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HIV seroconversion among Baltimore City residents tested at a mobile van programme

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Abstract

Background—Many individuals with HIV in the USA are unaware of their diagnosis, and therefore cannotbe engaged in treatment services, have worse clinical outcomes and are more likely to transmit HIV to others. Mobile van testing may increase HIV testing and diagnosis. Our objective was to characterise risk factors for HIV seroconversion among individuals using mobile van testing.

Methods—A case cohort study (n=543) was conducted within an HIV surveillance dataset of mobile van testing users with at least two HIV tests between September 2004 and August 2009 in Baltimore, Maryland. A subcohort (n=423) was randomly selected; all additional cases were added from the parent cohort. Cases (n=122 total, two from random subcohort) had documented seroconversion at the follow-up visit. A unique aspect of the analysis was use of Departmentof Corrections data to document incarceration between the times of initial and subsequent testing. Multivariate Cox proportional hazards models were used to compare HIV transmission risk factors between individuals who seroconverted and those who did not.

Results—One hundred and twenty-two HIV seroconversions occurred among 8756 individuals (1.4%), a rate higher than that in Baltimore City Health Department's STD Clinic clients (1%).

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Contributors

SP contributed to research question development, conduct of analyses and wrote the initial draft of the manuscript. PB, KP, RM and PC designed and directed the testing programme and oversaw data collection, contributed to research question development and performed critical revision. KG contributed to design of analyses, manuscript writing and critical revision. AM conducted research question development, design and conduct of analyses, manuscript writing and critical revision. All authors contributed to the writing and have approved the final manuscript.

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Increased HIV seroconversion risk was associated with men who have sex with men (MSM) (HR 32.76, 95% CI 5.62 to 191.12), sex with an HIV positive partner (HR 70.2, 95% CI 9.58 to 514.89), and intravenous drug use (IDU) (HR 5.65, 95% CI 2.41 to 13.23).

Conclusions—HIV testing is a crucial first step in the HIV care continuum and an important HIV prevention tool. This study confirmed the need to reach high-risk populations (MSM, sex with HIV-positive individuals, individuals with IDU) and to increase comprehensive prevention services so that high-risk individuals stay HIV uninfected. HIV testing in mobile vans may be an effective outreach strategy for identifying infection in certain populations at high risk for HIV.

INTRODUCTION

The HIV care continuum—diagnosis, linkage, retention, treatment and viral suppression—is well established.[1] Diagnosis remains a critical bottleneck, manifest in the estimated 156 300 adults with undiagnosed HIV in the USA.[2] These individuals forego the mortality and morbidity benefits of engaging in care and treatment,[3] and present a high risk of HIV transmission.[4] Early diagnosis to initiate the care continuum and prevent further infections is key.

Baltimore City implemented a mobile van HIV testing programme in 2002 in an effort to improve HIV testing, diagnosis and prevention among hard to-reach populations. The van targets sites proximal to traditional high-risk HIV transmission activities (eg, illicit drug use, commercial sex work) and city areas with established high HIV prevalence. By 2009, the programme was performing an estimated 11 000 tests annually. Mobile testing has been effective in accessing hard-to-reach populations,[5] particularly men and those with earlier stage disease.[6] In Baltimore, mobile testers have higher rates of HIV than traditional clinic users (5.45 vs 2%), are older (>=30 years) and more likely to report intravenous drug use (IDU).[5] Baltimore's mobile testing programme has many repeat testers and offers a unique opportunity to examine HIV seroconversions.

The purpose of this study was to examine factors associated with HIV seroconversion in individuals using mobile testing in Baltimore City to direct use of limited resources.

METHODS

Study design, population and setting

Our study population came from a Baltimore City Health Department observational cohort of persons tested for HIV in a mobile van programme. Participants were aged 12–97 years, HIV negative on initial testing in the van and underwent ≥1 subsequent HIV test between September 2004 and August 2009.

We used a case cohort design[7] to examine risk factors associated with HIV seroconversion, which allows for efficient measurement of the outcome with the temporal sequence and the power advantages of the large parent cohort (online supplementary references 1–2). Seroconversion cases had a negative then positive HIV test during the study period. The case cohort (n=543) was derived from the parent cohort (n=8756) and included a randomly selected subcohort (n=423) and all additional seroconversion cases (n=120) not in the

random subcohort (online supplementary figure 1). Additionally, there were two seroconversion cases in the random subcohort. We maintained the same proportion of age, sex and first test year in the random subcohort as in the original study cohort.

Cohort entry was at the first negative HIV test. Cohort exit occurred at either time of a positive test (cases) or time of the last negative test within the study period (non-cases).

The project was approved by Institutional Review Boards of Johns Hopkins Medical Institutions (Number NA_00002614) and the Maryland Department of Public Safety and Correctional Services (DPSCS).

Data collection

At the time of HIV testing, demographics and risk factor information were collected using a standardised data collection form (see table 1 for partial list of risk factors). For the case cohort, records were reidentified and history of incarceration and arrest/ disposition date(s) were extracted through the Maryland DPSCS to determine if incarceration occurred between sequential HIV testing events.

HIV positivity was confirmed by HIV RNA PCR or ELISA with positive Western Blot.

Statistical analyses

Race/ethnicity were fixed variables; all other demographic and risk factor variables were time varying, measured at the time of each test.

Univariate and multivariate Cox proportional hazards models were used to estimate HRs of HIV seroconversion for demographic and other potential risk factors. The models used robust variance adjustment and Barlow weighting method to correct for the inclusion of all the cases and to estimate parameters in the full cohort. Associations were considered statistically significant with a $p \leq 0.10$ in univariate analyses and $p \leq 0.05$ in multivariate analyses. The multivariate model included demographic covariates as well as all risk factor covariates significantly associated with seroconversion in univariate analysis and incarceration history. Statistical analyses used Stata V.14.0 (College Station, Texas, USA). Missing risk factor data were minimal (<0.5% of sample) and were not analysed.

RESULTS

Baseline characteristics

The case cohort (n=543) median age was 43 years, and most participants were male (59.5%) and black (81.6%) (table 1). Risk factors associated with HIV seroconversion are displayed in table 1.

HIV seroconversion and associated risk factors

In the parent cohort of 8756 individuals, 122 (1.4%) participants seroconverted between the time of initial and subsequent mobile van testing.

Table 1 shows the HRs of seroconversion and 95% CIs for statistically significant risk factors. In adjusted multivariate analysis, men who have sex with men (MSM; HR 32.76; 95% CI 5.62 to 191.12), sex with an HIV-positive partner (HR 70.23; 95% CI 9.58 to 514.89) and IDU (HR 5.65; 95% CI 2.41 to 13.23) were associated with seroconversion. Inconsistent/never condom use and alcohol use were inversely associated with seroconversion.

DISCUSSION

In this case cohort study of individuals frequenting mobile van HIV testing services in Baltimore City, individuals who seroconverted after an initial negative test were more likely to report being MSM, having sex with an HIV-positive partner and using intravenous drugs. In high HIV prevalence urban settings, our findings may help identify high-risk patients who would benefit from intensification of mobile van-based HIV prevention and testing services.

Strengths of this study include the parent cohort size and prospectively collected risk factor data. Additionally, the novel method for examining incarceration as an HIV risk factor adds to the robustness of the study, given its known association with HIV infection and the high prevalence of incarceration history among Baltimore residents.[8]

Our study has some important limitations. First, the number of cases may have been too small to detect differences in risk factors more weakly associated with seroconversion. While this helps to eliminate reverse causation, a larger sample size would improve generalisability. Second, the analysis may have differed if other variable metrics had been used, for example, frequency responses or time-limited recall periods. Third, we captured neither individuals who tested HIV positive at other venues nor one-time testers. Both exclusions may skew estimates of seroconversion and bias significance of risk factors; however, the prospective nature of cohort entry limited selection bias between cases and non-cases.

Many of our findings, while statistically significant, have wide CIs attributable to a small, heterogeneous sample population. We would pose, however, that among risk factor associations with the widest CIs—MSM (5.62–191.12), sex with an HIV-positive partner (9.58–514.89) and IDU (2.41–13.23)— even the lowest end of the CIs represent clinically significant increases in risk. Our results are otherwise notable for a protective effect of inconsistent/never condom use and alcohol use. For condom use, we suspect that we did not have a valid measure. The phrasing ‘inconsistent/never condom use’ does not measure frequency and is prone to intra-individual reporting, potentially affecting the observed association. Alternatively, individuals with increased awareness of their risk (eg, sex with an HIV-infected partner) may be more likely to use condoms and simultaneously more likely to seroconvert.

Our results build on the findings of Ellen *et al*,[5] who compared characteristics of mobile HIV testers to STD clinic users, finding higher HIV prevalence among mobile testers (5.4% vs 2.0%), with HIV-positive mobile testers more likely to be older and to report IDU, sex partners with IDU and prostitution. Our results expand on Ellen *et al* by identifying the

subset of these clients at highest risk for HIV seroconversion. In a subsequent study of HIV seroconversions in a Baltimore STD clinic, higher seroconversion risk was associated with IDU (incidence rate ratio (IRR)=3.06) and sex with an HIV-positive partner (IRR=4.86), similar to our findings.[9] In contrast to our results, there was no significant increase in risk for MSM. The number of individuals reporting MSM was low in both studies (3.9% in this study; 1.9% in Mehta *et al*),[9] MSM represented 9.8% of seroconversions in our study. This is in contrast to broader trends: MSM accounted for 23.8% of all people living with HIV (PLWH) in Baltimore in 2011.[10] The under-representation of MSM may be due to risk factor under-reporting or sampling bias of the mobile tester population.

In summary, this was an observational study aimed at understanding associations between risk factors and HIV seroconversion among mobile van testers. Based on the associations found, this study provides additional insights into the potential role of targeted mobile testing services to enhance prevention efforts, encourage repeat testing and facilitate early diagnosis and linkage to care for these high-risk groups. In urban settings such as Balti more, where many individuals have limited access to care, point of-care and community-based testing strategies are essential in lowering the barriers to diagnosis. Triaging the use of limited public health funding to effective testing strategies is paramount in our efforts to end the HIV epidemic. We currently face challenges in determining how best to reach MSM for HIV testing in the era of online applications to meet sexual partners rather than clubs or bars as a gathering spots, and venue-based testing will likely need to evolve. Additionally, mobile testing presents the opportunity to expand services beyond testing, taking advantage of its ability to reach high-risk HIV-uninfected individuals in order to provide prevention services such as pre-exposure prophylaxis.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Case cohort characteristics and risk factors, with univariate and multivariable associations with HIV seroconversion

Characteristic or risk factor	Non-cases n (%)	Cases n (%)	P[†]	Crude HR (95% Cl)	P[*]	Adjusted HR[‡] (95% Cl)	p[**]
Total	421	122					
Demographic characteristics							
Baseline age, median (IQR) years	44.0 (36–49)	42.0 (36–48)	0.35	0.77 (0.61 to 0.96)§	0.02	0.68 (0.50 to 0.92)[§]	0.01
Male sex	252 (59.9)	71 (58.2)	0.75	0.90 (0.56 to 1.45)	0.67	0.79 (0.43 to 1.45)	0.45
Race							
Black	343 (81.5)	100 (82.0)		0.98 (0.53 to 1.80)	0.95	2.47 (0.98 to 6.23)	0.06
Other[¶]	78 (18.5)	22 (18.0)					
Sexual risk factors							
Heterosexual sex	366 (86.9)	99 (81.2)	0.10	0.46 (0.25 to 0.87)	0.02	1.12 (0.38 to 3.28)	0.08
MSM	9 (2.1)	12 (9.8)	<0.001	16.41 (5.12 to 52.61)	<0.001	32.76 (5.62 to 191.12)	<0.001
Sex with HIV+partner	2 (0.5)	3 (2.5)	0.08	27.56 (4.10 to 184.88)	0.001	70.23 (9.58 to 514.89)	<0.001
Sex with partner with IDU	11 (2.6)	4 (3.3)	0.75	–	–	–	–
Inconsistent/Never condom use	105 (24.9)	25 (20.5)	0.34	0.54 (0.30 to 0.97)	0.04	0.49 (0.24 to 0.99)	0.05
Substance use risk factors							
Alcohol use	164 (39.0)	37 (30.33)	0.09	0.62 (0.37 to 1.02)	0.06	0.57 (0.30 to 1.08)	0.08
Illicit drug use (general)	201 (47.7)	78 (63.9)	0.002	1.74 (1.06 to 2.85	0.03	0.90 (0.47 to 1.72)	0.74
IDU	57 (13.5)	37 (30.3)	<0.001	3.70 (2.00 to 6.84)	<0.001	5.65 (2.41 to 13.23)	<0.001
Additional risk factors							
History of Incarceration	28 (6.7)	14 (11.5)	0.09	1.71 (0.80 to 3.67)	0.169	1.61 (0.63 to 4.17)	0.32

[*] p<0.05.

[**] p<0.10 for univariate model of all non-demographic variables listed except history of incarceration.

[†] p Value based on Fisher's exact test or Wilcoxon rank-sum test.

[‡] Adjusted HR represents the independent risk of the added characteristic or risk factor when adjusting for age, sex, MSM, heterosexual sex, inconsistent/never condom use, sex with an HIV-positive partner, illicit drug use, IDU, alcohol use and history of incarceration.

[§] Age-based HRs are calculated for every 10-year incremental increase in age.

[¶] Other races include white (68), Asian (2), Native American (3), mixed race or self-identified other (15) and unknown (12).

HR, hazard ratio; IDU, intravenous drug use; MSM, men who have sex with men.