratio was highly skewed to the right. To reduce the effect of this skewness on our conclusions derived from table 1 and figure 1, N/(V + B) was transformed to log(N/(V + B)), and analyses were performed on the transformed data. For ease of interpretation, final results obtained on log(N/(V + B)) were exponentiated and presented as needles per 100 trash items (N/100(V + B)), yielding a geometric mean and reflecting the natural scale of the original (untransformed) data.
TABLE 1. Total and block mean counts of surveyed items measured over 32 city blocks, and number of needles distributed through the Needle Exchange Program (NEP), by date, Baltimore NEP Discarded Needle Survey, 1994–1995

<table>
<thead>
<tr>
<th>Survey data</th>
<th>Pre-NEP*</th>
<th>Post-NEP*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>August 8, 1994</td>
<td>September 10, 1994</td>
</tr>
<tr>
<td></td>
<td>August 10, 1994</td>
<td>September 14, 1994</td>
</tr>
<tr>
<td>No. of needles (N)</td>
<td>44</td>
<td>71</td>
</tr>
<tr>
<td>No. of program needles (PN)</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>No. of vials (V)</td>
<td>199</td>
<td>239</td>
</tr>
<tr>
<td>No. of bottles (B)</td>
<td>1,263</td>
<td>1,752</td>
</tr>
<tr>
<td>Block mean = (N/(V+B))</td>
<td>1.32</td>
<td>1.95</td>
</tr>
</tbody>
</table>

Cumulative NEP data

| No. of needles distributed | 9,102 | 10,975 | 24,784 | 25,713 |
| No. of needles received | 8,709 | 10,567 | 24,089 | 25,002 |
| Needle return rate (%) | 95.7 | 96.3 | 97.2 | 97.2 |
| No. of clients registered | 432 | 479 | 758 | 783 |

* NEP opened on August 12, 1994.

† exp(mean of log(N/(V+B))) × 100 = block mean ratio of needle-to-(vial + bottle) taken on log scale to reduce skewness, exponentiated, and presented as needles per 100 trash items.

Analyses conducted included frequency distributions, block means for counts of items over the six dates, and generation of boxplots. Correlation analysis was performed to assess the level of association between the Saturday and Wednesday counts. Because of the proximity of count days, counts on successive days of the week are highly correlated (observed Pearson correlations are greater than 0.60). For the remaining analyses, counts were averaged by block to provide a more stable measure each time period. This reduced the data from six to three points in time: "pre-NEP" for data that were collected before the NEP opened.
opened (average of data collected on August 6, 1994 and August 10, 1994), “post1” for data collected 1 month after the NEP opened (average of data collected on September 10, 1994 and September 14, 1994), and “post2” for data collected 2 months after the NEP opened (average of data collected on October 8, 1994 and October 12, 1994). Descriptive statistics and pre/post comparisons were made both on the raw needle count (N) and on the ratio N/100(V + B). Because the same blocks were surveyed on each count date, the blocks were matched to one another over time. Confidence intervals for the mean pre- to post-NEP change were calculated based on the standard error of the within-block differences between each of the post-NEP surveys and the pre-NEP survey (analogous to a paired data t test). Analyses stratified by proximity to the NEP and by sides of the city (west versus east) were performed in a similar manner.

Since the data represent counts of items with many zero values, Poisson regression models were used to explore trends before and after the NEP opened while adjusting for additional covariates. To facilitate direct comparisons between the needle counts and background trash, we modeled both the number of needles (N) and the number of trash items (V + B) as outcomes within the same model. This was accomplished by treating needles and background trash as two separate observations and including an indicator term for N (versus trash) in the model. The coefficient associated with this indicator is interpreted as the log needles-to-trash ratio at baseline. Interaction terms between the needle indicator and other covariates, such as time, express the key relations of interest, one of which is the change in needle count relative to any changes in background trash. Covariates of interest included indicators for post1-NEP or post2-NEP versus pre-NEP observations, distance from the NEP site (greater than or equal to 0.5 mile or not), and west versus east side of the city.

The data consist of multiple observations on each city block, both across time and for two different types of trash. These observations generally will be correlated. This correlation arises since each block has its own unique set of unobserved covariates that affect the level of trash. Ignoring the correlation in the regression models will result in inefficient estimates and incorrect inferences (e.g., incorrect confidence intervals and p values). To account for this within-block correlation, regression models were built by using the generalized estimating equation (GEE) method, with the Poisson mean and variance structure and an exchangeable working correlation matrix (17, 18). The interpretation of the model coefficients is the same as that in the Poisson model; however, the GEE method provides asymptotically correct standard error estimates, leading to improved confidence intervals and hypothesis tests (19).

RESULTS

The descriptive statistics of counts over the 32 blocks (table 1), boxplots of the needle-to-100(vials + bottles) ratio (figure 1), and post-minus prechange data outlined in table 2 indicate that there was a slight increase in the absolute number of needles over time. However, despite the fact that there was a positive trend of increasing needles, the number of control or trash items (V + B) also increased with time, possibly reflecting an observer practice effect. Furthermore, the block mean of the needles per 100 trash items does not differ across the six time points (table 1 and figure 1).

In general, the needle counts per block were low, and many blocks had zero counts. In contrast, the vial and bottle counts were rather high and appeared more stable over time (table 1). When the post-NEP data were compared with the pre-NEP data (table 2), both the mean change in needle counts per block (0.38, 95 percent confidence interval (CI) −0.18 to 0.93 for post1-pre-NEP and 0.19, 95 percent CI −0.72 to 1.10 for post2-pre-NEP) and the mean change in the N/100(V + B) ratio (0.03, 95 percent CI −2.62 to 2.68 for post1-pre-NEP and 0.53, 95 percent CI −2.53 to 3.59 for post2-pre-NEP) were positive but not statistically significant; the confidence intervals included zero. Similar results were obtained using the nonparametric Wilcoxon signed rank test (results not shown).

The crude post-minus pre-NEP data were further stratified by distance from the NEP and by sides of the city (table 2). The significant post1-pre-NEP mean change in needles for blocks 0.5 mile or greater from the NEP (0.92, 95 percent CI 0.12 to 1.64) indicated a slight increase in the absolute number of needles found further from the NEP 1 month after opening. This trend is mirrored by a concurrent, nonsignificant decrease in the number of needles found closer to the NEP 1 month after the NEP opened (mean change = −0.32, 95 percent CI −1.04 to 0.40) and again 2 months after the NEP opened (mean change = −0.54, 95 percent CI −1.92 to 0.14). However, the N/100(V + B) ratio varied little over time and by distance. With regard to east versus west sides of the city, there were no significant changes in the needles or in the N/100(V + B) ratio over time. However, the crude data indicated a greater absolute number of needles on the west side compared with the east side (data not shown). The background trash was equally more abundant on the west side; thus, the
TABLE 2. Change in block needle count and \(N/(V + B)^*\) ratio over 32 city blocks before and after the opening of the Needle Exchange Program (NEP), stratified by distance from the NEP and by sides of the city, Baltimore NEP Discarded Needle Survey, 1994-1995

<table>
<thead>
<tr>
<th>Survey data</th>
<th>Needle count</th>
<th>(N/(V + B)^<em>) ratio</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean change†</td>
<td>95% CI‡</td>
</tr>
<tr>
<td>Post1 (Pre-NEP)$</td>
<td>0.38</td>
<td>-0.18 to 0.93</td>
</tr>
<tr>
<td>Distance &lt; 0.5 mile</td>
<td>-0.32</td>
<td>-1.04 to 0.40</td>
</tr>
<tr>
<td>Distance ≥ 0.5 mile</td>
<td>0.92</td>
<td>0.12 to 1.64</td>
</tr>
<tr>
<td>East side</td>
<td>0.56</td>
<td>-0.23 to 1.36</td>
</tr>
<tr>
<td>West side</td>
<td>0.19</td>
<td>-0.59 to 0.97</td>
</tr>
<tr>
<td>Post2 (Pre-NEP)$</td>
<td>0.19</td>
<td>-0.72 to 1.10</td>
</tr>
<tr>
<td>Distance &lt; 0.5 mile</td>
<td>-0.54</td>
<td>-1.92 to 0.14</td>
</tr>
<tr>
<td>Distance ≥ 0.5 mile</td>
<td>0.75</td>
<td>-0.43 to 1.93</td>
</tr>
<tr>
<td>East side</td>
<td>0.28</td>
<td>-0.32 to 0.88</td>
</tr>
<tr>
<td>West side</td>
<td>0.09</td>
<td>-1.66 to 1.85</td>
</tr>
</tbody>
</table>

\* \(N/(V + B)\) = number of needles to 100 \(\times\) (vials + bottles) expressed as ratio.
† Mean change is the change in geometric means.
‡ 95% confidence intervals (CI) around the mean change calculated from the standard error of the mean and 2-tailed probability of the \(t\)-distribution.
$ Pre-NEP = \{(August 6, 1994 + August 10, 1994)/2; Post1 = \{(September 10, 1994 + September 14, 1994)/2; Post2 = \{(October 8, 1994 + October 12, 1994)/2. Average values were taken to provide a more stable measure of the counts for each period.
§ 1 mile = 1.61 km.

Results from the GEE model were similar to those reported in table 2; the majority of the rate ratio estimates were positive, meaning that there was a slight trend toward increasing needles and vials + bottles over time. There was an average rate of three needles to 100 vials + bottles for the reference group. For post1 and post2 (1 and 2 months after the NEP opened, respectively), the needle count was higher on average but increased in step with the increases for the vial + bottle count. For post1 versus pre-NEP, the needle rate ratio (RR) was 1.23 (95 percent CI 0.91 to 1.65) while the vial + bottle RR was 1.26 (95 percent CI 1.01 to 1.56). For post2 versus pre-NEP, the needle RR = 1.11 (95 percent CI 0.68 to 1.83) while the

Table 3 presents the rate ratio estimates from the GEE model. Since needle counts were modeled simultaneously with the vial + bottle counts, each model included an indicator variable for needles that served to provide a baseline rate of \(N/(V + B)\) in the reference group (i.e., pre-NEP, east, and distance of 0.5 mile or greater). The model estimated changes over time measured by post1 and post2 and included the additional variables of distance from the NEP sites, east versus west sides of the city, and the interaction of all of these terms with an indicator variable for the needle count versus the vial + bottle count.

TABLE 3. Rate of change of needle count compared with the vial + bottle count over 32 city blocks using generalized estimating equation (GEE) regression methods, Baltimore NEP Discarded Needle Survey, 1994-1995

<table>
<thead>
<tr>
<th>Covariates</th>
<th>Needle count</th>
<th>Vial + bottle count</th>
<th>Difference between needle and vial + bottle (interaction term)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference categories†</td>
<td>Rate</td>
<td>95% CI*</td>
<td>Rate</td>
</tr>
<tr>
<td>Post1‡</td>
<td>1.02</td>
<td>0.60 to 1.72</td>
<td>37.34</td>
</tr>
<tr>
<td>Post2§</td>
<td>1.23</td>
<td>0.91 to 1.65</td>
<td>1.26</td>
</tr>
<tr>
<td>Distance &lt; 0.5 miles¶</td>
<td>1.11</td>
<td>0.68 to 1.83</td>
<td>1.25</td>
</tr>
<tr>
<td>West side‖</td>
<td>0.96</td>
<td>0.48 to 1.93</td>
<td>1.21</td>
</tr>
<tr>
<td>Reference categories†</td>
<td>2.41</td>
<td>1.32 to 4.41</td>
<td>1.85</td>
</tr>
</tbody>
</table>

* 95% confidence intervals (CI) based on the GEE robust estimates of the standard error.
† Reference category: \(V + B\), Pre, ≥ 0.5 miles, and east side.
‡ Reference category: (V + B, Pre, ≥ 0.5 miles, and east side).
§ Reference category: Pre-NEP.
¶ Reference category: distance from NEP ≥ 0.5 miles, 1 mile = 1.61 km.
‖ Reference category: east side.
vial + bottle RR = 1.25 (95 percent CI 0.99–1.56). Inferences are made more explicit via the interpretation of the rate ratios reported for the interaction terms between either post1 and the N versus (V + B) indicator variable or post2 and the N versus (V + B) indicator variable. Both 95 percent confidence intervals for the interaction terms trap the null value (1.0) of no difference in the average rate of change for the needles relative to the background trash (vial + bottle) over time. The GEE model showed a nonsignificant difference in the average needle count for blocks closer to the NEP compared with blocks further away (RR = 0.96, 95 percent CI 0.48 to 1.93). Furthermore, when needles were compared with the vial + bottle count, proximity to the NEP apparently had no effect (RR of the interaction term = 0.89, 95 percent CI 0.36 to 2.18). Discarded needle counts, as well as the vial + bottle counts, were about two times as great, on average, on the west versus the east side of the city (RR = 2.41, 95 percent CI 1.32 to 4.41 and RR = 1.85, 95 percent CI 1.15 to 2.97, respectively); however, the confidence interval for the interaction term (RR = 1.30, 95 percent CI 0.64 to 2.68) encompassed the null relative risk, corresponding to no difference in the needle relative to the vial + bottle counts. We checked for other two-way interactions; for both the needle counts and the vial + bottle counts, the estimates over time did not differ for east versus west sides of the city or near versus far from the NEP.

DISCUSSION

Overall, this study found no significant increase in the number of discarded needles over 32 different city blocks in Baltimore City from prior to the opening of the NEP through the first 2 months of its operation. Small increases in all counts occurred over time, which might be explained, at least in part, by an observer practice effect. Initially, identifying syringes on the street or in an alley was difficult, and it is conceivable that some needles were left uncounted. Over time, the surveyors seemed to become more proficient in their ability to identify and count less obvious needles and vials. These data suggest that the early nonstatistically significant trend toward increasing needles over time became negligible when examined in relation to background trash.

The only consistently significant result from the survey was that the blocks on the west side of the city had a greater number of discarded needles and trash items than did those on the east side during the time period of the survey. Anecdotal evidence suggests the west side might have a larger drug-using population and more open-air drug markets. The west side is more highly populated than is the east (20, 21), and proportionally, there might be a larger number of injectors on the west side compared with the east side.

As shown in table 1 for the last count day reported here, the overall return rate for any needles (defined as “cumulative program and nonprogram needles in/cumulative needles out”) to the NEP was high (97.2 percent). Considering that, cumulatively, 25,713 needles had been distributed by that date, there was an excess of 711 needles that could have entered the community and could have led to an increase in discarded needles. Some of these needles may have been disposed of properly in biohazard containers; some may have been disposed of without precautions. Nevertheless, it appears that only a small fraction of NEP needles distributed were disposed in the street. The observed positive trends may be related to external and environmental factors that could not be controlled in the study design. These factors include temporal changes in the block make up (e.g., demolition of abandoned buildings or clean up of vacant lots), changes in surveyors, changes in street-sweeping activities, the weather, or even the time it took the team to survey the area.

Because sampling was restricted to areas of high drug use, the data reported here should not be considered representative of discarded needles throughout all neighborhoods of Baltimore City. In addition, the survey does not identify the incidence of discarded needles, but instead reflects a series of cross-sectional surveys, made on the same blocks each time, inducing correlation on the multiple within-block observations. Ignoring this correlation and using standard statistical methods for independent data can yield correct point estimates, but these estimates will, in general, be inefficient. Worse, confidence intervals and p values will generally be incorrect and possibly anticonservative if the correlation is not taken into account. The GEE methodology used here was designed specifically to address these issues.

This study indicates that opening an NEP does not appear to lead to an increase in discarded needles in the street. While this result is not surprising in itself (because the needle exchange involves a one-for-one exchange), the more relevant issue is that no geographic shift in discarded needles was identified with the opening of a NEP. A major shift in where needles are discarded would have had important implications for placement of the NEP van. For example, if there were a major increase in discarded needles near the van, then this might add more reason to place NEPs at a distance from parks or schools. However, the data in this report suggest that from a standpoint of discarded
needles in the community, the location of the NEP does not appear to be an important consideration. Finally, while NEPs do not lead to an increase in discarded needles, at least for programs that operate on a close to one-for-one exchange basis, research on safe disposal of used injection equipment is needed, particularly for pharmacy sales of needles to injection drug users. The methods presented here can be applied to measure the impact of removing restrictions of pharmacy sales to injection drug users and monitoring novel programs to encourage proper needle disposal in this population.

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This paper is dedicated to the memory of James E. Commander.

REFERENCES