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Previously Undiagnosed HIV Infections Identified Through Cluster Investigation, North Carolina, 2002–2007

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Abstract

During cluster investigation, index patients name social contacts that are not sex or drug-sharing partners. The likelihood of identifying new HIV infections among social contacts is unknown. We hypothesized greater odds of identifying new infections among social contacts identified by men who report sex with men (MSM). We reviewed North Carolina HIV diagnoses during 2002–2005 and used logistic regression to compare testing results among social contacts of MSM, men who report sex with women only (MSW) and women. HIV was newly diagnosed among 54/601 (9.0%) social contacts tested named by MSM, 16/522 (3.1%) named by MSW, and 23/639 (3.6%) named by women. Compared with those named by MSW, odds of new HIV diagnosis were greater among MSM social contacts (adjusted odds ratio: 2.5; 95% confidence interval: 1.3–4.7). Testing social contacts identified previously undiagnosed HIV infections and could provide an opportunity to interrupt transmission.

Keywords

contact tracing; HIV infections; prevention & control; male; sexual behavior

Introduction

Partner notification and contact tracing have been key strategies for limiting HIV transmission (1–4). Contact tracing consists of interviewing persons who have been newly diagnosed and asking for names of sexual and needle-sharing partners. These persons are

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then contacted and offered testing and, if they are infected, treatment. In many states, disease intervention specialists (DIS) perform these voluntary interviews, arrange for testing, and link newly diagnosed persons to care. In some states, DIS also use adjunct practices, known as clustering and cluster interviewing, where they interview social contacts in addition to partners to increase case finding and gather information about an index patient's social network (5–8). Social contacts are persons named during the course of a contact investigation either by the index patient (i.e., a “suspect”) or a partner of the index patient (i.e., an “associate”). A social contact is someone who is part of an index patient's social network and (1) has symptoms of sexually transmitted infection (STI), (2) is the partner of an STI case, or (3) might otherwise benefit from testing for STI (5, 6). By definition, social contacts are not recent sexual or needle-sharing partners of the index patient. Although cluster investigation has been used as a strategy for syphilis control in certain states (e.g., Georgia, Louisiana, Alabama) (8–11), few states (i.e., Mississippi) have reported its use in HIV contact investigations (12). In North Carolina, cluster investigation is part of the strategy used to prevent HIV transmission.

In late 2008, the North Carolina Department of Health and Human Services (NC-DHHS) noted an increase in early syphilis and incident HIV cases, particularly among young black males. In 2006, the syphilis rate among black males was 16.9 per 100,000; by 2009, the rate in this group had increased to 36.1 per 100,000 (13). Similarly, the rate of new HIV diagnoses in 2006 was 98.6 per 100,000 and increased to 107.3 per 100,000 in 2008 (13). These increases were particularly seen among men who have sex with men (MSM) (14). In response, the state began targeted testing campaigns, including testing in jails, outside nightclubs, and through active community outreach efforts, in the counties with the highest incidence rates. Although these measures had been successful in controlling previous outbreaks (15), few new cases were identified. As a result, NC-DHHS explored ways to increase the yield of new cases to better control the outbreak, including extensive social network analysis (14). Anecdotally, DIS noted that during 2010 they identified more early syphilis cases and undiagnosed HIV infections by testing social contacts, in addition to sex and intravenous drug sharing partners, named by MSM than through targeted testing campaigns.

Previous studies have evaluated the prevalence of undiagnosed HIV infections among sex or needle-sharing partners named by HIV-infected persons (1–3, 16, 17). Studies have shown the prevalence of new diagnoses among social contacts identified through syphilis cluster investigations, 0.3–9% of social contacts during 1985–2005, has been lower than that reported among partners (9). However, few data exist regarding the prevalence of undiagnosed HIV infections among social contacts (6, 9, 18). We undertook the current study to investigate whether undiagnosed HIV infections were present among social contacts examined and tested during an earlier time period, particularly those named by MSM. We hypothesized that cluster investigation would identify undiagnosed HIV infections and that the odds of undiagnosed infection would be associated with the sex or sexual risk behavior reported by the index patient.

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Methods

Database Structure

North Carolina is divided into 7 regions, each of which collects the same information on infectious diseases in the same format in the Sexually Transmitted Disease Management Information System (STD-MIS). The entered information is verified as complete by DIS supervisors. We combined each region's STD-MIS data and used them to identify persons aged ≥18 years with HIV newly diagnosed during November 1, 2002–October 31, 2007. Included in these databases were all HIV-infected persons reported to the state during this period, their sex and needle-sharing partners, and identified social contacts. This period was chosen because data on sexual and needle-sharing partners from the same time period were available for comparison (17). Age groups are reported as seen previously (17), with breakdowns of 5 years per group beginning at age 18 up to age 41 or greater. We defined MSM as men who ever reported same-sex activity and men who have sex with women only (MSW) as men who reported no same-sex activity. Women were not further divided into sexual behavior groups. We excluded index patients for whom sex was unknown and men for whom same-sex activity was unknown. Acute HIV was defined previously as (1) a positive nucleic acid amplification test (NAAT) from a specimen with negative or indeterminate antibody result or (2) a positive NAAT, antigen test, or antibody test from the specimen of a person who had a negative or indeterminate HIV test within the preceding 30 days (17). This study underwent human subjects review by the Centers for Disease Control and Prevention and, because it was undertaken as part of control of a public health problem, was determined to be non-research and exempt from IRB review.

Identifying and Categorizing Social contacts

All persons with a newly diagnosed HIV infection and their sex and needle-sharing partners are asked to identify persons within their social network who might benefit from interview or testing but who are not sex or needle-sharing partners. Social contacts are categorized as suspects or associates based solely on the testing status of the person who named them during the investigation. Suspects are social contacts named by an infected person (usually the index patient) (5). Associates are social contacts named by an uninfected person (usually a sex or needle-sharing partner of an index patient) (5). The DIS performing the interview then further categorizes suspects and associates based on information obtained from the index patient or a partner. Type 1 (those most likely to have infection) refers to persons reported by the interviewee to have symptoms indicative of disease. Type 2 refers to persons known to the interviewee to be a partner of an HIV-infected person but who do not meet Type 1 criteria. Type 3 refers to any other persons named who, in the opinion of the interviewee, might benefit from sexually transmitted disease examination, including pregnant women (5). After testing, social contacts were categorized as having a previous diagnosis of HIV infection, having a new diagnosis, or uninfected based on all available information, including interview and information listed in the STD-MIS databases.

HIV Testing

We reviewed the STD-MIS database for the names of any named social contacts. Social contacts without a previous record of HIV infection were offered HIV testing and provided

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written consent before testing. Publications have reported in detail methods for HIV testing of specimens submitted to the North Carolina State Laboratory of Public Health (17,19). In summary, serum samples were examined for HIV antibodies by using the Vironostika® HIV-1 enzyme immunoassay kit. Samples that tested positive were then tested by Western blot (Bio-Rad Laboratories, Hercules, California) analysis kit. Samples that tested positive by both of these methods were considered positive. Samples with indeterminate antibody results by these two methods were tested individually for HIV-1 ribonucleic acid (RNA) by using the Procleix® HIV-1 assay (Gen-Probe Incorporated, San Diego, California) if tested before July 2005 or the EasyQ® HIV-1 quantitative assay (bioMerieux SA, Marcy l'Etoile, France) if tested after that date. If HIV antibodies were not detected by immunoassay and Western blot, samples were pooled and examined for HIV-1 RNA, a method with positive predictive value of 0.997 (19). If HIV-1 RNA was detected, the pooled samples were then tested individually. All individual samples with detectable HIV-1 RNA underwent repeat enzyme immunoassay testing or quantitative HIV-1 RNA testing (Roche Amplicor™ 1.5; Roche Molecular Systems, Pleasanton, California) and were confirmed by testing of a sample collected after results from the first sample were available.

Statistical Analysis

We calculated the mean number of social contacts named by MSM, MSW, and women during DIS interviews. We compared and derived adjusted ratios of these means by using a negative binomial regression model, appropriate for the skewed distribution of our data. We excluded 257 social contacts. These contacts were associated with index patients whose sex was unknown, male index patients for whom same-sex activity was unknown, or we were unable to link them to an index patient. We controlled for age, race/ethnicity, substance use, and acute versus established HIV infection on the basis of previous reports linking these factors to the number of partners named (2, 17, 20).

We constructed a multilevel logistic regression model to estimate the association between index patients' sex or sexual risk behavior and the odds of social contacts being newly identified with HIV infection, while accounting for clustering within the data. We adjusted for index patient age and race/ethnicity, whether the social contact was a suspect or associate, and social contact type. Multilevel modeling was used to account for potential covariance between social contacts named by the same index patient. By using the same independent variables, a second multilevel logistic regression model was fit to estimate the odds of having any HIV infection (i.e., newly or previously identified) among tested social contacts. Finally, we calculated the number of named social contacts needed to identify ≥1 new HIV infection. Analyses were performed by using SAS® v.9.2 (SAS Institute Incorporated, Cary, North Carolina).

Results

Index Patient Characteristics

During November 1, 2002–October 31, 2007, a total of 6,502 men and 2,681 women received diagnosis of HIV infection in North Carolina (Table I). Among men, 3,141 were classified as MSM and 3,361 as MSW. MSM index patients identified during the study

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period were younger (median age: 35.4 years) than index patients in the other two groups (MSW median age: 41.7 years; women median age: 38.9 years). More MSM index patients were white (40% versus 18% and 15%, respectively), fewer reported injection drug use within the preceding year (3.3% versus 9.4% and 6.2%, respectively), and more received acute HIV infection diagnoses (2.4% versus 0.7% and 0.9%, respectively).

Numbers of Social Contacts Named

Most index patients (7,394/9,183) did not name any social contacts. More index patients 18–23 years (32%) named social contacts as compared with index patients ≥41 years (16%); older index patients named progressively fewer social contacts (P for trend < 0.001). Fewer Hispanic index patients (13%) named social contacts as compared with index patients of other races/ethnicities (17% white, 21% black, 20% other) ($P < 0.001$). More index patients reporting any drug use during the preceding year (25%) named social contacts as compared with those who reported no drug use during that time (16%) ($P < 0.001$). More index patients with acute HIV (37%) named social contacts as compared with those without acute HIV (19%) ($P < 0.001$). The majority of index patients in all 3 sex or sexual risk behavior groups did not identify any social contacts (Table II). Compared with MSM and MSW, women index patients were most likely to identify ≥1 social contact (23.9% versus 20.2% for MSM and 15.3% for MSW) ($P < 0.001$). More MSM and women index patients identified ≥3 social contacts (5.4% and 4.5%, respectively), compared with MSW (3.2%).

Of 3,141 MSM 635 named 1,520 social contacts; 515/3,361 MSW named 1,045 social contacts; and 639/2,681 women named 1,287 social contacts (Table II). The mean numbers of social contacts named by MSM (0.48; 95% confidence interval [CI]: 0.44–0.53) and women (0.48; 95% CI: 0.43–0.53) were significantly higher than the mean number of social contacts named by MSW index patients (0.31; 95% CI: 0.28–0.34). After accounting for differences in race/ethnicity, age, noninjectable drug use, and acute HIV status, the mean number of social contacts named by women remained significantly greater than the mean number named by MSW ($P < 0.001$). The mean number of social contacts named also remained greater for MSM than MSW, but the difference was not statistically significant. Index patients who were younger ($P < 0.001$), black ($P = 0.04$), had a history of noninjection drug use within the preceding year ($P < 0.001$), or had acute HIV infection ($P < 0.001$) named significantly more social contacts. Injection-drug use was not significantly associated with mean number of social contacts named. The association between sex or sexual risk behavior and the mean number of named social contacts varied significantly by race ($P < 0.01$) (Table III). Black MSM and black women index patients on average named 1.5 (95% CI: 1.3–1.8) and 1.3 (95% CI: 1.1–1.5) times more social contacts, respectively, than black MSW, whereas white women on average named 2.3 (95% CI: 1.6–3.4) times more social contacts than white MSW. White MSM did not differ significantly from white MSW in the ratio of social contacts named (1.2; 95% CI 0.9–1.6). The association between sex or sexual risk behavior and mean number of social contacts named did not vary with age.

Among 1,520 social contacts named by MSM, 413 (27%) had previously identified infections, and 506 (33%) were not tested. Reasons for not being tested included refusal (n = 334), insufficient information to investigate (n = 7), inability to locate (n = 139), and out of

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jurisdiction (n = 10). Among the remaining 601 (40%) social contacts of MSM tested for HIV, 54 (9%) were newly identified with HIV infection. Among 1,045 social contacts named by MSW, 143 (14%) had previously identified infections, and 380 (36%) were not tested. Reasons for not being tested included refusal (n = 255), insufficient information to investigate (n = 1), inability to locate (n = 103), and out of jurisdiction (n = 7). Of the 522 (50%) social contacts of MSW tested, 16 (3%) were newly identified with HIV infection. Among 1,287 social contacts named by women index patients, 205 (16%) had previously identified infections, and 443 (34%) were not tested. Reasons for not being tested included refusal (n = 288), insufficient information to investigate (n = 3), inability to locate (n = 117), and out of jurisdiction (n = 5). Of the 639 (50%) tested, 23 (4%) were newly identified with HIV infection. Overall, 46 (1.5%) of 3,141 MSM index patients, 16 (0.5%) of 3,361 MSW index patients, and 23 (0.9%) of 2,681 female index patients named ≥1 social contact newly identified with HIV infection (Table II). Certain social contacts were also index patients; we performed sensitivity analyses (data not shown) excluding these persons from the models and noted no change in our findings.

Newly Diagnosed HIV Infection Among Social Contacts

The odds of having a newly identified HIV infection were greater among social contacts named by MSM than those named by MSW (adjusted odds ratio [aOR]: 2.4; 95% CI: 1.3–4.6), after adjusting for index patient age, race/ethnicity, whether the social contact was a suspect or associate, and social contact type (Table IV). The odds of having a newly identified HIV infection were similar among social contacts named by women and those named by MSW (aOR: 1.1; 95% CI: 0.6–2.3). Only social contact type, in addition to sex or sexual risk behavior, independently predicted whether the social contact had a newly identified infection ($P = 0.01$). Type-2 social contacts (i.e., persons known to have an HIV-infected partner) had higher odds of being newly diagnosed with HIV infection, compared with type-3 social contacts (i.e., others who might benefit from testing) (aOR: 2.1; 95% CI: 1.3–3.4). No significant difference was reported between the odds of being newly diagnosed with HIV infection comparing type-1 (i.e., persons with symptoms indicative of disease) with type-3 social contacts (aOR: 0.84; 95% CI: 0.2–3.6).

In multivariable analysis, the odds of having any HIV infection (i.e., previously or newly diagnosed) were greater among social contacts named by MSM than among those named by MSW (aOR: 3.3; 95% CI: 2.6–4.4) (Table IV). Similarly, odds of any HIV infection were higher among social contacts of women, compared with those of MSW (aOR 1.3; 95% CI: 1.0–1.7). All of the predictor variables in the model (index patient sex or sexual risk behavior, age, race/ethnicity, whether the social contact was a suspect or associate and social contact type) independently predicted the likelihood of any HIV infection among social contacts.

Number Needed to Identify a New Infection

Finally, we calculated the number of social contacts who would need to be named to identify 1 new HIV infection. Among 3,141 MSM index patients, 46 named ≥1 social contact in whom HIV infection was newly diagnosed (Table II). Among all social contacts named by MSM, 54/1,520 were newly identified with HIV, indicating that approximately 28 (95% CI:

22–38) social contacts had to be named to identify 1 new infection (Table IV). Taking into account the distribution of how many social contacts were named, we estimate that DIS would need to interview 83 MSM index patients and their social contacts to identify 28 social contacts and 1 new infection. By comparison, 16/3,361 MSW index patients named 1 social contact in whom HIV infection was newly diagnosed (Table II). Among 1,045 social contacts named by MSW, 16 new infections were identified indicating that approximately 65 (95% CI: 44–127) social contacts would need to be named (Table IV). Overall, DIS would need to interview 271 MSW index patients and their social contacts to identify 1 new HIV infection. Among women index patients 23/2,681 named 1 social contact in whom HIV infection was newly diagnosed (Table II); 23 new infections were identified among 1,287 named social contacts (Table IV). Approximately 56 (95% CI: 40–93) social contacts would need to be named. DIS would need to interview 137 women index patients and their social contacts to identify 1 new HIV infection.

Discussion

Our findings demonstrate that public health officials can identify previously undiagnosed HIV infections by interviewing and testing social contacts, particularly those named by MSM. Identifying persons with previously undiagnosed HIV infection is considered an important part of controlling the HIV epidemic. Persons who know they are HIV-infected can enter care and begin antiretroviral therapy and treatment for opportunistic infections to decrease morbidity and mortality. Lower viral loads are also associated with decreased infectivity and transmission (21–24). Furthermore, knowledge of one's positive HIV status might result in decreased risk behavior and provide an opportunity to intervene and mitigate risk (25–28).

The nature of social networks through which HIV and other infections are transmitted is changing. For example, certain MSM seek partners through Web sites and digital applications, forgoing the traditional bar or club (14, 29). As the nature of social networking changes, we need new ways of identifying those at risk in order to better control disease outbreaks. Cluster investigation, or interviewing and testing social contacts, may be one additional tool in the arsenal. Louisiana, Georgia, and Alabama have reported using cluster investigation during syphilis contact investigations (8–11). Mississippi reported interviewing social contacts during HIV contact investigation but did not evaluate the yield of new cases among social contacts (12). Although the reported yield has been low during syphilis investigations, the Centers for Disease Control and Prevention guidelines suggest that cluster investigation can be useful during outbreak investigations (6, 8). The cluster interview presents an opportunity to reiterate prevention messaging to all social contacts, and particularly to those with newly or previously identified HIV infection. In addition, eliciting names of social contacts might provide index patients with the opportunity to discreetly identify partners who are at increased risk for infection but whom the index patient might not want to name as a partner.

Our study indicated that black MSM named greater numbers of social contacts than white MSM, and social contacts of MSM had increased odds of having a newly identified HIV infection. The number of new infections among black males 13–24 years of age nationally

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has increased during recent years, particularly among MSM who have a greater HIV infection prevalence and are often unaware of their infection status (30–32). This finding is particularly relevant in North Carolina, given the recent outbreak of acute HIV infections among young black MSM that was first noted during late 2008 (13, 14). Because black MSM are at increased risk for HIV infection within the United States, including North Carolina, further studies are needed to devise and assess strategies for decreasing risk for infection and encouraging earlier diagnosis.

Although this study establishes that interviews of social contacts can identify a limited number with previously undiagnosed HIV infection, doing so is resource-intensive. DIS in North Carolina interviewed 795 social contacts affiliated with persons with newly identified HIV infections during 2009 (Todd Vanhoy, personal communication, 2011). No estimates in the literature of the cost of identifying, interviewing, and testing social contacts are available. This information has not been assessed in North Carolina, nor did we conduct any cost analyses. Cost-effectiveness studies of sex and needle-sharing partner notification indicate that identifying infected and uninfected partners prevents infections and saves money, particularly among persons at high risk (e.g., MSM) (33). Although the assumptions of such analyses are not necessarily applicable to social contacts, the findings for sex and needle-sharing partners might also be true for identifying infected social contacts among these same persons at high risk (34). In fact, our findings indicate that interviews and testing, at least among social contacts named by MSM, find new infections at a frequency similar to that reported with partner notification for persons with new HIV diagnoses. For example, as previously published, 209 persons with newly diagnosed HIV infection were identified among 6,238 sex or needle-sharing partners named by MSM index patients in North Carolina during the same period (17), indicating that approximately 30 (95% CI: 26–34) sex and needle-sharing partners would need to be named to identify a single new infection, comparable with naming 28 social contacts to identify a single new infection. As discussed above, identifying a single new infection would require interviewing 28 social contacts and 83 MSM index patients. Using estimates from syphilis investigations (35), a phone call to arrange an interview and a field visit to perform an interview would likely require 130 minutes of DIS time per interview. Therefore, to identify one new infection would require 14,430 minutes, 240.5 hours, 6 weeks or 0.12 FTE. North Carolina DIS salary is approximately $42,000, so cost could be estimated at $5,040 per newly identified infection. By comparison, community-based screening event costs have ranged from $40–$86,579 per identified syphilis case (36). Among those social contacts named by MSM who were subsequently tested (54/601), only 11 tests would be needed to identify a new infection. Because fewer social contacts of MSM need to be named and tested to identify a single new infection than for MSW or women, focusing on social contacts named by MSM might be more cost-effective than testing social contacts named by other index patients and might be a consideration if resources are limited. Interestingly, our study further found that type-2 social contacts, those known to have a partner infected with HIV, were more likely to have a previously undiagnosed HIV infection than social contacts with symptoms indicative of disease or those who could otherwise benefit from testing. This finding could mean that index patients are not aware of symptoms indicative of HIV infection. Further, in light of the resource intensive nature of cluster investigation, this finding may suggest that focusing on

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testing these social contacts could be another way to improve cost effectiveness. Additional studies are needed to confirm this possibility.

Among limitations of our study was the potential for differential practices among DIS. Ideally, all persons in North Carolina who first test positive for HIV and their partners will be asked to list social contacts. However, identification and testing of social contacts might have differed among regions or on the basis of index patient sex or sexual risk behavior or other characteristics. Preferential screening of social contacts named by certain index patients might have resulted in an under- or overestimation of the probability of identifying previously undiagnosed infections. Furthermore, social contacts might have been misclassified as suspects versus associates or with regard to type, and such misclassification might have differed on the basis of certain characteristics of the index patients. Additionally, certain index patients might have named partners as social contacts. Although this practice might have artificially inflated the risk for new infection attributed to social contacts, it ultimately could have contributed to identifying persons with previously unidentified HIV infection and could have resulted in decreased transmission, an important public health goal. In addition, MSM, particularly black men who may not self-identify as gay, may have been misclassified as MSW. DIS attempted to avoid this misclassification by asking about behavior rather than identity. However, such misclassification would likely have resulted in a decreased difference between MSM and MSW and would have attenuated our effect measure but is unlikely to have altered our interpretation. In addition, MSM are a heterogeneous group; we were unable to perform additional analyses further characterizing the study MSM population and who among these persons were more likely to name HIV-infected social contacts. Although we noted that the number of social contacts named varied by sex or sexual risk behavior and race, we had too few patients to assess the effect of race on the risk of having a previously undiagnosed infection. Furthermore, we excluded 8% of index patients for whom demographic data were missing. These patients could be markedly different than those that were included, as could their social contacts. However, the percentage of missing data is small and unlikely to have altered our conclusions. Finally, generalizability of our findings is limited to states with similar protocols for investigating and responding to HIV cases.

In conclusion, our study indicated that testing social contacts of persons receiving new HIV diagnoses identified previously undiagnosed HIV infections and might be useful as a strategy to prevent HIV transmission. Screening in any health care setting where HIV prevalence is ≥0.1% is associated with cost-effectiveness similar to that reported when screening for other chronic conditions (37, 38). At least 2% of social contacts named had a newly identified HIV infection regardless of index patient sex or sexual risk behavior. Our findings demonstrate that screening is particularly important among social contacts named by MSM index patients, because the prevalence of newly identified infection among such social contacts tested was 9.0%. Testing of social contacts provides an opportunity to identify persons previously unaware of their HIV infection and link them to treatment and prevention services to protect their own health and potentially to decrease the likelihood of HIV transmission.

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Table I

Selected Demographic Characteristics and Risk Factors Among HIV-Positive Persons, by Sex or Sexual Risk Behavior — North Carolina, November 1, 2002–October 31, 2007[a]

	MSM (n = 3,141) No. (%)	**MSW (n = 3,361) No. (%)**	**Women (n = 2,681) No. (%)**
Age group (yrs)			
18–23	505 (16)	180 (5)	277 (10)
24–30	656 (21)	391 (12)	430 (16)
31–40	1,002 (32)	1,003 (30)	859 (32)
≥41	978 (31)	1,787 (53)	1,115 (42)
Race/ethnicity			
Hispanic	161 (5)	338 (10)	163 (6)
Black	1,605 (51)	2,252 (67)	2,000 (75)
White	1,243 (40)	591 (18)	391 (15)
Other	50 (2)	38 (1)	45 (2)
Any drug use[b]	1,059 (34)	1,276 (38)	927 (35)
Injection drug use	102 (3)	316 (9)	167 (6)
Noninjection drug use	997 (33)	1,148 (36)	851 (33)
Acute HIV infection[c]	74 (2)	23 (1)	23 (1)

[a] 104 missing age; 411 missing race/ethnicity; 107 missing information about any drug use; 129 missing information about acute HIV infection. Percentage totals may not add up to 100 because of rounding.

[b] Drug use reported during the year prior to interview.

[c] Acute HIV was defined previously as "(1) a positive nucleic acid amplification test (NAAT) from a specimen with negative or indeterminate antibody result or (2) a positive NAAT, antigen test, or antibody test from the specimen of a person who had a negative or indeterminate HIV test within the preceding 30 days" (17).

HIV, human immunodeficiency virus; MSM, men who have sex with men; MSW, men who have sex with women.

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Table II

Number of Social Contacts Identified During Case Investigations by Index Patient Sex or Sexual Risk Behavior — North Carolina, November 1, 2002–October 31, 2007

	MSM (n = 3,141) No. (%)	MSW (n = 3,361) No. (%)	Women (n = 2,681) No. (%)
Number of social contacts identified			
0	2,506 (80)[a]	2,846 (85)	2,042 (76)
1	353 (11)	311 (9)	369 (14)
2	113 (4)	95 (3)	149 (6)
≥3	169 (5)	109 (3)	121 (5)
Number of social contacts newly identified with HIV			
0	3,095 (99)	3,345 (100)	2,658 (99)
1	40 (1)	16 (1)	23 (1)
2	4 (0)	0	0
≥3	2 (0)	0	0

[a]Total percentages may not add up to 100 due to rounding.

MSM, men who have sex with men; MSW, men who have sex with women; HIV, human immunodeficiency virus.

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Table III

Mean Number of Social Contacts Identified By Index Patient Sex or Sexual Risk Behavior and Index Patient Race/Ethnicity — North Carolina, November 1, 2002–October 31, 2007[a]

	Mean (Min, Max)	Adjusted Ratio[b] (95% CI)
White		
MSM	0.3 (0, 12)	1.2 (0.9–1.6)
Women	0.7 (0, 14)	2.3 (1.6–3.4)
MSW	0.2 (0, 11)	1.0
Black		
MSM	0.7 (0, 26)	1.5 (1.3–1.8)
Women	0.5 (0, 43)	1.3 (1.1–1.5)
MSW	0.4 (0, 24)	1.0
Hispanic		
MSM	0.2 (0, 21)	1.4 (0.8–2.5)
Women	0.3 (0, 3)	1.4 (0.8–2.5)
MSW	0.2 (0, 7)	1.0
Other		
MSM	0.4 (0, 7)	1.0 (0.3–3.3)
Women	0.6 (0, 9)	1.6 (0.5–5.3)
MSW	0.3 (0, 3)	1.0

[a]Persons with unknown race/ethnicity, sex or sexual risk behavior, age group, drug use, or acute HIV status (n = 766) excluded from analysis.

[b]Model includes sex or sexual risk behavior, age group, race/ethnicity, interaction between sex or sexual risk behavior and race/ethnicity, noninjectable drug use, and acute HIV status.

CI, confidence interval; MSM, men who have sex with men; MSW, men who have sex with women; HIV, human immunodeficiency virus.

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Table IV

HIV Infection Among Social Contacts by Index Patient Sex or Sexual Risk Behavior — North Carolina, November 1, 2002–October 31, 2007 (n = 3,852)[a]

	No. of Infections/No. Tested (%)	No. Needed to Test to Identify One New Infection[b]	No. of Infections/No. Named (%)	No. Needed to Name to Identify One New Infection[b]	Adjusted Odds Ratio for New Infection Among Those Named (95% CI)
Newly identified HIV Infection[c]					
MSM	54/601 (9.0)	11	54/1,520 (3.6)	28	2.4 (1.3 to 4.6)
Women	23/639 (3.5)	28	23/1,287 (1.8)	56	1.1 (0.6 to 2.3)
MSW	16/522 (3.1)	33	16/1,045 (1.5)	65	1.0
Any HIV infection[d]					
MSM	N/A	N/A	467/1,520 (30.7)	N/A	3.3 (2.6 to 4.4)
Women	N/A	N/A	228/1,287 (17.7)	N/A	1.3 (1.0 to 1.7)
MSW	N/A	N/A	159/1,045 (15.2)	N/A	1.0

[a] Adjusted for age, race/ethnicity, social contact type, and suspect or associate status.

[b] Rounded to nearest whole number.

[c] Compared with social contacts without infection or with previously identified infection.

[d] Compared with social contacts without infection.

HIV, human immunodeficiency virus; CI, confidence interval; MSM, men who have sex with men; MSW, men who have sex with women.