

HIV Outbreak Control With Effective Access to Care and Harm Reduction in North Carolina, 2017–2018


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Objectives. To assess and control a potential outbreak of HIV among people who inject drugs in Western North Carolina.

Methods. Disease intervention specialists offered testing for hepatitis B and hepatitis C, harm reduction materials, and linkage to care to 7 linked people recently diagnosed with HIV who also injected drugs. Contacts were offered the same services and HIV testing. HIV genotype analysis was used to characterize HIV spread. We assessed testing and care outcomes by using state surveillance information.

Results. Disease intervention specialists contacted 6 of 7 linked group members and received information on 177 contacts; among 96 prioritized contacts, 42 of 96 (44%) were exposed to or diagnosed with hepatitis C, 4 of 96 (4%) had hepatitis B, and 14 of 96 (15%) had HIV (2 newly diagnosed during the investigation). HIV genotype analysis suggested recent transmission to linked group members and 1 contact. Eleven of 14 with HIV were virally suppressed following the outbreak response.

Conclusions. North Carolina identified and rapidly responded to an HIV outbreak among people reporting injecting drugs. Effective HIV care, the availability of syringe exchange services, and the rapid response likely contributed to controlling this outbreak. (*Am J Public Health.* 2020;110:394–400. doi:10.2105/AJPH.2019.305490)

 See also Cranston, p. 276.

Among people diagnosed with HIV in the United States in 2017, 9.4% of the transmission was attributed to injection drug use¹; in North Carolina it was 4%.² These figures have remained stable for the past 5 years. However, poor health outcomes associated with injection drug use, including death from overdose, have increased dramatically both nationally³ and in North Carolina.⁴ While these outcomes may be attributable to the use of increasingly dangerous drugs such as fentanyl, it is also possible that an increase in overall injections of drugs is a contributor; if so, an increase in HIV transmission related to injection drug use could also be expected.

This scenario was observed in 2014, when a severe outbreak of HIV and HCV infections was detected among people who inject drugs in Scott County, Indiana.⁵ Following that outbreak, the Centers for Disease Control and Prevention conducted an analysis to

identify counties vulnerable to a similar outbreak.⁶ Many of the identified high-risk counties were in the rural and low-income Appalachian regions of the United States, including North Carolina's Appalachian region. Like other states, North Carolina tracks reports of injection drug use among people newly diagnosed with HIV, particularly in counties identified by Centers for Disease Control and Prevention and the North

Carolina Division of Public Health (NC DPH) as at high risk for an outbreak.

Concurrent with these efforts, work by harm-reduction advocates in North Carolina resulted in the successful passage of legislation legalizing syringe exchange organizations in 2016. Although syringe exchange services had been operating in North Carolina before 2016 (C. R. C., oral communication, December 10, 2018), because of this legalization and publicity around poor health outcomes attributed to injection drug use, funding and subsequently the number of consumers served by syringe exchange services increased between 2016 and 2018.⁷ In 2018, syringe exchange services were serving 34 of the 100 counties in North Carolina.

Also concurrent with these efforts, North Carolina has improved access to care for HIV. Each county in North Carolina has a local health department that offers free testing and treatment of sexually transmitted infections. More than 95% of people newly diagnosed with HIV in North Carolina each year are interviewed to ensure partner notification, collect information about people living with HIV and their transmission risk, and ensure linkage to care (V. M., North Carolina Division of Public Health Field Services Unit, e-mail communication, January 10, 2019). In 2018, 91% of people

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Note. The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

newly diagnosed with HIV were linked to care within 6 months.⁸

In early 2018, a review of cases in western North Carolina identified an increase in new HIV diagnoses among people who inject drugs in that region, from 2 cases in 2016 to 10 in 2017. Upon further investigation, NC DPH identified a group of 7 epidemiologically linked people (i.e., people naming each other as sexual or needle-sharing partners) who reported injection drug use, among whom 5 were diagnosed with HIV between 2017 and early 2018 from 3 neighboring counties. To investigate this increase, the NC DPH mounted a public health response. The response included molecular surveillance for HIV and phylodynamic analysis of HIV genetic sequences; these techniques were novel to HIV outbreak response in North Carolina. We hypothesized that use of heroin or other opioids by injection would be more prevalent in this group than among other groups of people with HIV and their contacts, and that we would find more than 5 new cases of HIV resulting from transmission between people injecting drugs.

METHODS

The investigation covered an area centered on 3 counties in the western region of North Carolina. During the outbreak response, disease investigation specialists attempted to interview all people living with HIV identified in the original group of 7 (referred to as the outbreak group) to collect demographic, clinical, sexual exposure, and drug use information. Disease investigation specialist intervention with members of this group not in care for HIV also included attempts to make care appointments and confirm that appointments were attended. Disease investigation specialists also attempted to interview contacts referred by the outbreak group; this investigation was focused on injection drug use partners. People were identified as epidemiologically linked to the group if referred by an outbreak group member or their contacts during the investigation conducted during March through

October 2018. Contacts included primary sex and needle-sharing contacts (named by someone in the original group), secondary contacts (named by a primary contact), and tertiary contacts (named by a secondary contact). Attempts were made to locate and offer testing to all contacts.

Positive laboratory test results for confirmed HIV⁸; acute or chronic hepatitis B (HBV), confirmed^{9,10}; and acute or chronic, confirmed or probable HCV^{11,12} were reported to NC DPH; patients were also tested for syphilis, but there were no positive results. All data collected, including laboratory results, clinical and risk data, and contact investigation results were captured in North Carolina's electronic disease surveillance system. We constructed network diagrams based on partnership information at the beginning and monthly following the investigation by using UCINET (version 6.682) and Netdraw (version 2.168; Analytic Technologies, Lexington, KY).

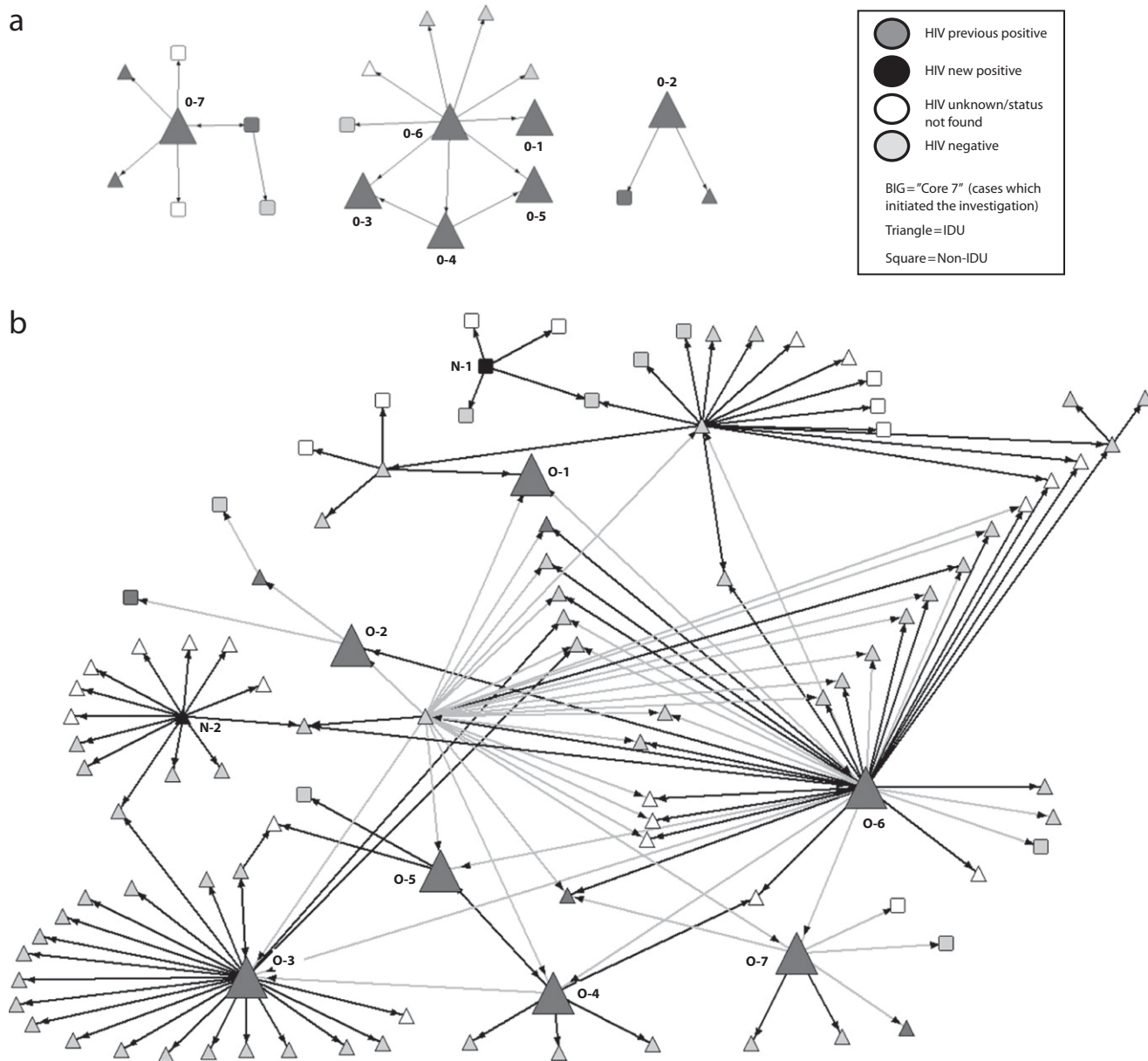
HIV nucleotide sequences were reported by reference laboratories each month.¹³ Molecular clusters were identified as previously described¹³ as identification of 2 or more persons with reverse transcriptase and protease sequences with TN-93 pairwise genetic distances of 1.5% or less. Outbreak-linked clusters were confirmed and further interrogated using phylogenetic trees. We conducted phylodynamic analyses as previously described¹⁴ in BEAST version 2.4.8¹⁵ using the GTR + γ model of nucleotide substitution, a Bayesian Skyline coalescent prior, and a relaxed log-normal molecular clock to evaluate transmission timing and the effective reproductive number (R_e) within a single cluster at the center of the outbreak investigation. This evaluation of transmission timing allowed us to estimate the years over which the outbreak transmissions occurred.

We assessed the number of contacts located, interviewed, and newly diagnosed with HIV, HBV, or HCV. A person was considered newly diagnosed with HIV if the laboratory results indicated confirmed HIV infection and no record of earlier diagnosis could be identified, and previously diagnosed if a record of diagnosis

before the outbreak period existed in North Carolina surveillance records. We counted the number of new diagnoses of HIV in genetic clusters containing outbreak group members and the number and proportion of people with HIV linked to care and virally suppressed (<200 virus copies per mL). We also summarized the drugs reported to be used by injection in this network. We used network links (both social and genetic) to understand whether new HIV cases were linked to the outbreak group and could be considered as spread of the outbreak. We used indicators of linkage to care (Medicaid HIV appointment date, HIV Medication Assistance Program drug dispense, CAREWare appointment date, CD4 test result date, HIV viral load result date) and viral load information to determine public health success in decreasing exposure to HIV in the outbreak network.

RESULTS

In March of 2018, disease investigators attempted to contact the 7 original linked group members. Figure 1a shows the social network links known at the beginning of the investigation, including the linked people newly diagnosed with HIV and reporting injection drug use. Six of the 7 were successfully contacted, and investigators were informed of 177 primary, secondary, and tertiary injection drug use network contacts. Among this group, 96 people were reported to be linked to the original group by sharing needles (needle-sharing contacts); 28 of these were also linked by sexual partnerships (sex contacts). This group of 96 was prioritized for interview, and these interviews were attempted by the 2 disease investigation specialist staff based in the region and 2 staff temporarily posted to the region. Of these referred contacts, 22 of 96 (23%) were impossible to locate or out of state and 2 were deceased; the remaining 72 (75%) were contacted. The final contact index was 10 contacts interviewed per original case patient. Figure 1b shows the network generated at the close of the investigation, in October 2018. This network shows a



Note. IDU = injecting drug user. These charts show the original group of 7, which was the core of the investigation, and their contacts. Each triangle represents a person reporting injection drug use or named as a needle-sharing partner by a person diagnosed with HIV; squares represent people with no report of injection drug use. Partner type is not indicated. Large triangles indicate the original group of 7 that started the investigation. Shades indicate HIV status: black represents people newly diagnosed with HIV in Western North Carolina on or after March 1, 2018; dark gray represents people diagnosed with HIV before March 1, 2018 (both newly diagnosed people and their contacts); light gray represents people named as contacts who had a negative test result for HIV in 2018; and white indicates people named as contacts for whom no HIV test result is available. Arrows indicate the direction of partner naming. Figure 1a: Social network of original group before investigation (March 2018); the original group of 7 (indicated by large triangles) is labeled O1–O7. Figure 1b: Social network following investigation (October 2018). Dark lines indicate the new connections identified during the investigation, while light lines indicate the connections shown in Figure 1a.

FIGURE 1—Social Network Diagram of (a) the Outbreak Group and (b) Their Contacts Residing in Western North Carolina: January 2017–March 2018

highly linked component of people reporting injection drug use; this group was linked by few connections to networks of other people diagnosed with HIV in the region.

Among the total group investigated (n = 103; 7 members of the original group and 96 contacts), 41 (40%) were women and 62 (60%) were men (0 transgender). Ages ranged from 20 to 63 years, and the majority were

middle-aged (median = 36 years; interquartile range = 30–44 years). The majority reported being non-Hispanic White (96%), 2 reported being Asian, and 2 reported being White and Hispanic.

Disease and Care Outcomes

Sixty-five of the 96 contacts were tested for HIV and HBV infection and either past or present HCV infection during the investigation, and test results for an additional 29 were found in surveillance data. Of the total 96, HCV exposure was identified in 42 (44%; 20 with HCV antibody test results with or without HCV RNA testing for current viremia during the investigation, 22 with HCV detected from surveillance records), current HBV infection was identified in 4 (4%; 2 diagnosed during the investigation), and current HIV infection was identified in 14 (15%; the original linked group of 7, 5 identified from surveillance records and diagnosed before 2017, and 2 diagnosed during the investigation). Nine of the 14 people with HIV had confirmed HCV coinfection including 6 of the original group. Figure 2 shows testing outcomes.

Nine people newly or previously diagnosed with HIV participated in a full case interview as part of this investigation and provided information on the drugs being used. They reported injecting methamphetamines (named by 6 people; 66%), heroin (n = 1; 11%), narcotics or other nonheroin opioids (n = 2; 22%), and cocaine (n = 1;

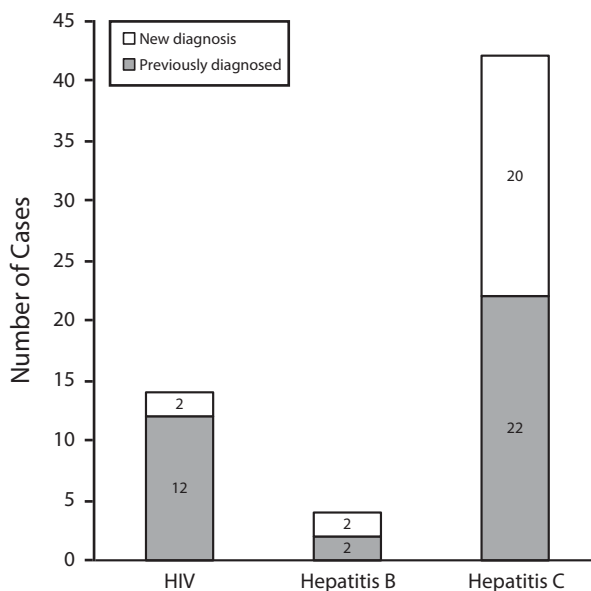
11%). In comparison, among the 43 people newly diagnosed with HIV in 2017 and reporting injection drug use who were not linked to this investigation, the injecting use of heroin (n = 12; 28%) was most frequently reported, followed by methamphetamines (n = 11; 26%), cocaine (n = 9; 21%), narcotics or other opioids (n = 4; 9%), and crack (n = 4; 9%).

Genetic clusters were identified from 12 243 people living with HIV in North Carolina with available viral sequences, including all the people identified in the network as investigation cases. Five of the outbreak group and 1 person newly diagnosed with HIV were linked in a primary genetic cluster containing a total of 14 individuals diagnosed between 2011 and 2018 (Figure A); within this genetic cluster, 6 people linked in the investigation reported injection drug use. Phylodynamic analyses identified the primary genetic distance cluster as a single phylogenetic cluster, where the 6 people reporting injection drug use comprised a distinct subcluster. Based on this phylodynamic analysis, 5 of these 6 transmissions were estimated to have originated after 2016, suggesting a recent outbreak. The phylogenetic cluster showed 2 or more

transmissions per year and an R_e of 1.6 (95% highest probability density interval = 0.5, 2.9; Figure A). No cases linked to the cluster containing 5 of the 7 investigation cases have been identified between the investigation and the writing of this article, although people have been newly diagnosed with HIV in the region and linked to other genetic clusters.

All people testing positive during the investigation were referred to providers of care and treatment of HIV, HCV, and HBV by trained linkage counselors. Before the commencement of the investigation, 7 of 7 people in the original linked group had been linked to care for HIV at the time of their diagnosis. Three of the 7 had records of viral suppression within the 12 months before the investigation; the remaining 4 were assumed to be not virally suppressed. Although information on use of the syringe exchange was not collected from all investigation participants, some did report use of the exchange, including 2 people living with HIV.

Care and viral suppression dynamics for the outbreak group and the 2 people newly diagnosed are shown in Figure 3. At 6 and 12 months following the identification of the outbreak, we reviewed care outcomes following the investigation. In October 2018 (6 months), all of the 7 outbreak group members and the 2 newly diagnosed people had accessed care for HIV and 8 of these 9 people were virally suppressed. As of March 2019 (12 months), 5 of 7 people in the original group and both people newly diagnosed during the investigation remained virally suppressed; 1 of the original 7 was deceased in March 2019, and 1 did not have care records during the 12 months between February 2018 and February 2019 and is considered to be out of care. The 7 remaining people living with HIV linked to the outbreak (diagnosed with HIV before 2017 and not genetically linked to the outbreak cluster) had accessed HIV care at least once since diagnosis; 6 of 7 were in care as of March 2019 and 4 of 6 were virally suppressed.

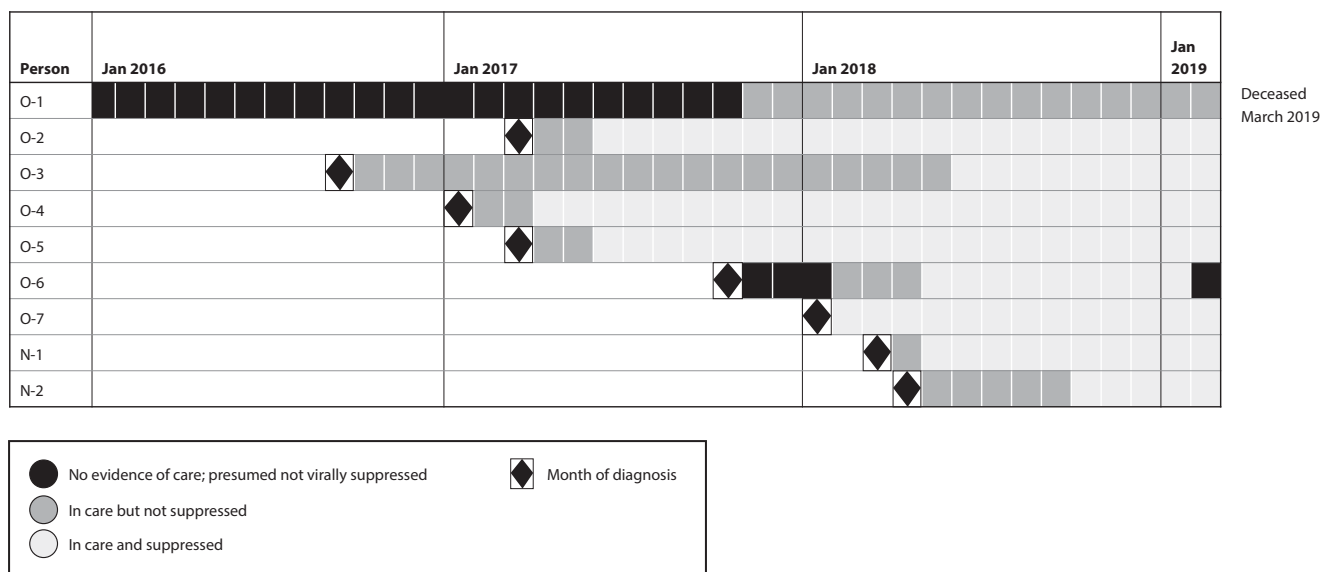


Note. HIV represents confirmed cases; hepatitis B, confirmed acute or chronic cases; hepatitis C, confirmed acute and confirmed or probable chronic cases. The total number of people in the network was 96.

FIGURE 2—Number of People Diagnosed With Bloodborne Disease in the Investigated Network Through May 2018: Western North Carolina

Programmatic Interventions

NC DPH created communication and training programs to support local health care services. Group conference calls and other communication efforts were made for a group that included local health department staff



Note. Month of diagnosis (striped), months with no evidence of medical care based on surveillance records (black), evidence of regular access to medical care but viral loads greater than 200 copies per milliliter (gray) and evidence of regular access to care and suppressed viral loads (pale gray) are shown across the estimated outbreak period. Rows O-1 through O-7 show the 7 original group members, and N-1 and N-2 are the 2 people newly diagnosed with HIV.

FIGURE 3—Viral Load Dynamics Among the Original Group of Outbreak Case-Patients During the Outbreak: Western North Carolina, 2016 to January 2019

from the 27 counties in the western region of North Carolina, syringe service providers, and community-based HIV organization staff. NC DPH staff worked to increase awareness among local health department staff of the availability of hepatitis A and HBV vaccine. Training in rapid test technology for HIV was provided to syringe service providers and local health department staff. A small number of contacts contacted during the investigation reported use of local syringe services; syringe service information was provided to those not already aware of the service, in addition to other harm-reduction information and harm-reduction kits containing materials for hygiene and wound care. Longer-term collaboration with syringe service providers has resulted in several collaborative testing events where state HCV linkage counselors and outreach workers worked with syringe service staff to host the event and provide phlebotomy and linkage services.

DISCUSSION

This public health investigation identified a cluster of recent HIV transmissions among a

group of people reporting injection drug use with a wide contact network, suggesting the potential for a large outbreak. Our hypotheses were not supported (neither heroin nor other opioids were the most frequently injected drug; we found only 2 new cases), suggesting that this outbreak is different from previously reported outbreaks of HIV among people injecting drugs.^{5,16} Our early and rapid response and community support ensured that people both newly and previously diagnosed with HIV were engaged with medical care. Although this community was rural and low-income, with the support of state personnel, staff of community-based organizations, and community providers, most people living with HIV linked to the outbreak achieved and maintained viral suppression.

High completeness of sequence data in the outbreak region allowed the supplementation of contact tracing network information with molecular data. Sequencing results indicated no additional linked cases, suggesting that the allocation of additional investigation and linkage to care resources to the region may have prevented further transmission. This finding is encouraging because the primary cluster showed an effective reproductive number of 1.6 in phylodynamic analyses and

may have continued to expand in the absence of intervention.

We observed several differences between this outbreak and larger outbreaks among people who inject drugs, including the Scott County outbreak.^{5,16} First, North Carolina's outbreak was recognized early in development because of excellent disease investigation work and capture of partner data in our surveillance system, regular data review, and good communication with local colleagues. Second, this community was supported by syringe exchange services. Finally, this outbreak occurred in an area with access to health care for HIV. Access to health care in this area includes several HIV care practices within the affected counties with capacity to take on new patients and a strong commitment to working as an integrated network, the availability of Ryan White-funded medical care, the HIV medication assistance program, and support from state and local linkage counselors. Rapid access to care and treatment of HIV with subsequent viral suppression decreases the potential risk to the larger community. Overall, 68% of people known to be living with HIV in North Carolina were retained in care

in 2018; among people diagnosed in the past 5 years, this rate was 73%.

While only a small number of new HIV cases were identified, a higher proportion of people involved in the network had evidence of HBV or HCV exposure or infection. This created an opportunity to perform integrated testing and linkage to care, and therefore serve this community more effectively at both the public health and provider levels. A final benefit of this integrated outbreak response was the ability to communicate about this kind of outbreak (bloodborne and characterized by multiple infections) to providers in the region.

This analysis was subject to certain limitations. Following our normal practice, the extensive interview performed with people diagnosed with disease was not performed with contacts; therefore, information on the use of specific drugs such as methamphetamine, and protective behaviors, including use of a syringe exchange, was not available from this group. This limits our ability to draw conclusions about the use of syringe exchange services in preventing the spread of disease. It is important to recognize that some people living with HIV and contacts did report using the syringe exchange, which is likely to have decreased the risk of HIV transmission. Given that injection drug use is a stigmatized behavior, participants may have been reluctant to refer contacts to our disease investigators, and, therefore, the outbreak network may be larger than shown here; however, the high contact index suggests effective relationship building between disease investigation specialists and the affected community. Finally, the people not located for testing may have HIV, HCV, or HBV, and the true prevalence in the group may be higher than we were able to detect.

Public Health Implications

We found a relatively high prevalence of HIV in this group (15%) but limited spread of HIV linked to this outbreak. Our findings were in agreement with findings of high HCV test positivity, but not in agreement with findings of low HIV prevalence (0%–3%) in a small number of studies among nonurban people reporting injection drug use^{17–21} and a national estimate of HIV prevalence among people reporting ever

having injected drugs (2%).²² In fact, our finding was more similar to studies of cities, where HIV prevalence among people injecting drugs in the past year is higher (9%).²³ This may reflect the high proportion of testing in the outbreak group and their contacts; the quoted nonurban studies include self-report data and may be underreporting true HIV prevalence. Alternatively, the higher HIV prevalence may reflect contained outbreaks of more than 1 genotype. Despite the higher prevalence, we found limited spread of the outbreak genotype, suggesting 2 possibilities: either that some injection-associated exposure, possibly very frequent injection as suggested by the Scott County outbreak, may be required for widespread HIV transmission in injection drug users, or that access to HIV care and viral suppression, even if incomplete, may have protected North Carolina against several potential outbreaks.

Effective linkage to care and treatment of HIV likely halted the spread of HIV in this setting. In general, because of fewer providers, longer travel distances, and increased stigma, accessing HIV care is more difficult in rural areas.²⁴ To support people with HIV, in North Carolina, state health department staff are assigned to ensure that an initial care appointment is scheduled for people newly diagnosed with HIV (disease investigation specialist) and to ensure that a first appointment was attended (linkage counselor). As a result of this investment and the commitment of local HIV care providers, rapid linkage to care and viral suppression was achieved for most even in this rural setting. Effective collaboration between government agencies and local providers, including syringe service providers, can support rural communities to decrease the risk for disease transmission via injection drug use.

Only 3 of 9 people with HIV interviewed during the investigation reported injection use of heroin or opioids; reported use of methamphetamines by injecting was more frequent, and the 3 reporting injecting heroin or opioids also reported injecting methamphetamine. Although fentanyl was an important component of the outbreak that occurred in Massachusetts,¹⁶ it does not appear to have been central in this outbreak. Our investigation suggests that a true outbreak was created in a setting where heroin or

other opioids were not the most frequently used drug. Therefore, injection patterns unique to these drugs may not be the only driver of this kind of outbreak, and it is important to consider this kind of outbreak in settings of injection of nonopioid drugs.

Conclusions

Based on regular surveillance review incorporating social and genetic network analysis, North Carolina identified an outbreak of HIV and responded; a small number of additional cases were detected. The intensive response linked people living with HIV to medical care and other services, provided education, and strengthened the testing resources available in the area. Ongoing work to link people newly diagnosed with HIV to medical care and monitor surveillance for potential outbreaks can avert outbreaks of HIV among people who inject drugs. **AJPH**

CONTRIBUTORS

All authors worked together to conceptualize and design the analysis. V. Mobley, M. Hudgins, and C. A. Crowley performed data collection. C. R. Caputo and J. M. Clymore provided data on programmatic interventions. A. B. Cope performed social network analysis, A. M. Dennis and R. M. Billock performed genetic network analysis, and E. Samoff and N. D. Adams performed epidemiological analysis. E. Samoff authored the first draft of the article, and all authors reviewed the article and revised the content.

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Note. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

CONFLICTS OF INTEREST

The authors have no conflicts to disclose.

HUMAN PARTICIPANT PROTECTION

This article describes an outbreak response, for which institutional review board approval is not needed.

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Our Communities Our Sexual Health

Awareness and Prevention for African Americans

Edited By: Madeline Sutton, MD, MPH;
Jo A. Valentine, MSW; and
William C. Jenkins, PhD, MS, MPH

This groundbreaking book provides a comprehensive historical prospective of the disproportionate burden of HIV and other sexually transmitted infections (STIs) among African Americans. Chapters that follow explore the context of HIV and STIs in African American communities and include discussions of sexuality and the roles of faith and spirituality in HIV and STI prevention efforts. Additional chapters provide insight into strategies, e.g., HIV testing, condom distribution and marketing campaigns, parent-child communication, effective clinical care and support, and partnerships, for addressing HIV and other STI-related health disparities within these communities. The book is a valuable resource for practitioners, scholars, clinicians, educators, providers, policy makers and students.



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