

Strategies to link people with undiagnosed HIV infection to HIV testing, care, and prevention services

? Questions

- What strategies have been successful at linking people with undiagnosed HIV infection to HIV testing, care, and prevention services?

🔑 Key Take-Home Messages

- A variety of strategies have shown promise for identifying individuals with undiagnosed HIV and engaging them with HIV testing using clinical, community-based, network-based, and self-directed approaches.
- Various service delivery models for implementing rapid initiation of antiretroviral treatment have demonstrated benefits for linking the newly HIV diagnosed to care (1).
- Integrated programs, using a combination of strategies tailored to specific populations, jurisdictions, and characteristics of local epidemics, may effectively identify previously undiagnosed cases of HIV infection, link them to care, and address barriers (2). These could include routine opt-out testing in clinical or alternative health care settings (such as correctional health clinics), social network testing in the community, updating HIV testing technologies (e.g. fourth-generation testing), partner notification services, or developing navigation and other linkage, retention, and reengagement programs (2).

! The Issue and Why it's Important

Diagnosis is the first step towards the engagement of people living with HIV in treatment and care (3). Early diagnosis through HIV testing, when followed by engagement in care and initiation of antiretroviral therapy, decreases morbidity and mortality, as well as reduces risk of HIV transmission (3). Yet substantial and preventable morbidity and mortality persist among people living with HIV, much of which can be attributed to late or missed opportunities for diagnosis (4).

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While progress has been made in Canada to reach the UNAIDS global target for 90% of people living with HIV to be diagnosed by 2020 (5), an estimated 14% of the approximately 63,000 people living with HIV in Canada were unaware of their status in 2016 (6). This group represents a hidden population that may account for a large proportion of onwards transmissions; a recent U.S. Centers for Disease Control and Prevention (CDC) report found that in 2015, an estimated 14.5% of people living with HIV in the U.S. did not know their status, and 37.6% of new HIV infections were attributable to this group, including those acutely and non-acutely infected (7). Reaching the undiagnosed is critical to ending the epidemic (5).

This review outlines strategies that have been successful at linking people with undiagnosed HIV infection to HIV testing, care, and prevention services.

What We Found

HIV testing is necessary to realize the benefits of HIV treatment, and may also be the gateway to engagement in HIV prevention for those who test HIV-negative, but are still at high risk of infection (3). Many recent studies have explored numerous strategies to increase the uptake of HIV testing, or improve an organizations' capacity for HIV testing, some of which also provide information on linkage to care outcomes. Fewer studies, however, specifically explore strategies to improve linkage to care among those newly diagnosed with HIV. Strategies are discussed in the sections below.

Reaching the undiagnosed in clinical settings

Targeted approaches

In Canada, specific populations such as Indigenous peoples and men who have sex with men are disproportionately affected by HIV compared to the general population (6). This provides evidence for the potential utility of targeted strategies for engaging hard-to-reach individuals (6), like those with undiagnosed HIV. The Public Health Agency of Canada (PHAC) and the CDC recommend at least annual testing for people at high-risk of HIV (8, 9). Researchers have suggested that targeted strategies may address population-specific barriers to HIV testing such as HIV stigma, lack of perceived risk, and lack of knowledge (10). They also suggest that targeted testing can ensure that facilities make the most of limited testing resources by focusing their activities on higher risk populations (3).

GayZone, a gay men's STI/HIV testing and treatment clinic in Ottawa, demonstrated the utility of targeted HIV rapid testing (11). For three hours per week, free HIV testing (anonymous or nominal) was offered to patients based on sexual history and symptoms. Referral to local HIV care physicians, pre-exposure prophylaxis

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(PrEP), and HIV prevention counselling was also provided. A total of 28 individuals were diagnosed with HIV (HIV positivity rate ranging between 0.7% to 1.8% from 2011-2013). This rate reached 3.6% for anonymous HIV testing. This represented between 8% and nearly 20% of all HIV diagnoses across the city of Ottawa during that time period. All of these individuals were previously unaware of their HIV status (11).

However, the implementation of targeted testing in some clinical settings may not be achieving full potential. Some evaluations of existing targeted HIV testing strategies in clinical settings have revealed significant missed opportunities for reaching the HIV undiagnosed. One retrospective cohort analysis in New Zealand examined missed opportunities among adults presenting to a hospital offering risk-based screening (12). Results showed that nearly 34% of individuals who were newly diagnosed over a seven-year period had had contact with medical services prior to diagnosis, and within their estimated window of HIV infection. They also showed that these patients could have been diagnosed earlier by a median of 12 months. Furthermore, more than half of these missed opportunity visits were for conditions that indicated risk for or actual HIV infection – some of which could have been prevented if diagnosed with HIV earlier (12).

Some researchers have suggested that there is a need for alternative provider-initiated targeted HIV testing strategies to those based on risk behaviours (13). Indicator Conditions (ICs) are conditions that tend to affect HIV-infected individuals more frequently, either because they are facilitated by immune deficiency, or they share modes of transmission (14). Many researchers believe that offering HIV testing based on the presence of ICs has the potential to increase HIV testing and reduce stigma, as it removes the need for behavioural risk assessment (13). Using this strategy may also provide a means to prevent missed opportunities for HIV diagnosis. For example, a retrospective case-control study conducted in six general practices in Amsterdam found that 58.8% of new HIV cases had exhibited an HIV IC (most commonly syphilis and gonorrhoea), compared with 7.4% of non-infected controls (13). Results also showed that these patients frequently visited a general practitioner before their HIV diagnosis (13). Similarly, a retrospective cohort data linkage study in Australia showed that sexually transmitted infections (STIs) and certain hospital admissions were common among people estimated to be living with undiagnosed HIV; gonorrhoea diagnosis was 18 times higher among people living with undiagnosed HIV (15). Despite this, the rate of missed opportunities for HIV diagnosis at the time of IC diagnosis was far higher among people living with undiagnosed HIV (2.5 per 1000 person-years) than the general population (0.3 per 100,000 person-years) (15).

Another case-control study using national registry data in Denmark found that during the three-year period prior to diagnosis, 93% of HIV-positive cases had at least one contact with primary health

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care, compared to 88% of general controls during that same time (16). The median number of visits to primary health care was also higher among cases than controls. Nearly half of cases with newly diagnosed HIV were diagnosed in late or very late stages of infection. Many of the procedures performed in the last year before HIV diagnosis were strongly associated with subsequent HIV infection, however authors concluded that targeted testing based on performance of these procedures would not capture a high percentage of the undiagnosed, due to low procedure prevalence (16).

Prompting the offer of IC-targeted HIV testing through electronic medical records (EMRs) and case notes may improve this strategy. An observational study in the UK found that case note prompts highlighting the presence of HIV ICs were associated with a significant increase in HIV test offer in three outpatient departments (34% offered versus 3% without prompt) (14). The overall prevalence of HIV within patients tested was 4.1%, but no new cases of HIV were identified. HIV test offer was still very low, as only 17.6% of patients overall had been offered a test. Authors concluded that this strategy is hindered by clinicians' failure to recognize ICs, as 23% of individuals were not offered an HIV test because the clinician thought testing was inappropriate, despite the test prompt (14).

Routine approaches

Routine testing rests on the concept that testing based on an individual's risk for HIV may not be sufficient to identify all undiagnosed HIV infections (4). Using this strategy, HIV tests are offered to individuals by health care providers, with neither patient nor provider needing to discover or disclose risk factors for HIV – potentially removing stigma-related barriers (3). Testing may be offered in “opt-in” (i.e. being given the opportunity to accept a routine test) or “opt-out” (i.e. being given the opportunity to *decline* a routine test) formats (3). Routine, or universal testing, has been implemented in Canada in a variety of clinical settings (3) and has been recommended by PHAC (8), as well as some provincial governments (such as British Columbia and Saskatchewan) (4, 17), and the CDC (9).

The effectiveness of routine HIV testing for identifying undiagnosed HIV infections has been demonstrated in some clinical settings. For example, results from a Danish case-control study revealed that by testing all adult individuals attending primary health care at least once during a year, approximately 80% of the undiagnosed Danish-born HIV-infected population and 70% of the undiagnosed non-Danish born HIV-infected population could be identified (16).

However, this has not been the case in some clinical settings. One cross-sectional multicentre study conducted in two large cities in the Netherlands (Amsterdam and Rotterdam) investigated non-targeted (i.e. routine) HIV testing in emergency departments at

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two tertiary referral hospitals and one large general hospital (18). Patients who had blood samples taken for clinical care had an active choice (opt-in) to also be tested for HIV. Only two previously undiagnosed HIV infections were identified (0.06% of 3,223 tests administered). Authors concluded that this approach was not cost-effective. Furthermore, since the HIV prevalence is 0.5% in Rotterdam and 0.9% in Amsterdam (approximately 0.12% among undiagnosed persons), they concluded that targeted HIV testing may be more effective in these cities. However, authors noted that various other interventions (e.g. opt-out screening among pregnant women and in STI clinics) already implemented in the Netherlands with high uptake may have contributed to the low percentage of new HIV infections identified (18).

Ineffective implementation of universal testing strategies has been revealed in some settings, potentially explaining missed opportunities. For example, the HPTN 065 study evaluated the offer of universal HIV testing during emergency department visits and inpatient admissions in 16 hospitals in the Bronx, New York and Washington, D.C. between 2011 and 2014 (19). While previously undiagnosed HIV infections were consistently and effectively identified during this study (0.3% to 0.5% of patients tested in New York, 0.4% to 0.7% in of patients tested in Washington), universal testing was not achieved as HIV tests were conducted in less than 25% of patients overall. Authors noted that testing even a small number of patients can have an important cumulative effect on the proportion of individuals newly diagnosed, however additional strategies will be required to realize full potential of universal testing. They also noted that many hospitals did not implement proposed organizational changes, such as eliminating written consent, integrating screening into the triage process, and real-time electronic reminders, that could increase testing (19).

With the implementation of such changes, other settings have demonstrated successes in routine HIV testing. For example, a publicly funded teaching hospital in Cleveland, Ohio implemented an electronic medical record (EMR) prompt that successfully increased routine testing and diagnoses in primary office visits among patients (20). A follow-up of this study compared characteristics of people newly diagnosed (n=89) before and after the intervention (21). Analysis showed that men were more than five times as likely to be newly diagnosed than women, and individuals reporting heterosexual sex were 2.5 times more likely to be diagnosed than other risk groups after the intervention. It also showed that after the intervention, individuals were nearly six times more likely to not have been hospitalized one year prior to diagnosis. Furthermore, for every 50 cells/mm³ increase in CD4 count, diagnosis after the intervention increased by 14%. This meant that the intervention not only reached a subgroup of the population that infrequently uses primary care, but also individuals earlier in disease progression. These patients may have been otherwise undiagnosed until developing symptoms from advanced disease progression (21).

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A quasi-experimental pre-post test study also assessed the impact of implementing EMR prompts for routine HIV testing for hospitalized patients in New York City (22). While the prompt was inactive, 9.5% of 36,610 admissions had an HIV test performed, compared to 21.8% of 18,943 admissions while the prompt was active. The prompt was also associated with increased testing among those without a prior HIV test and those with a prior negative test. While active, the prompt was associated with a diversification of patients who were tested, including populations with historically lower testing rates. That is, the proportion of admissions that were tested increased among patients who were female, in older age groups, black or white, had private insurance, and were admitted to non-medicine services. The rate of new HIV diagnoses increased from 8.2 per 100,000 admissions to 37.0 per 100,000 admissions while the prompt was active versus inactive, respectively (22).

Another study used EMR data to identify patients in three primary care clinics in Seattle who met national criteria for routine HCV or HIV testing and had no documented history of prior testing (23). During the study period, the percentage of previously untested patients tested for HIV and HCV increased from between 15% and 18%, to between 31% and over 35%. Although the percentage of newly diagnosed patients did not increase during the study period (0.7% before and after), the targeted intervention was determined to be successful at increasing uptake of HIV testing (23).

Implementation of other organizational changes, alongside routine HIV testing, have also increased rates of early HIV diagnosis in some settings. In a cluster randomized controlled trial in the UK, 40 general practices were randomly assigned to receive an intervention to offer opt-out rapid HIV testing to adults (n=20; 44,971 patients) or a control group offering testing opportunistically or upon patient request (n=20; 38,464 patients) (24). Intervention practices received an outreach educational program with training for nurses or health-care assistants, integration of rapid HIV testing, and free rapid HIV tests with remuneration for each test completed. During the two-year study period, uptake of HIV testing in intervention practices was 45%, with 32 new HIV diagnoses (a rate of 0.32 per 10,000 patients per year) – compared to 14 in control practices (0.07 per 10,000 patients per year). When excluding diagnoses made through antenatal screening, or those who defaulted from care, mean CD4 count was significantly higher in individuals diagnosed through intervention practices than control practices. All patients diagnosed in intervention practices were successfully linked to care (24).

Implementation of organizational changes to routine testing programs can also effectively link previously undiagnosed individuals with HIV care. In 2013, a Baltimore academic medical centre launched a routine HIV testing initiative with the goal of 75% rates of offer and acceptance of HIV testing, as well as increased linkage to care (25). This included an extensive organizational

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change process consisting of stakeholder buy-in, identification of an interdisciplinary leadership team, infrastructure development, staff education, implementation, and continuous quality improvement. In the first month of implementation, the offer of HIV testing increased from 3% to 49% when this was the responsibility of medical providers. This increased to an average of 89% when both nurses and physicians offered testing. Approximately 80% of individuals who were offered HIV testing accepted it. This resulted in 15 (0.82%) newly diagnosed HIV infections, 14 of which (93%) were linked to care (i.e. attending at least two HIV primary care visits within six months). Additionally, 47% of those previously diagnosed with HIV, but not engaged in care, were linked to care. The process was deemed successful, as the project exceeded its goals, and continues as routine practice within the medical centre. Authors stated that the systematic implementation process was essential to the success of their program, and may serve as a guide for other institutions in areas with a high prevalence of HIV (25).

The conservation of well-implemented routine HIV testing programs can have a considerable contribution to local HIV epidemics. For example, one study assessed the impact of a sustained emergency department-based HIV screening and linkage-to-care program at the Johns Hopkins Hospital in Baltimore (26). Using data from serosurveys conducted between 1987 and 2013, results showed that outcomes for stages of the continuum of care improved significantly with the program: linkage to care increased from between 32% and 77% to between 72% and 88%; the proportion of HIV positive patients with detectable antiretrovirals increased from 27% to 80%; the proportion of virally suppressed patients increased from 23% to 59%; and the rate of newly diagnosed HIV declined from 1.1% to 0.4%, reflecting a significant downward trend in new diagnoses in Baltimore in the same time period (26).

Whether universal testing is offered in opt-in or opt-out formats may also have an impact on its effectiveness as a strategy for identifying cases of undiagnosed HIV. One study found a high undiagnosed HIV prevalence in patients of a Baltimore emergency department not offered testing (27). At the time, the emergency department had an ongoing opt-in rapid oral-fluid HIV screening program. During an eight-week period, blood samples from all patients over 18-years-old with blood drawn for clinical purposes were included, using an identity-unlinked seroprevalence methodology. After excluding known HIV-positive patients, the prevalence of undiagnosed HIV infection was 1% in those offered testing versus 3% in those not offered testing; and 1.3% in those who declined testing compared to 0.4% in those who were tested. Higher viral loads were also observed in those not offered testing. This demonstrated significant missed opportunities, even with an ongoing HIV testing program: only 2.7% of the undiagnosed HIV infected individuals who visited the emergency department during the study period were diagnosed and 84% of undiagnosed individuals had not even been offered an HIV test. Authors suggested that opt-out, clinical staff-driven,

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triage-based, integrated routine testing models may curtail missed opportunities (27).

Gilead Science's HIV on the Frontlines of Communities in the United States (FOCUS) program demonstrated that opt-out routine testing, with a strategic implementation plan, can be more effective than opt-in or targeted testing at identifying new HIV cases and linking these individuals to HIV care (28). The implementation plan was based on four principles: 1) institutional policy changes that reinforced the commitment to routine HIV testing; 2) integration of HIV testing into existing workflows to promote normalization and sustainability; 3) use of EMRs to prompt testing, automate laboratory orders, and track performance and 4) required staff education on HIV testing best practices and outcomes (28). Following the implementation of FOCUS in a New York health centre that previously conducted risk-based screening, the percentage of patients tested for HIV increased from 8% to 56% (28). The proportion of newly diagnosed cases also increased from 16% to 29% of all HIV-positive cases. Finally, 81% of all individuals diagnosed with HIV during the evaluation period were linked to HIV care, none of whom were previously engaged in care. At a New Orleans hospital that had previously conducted opt-in routine testing, the opt-out approach of the FOCUS program increased the proportion of patients tested from 17% and 3% to 26% and 17% in its emergency department and urgent care centre, respectively. The proportion of previously undiagnosed cases increased from 51% to 75% (5% of which were acute HIV infections). Of the 91 patients not already in care, linkage to HIV care was successful for 67 patients (74%). Authors concluded that FOCUS guiding principles contributed to the sustainability and scalability of routine testing, and could be adapted by other health-care settings (28).

In fact, the success of routine HIV testing has led some researchers to explore its implementation in alternative clinical settings. For example, one study initiated a routine HIV and hepatitis C screening and linkage-to-care program in a Level 1 Trauma Center in South Carolina (29). Uptake was 64% and, at 1.1% (n=13), the rate of HIV positivity was almost triple the national average. However, the rate of new diagnoses was less than the national average (0.25% compared to 0.44%). All patients diagnosed with HIV (including those newly diagnosed) received disease-related education, were referred to HIV care or had ongoing HIV care verified prior to discharge (29).

Routine opt-in HIV screening was offered to patients attending a dental school clinic in Los Angeles in another study (30). Testing uptake was 39.3% of whom more than 35% were fist-time testers. Four possible undiagnosed infections were initially identified with testing, with one completing to case confirmation. While this number is low, prevalence of HIV infection through initial screening in this clinic (0.31%) far surpassed that of Los Angeles County (0.018%) (30).

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One multicenter prospective cohort study assessing HIV, and hepatitis B and C in patients with newly diagnosed cancer at 18 oncology institutions in the U.S. found an HIV infection rate of 1.1% (n=34), 5.9% of which were newly diagnosed (31). The low yield of HIV cases caused authors to conclude that universal testing for HIV within this setting may not be effective (31).

Alternative testing methods or strategies

Studies assessing the use of alternative testing methods in clinical settings have promising results. One study described a non-targeted opt-out HIV screening program using a 4th generation antigen/antibody combination HIV assay test in an emergency department in Arizona (32). From 2011 to 2014, 22,468 unique patients were tested for HIV (uptake of 35.6%), and 78 (0.28%) of them were newly diagnosed with HIV. A surprisingly high number of the new diagnoses (n=18; 23%) were acute HIV infections which would have likely been missed with earlier testing technology, and 22 (28%) had AIDS-defining conditions such as CD4 count of less than 200 cells/mL or an opportunistic infection. A major barrier in the HIV testing workflow, according to authors, was the exclusion of patients due to the provider not placing HIV test orders in EMRs despite eligibility, consent, and blood samples taken (32).

A prospective cross-sectional study conducted over a three-month period in 2016 examined the use of point-of-care testing (POCT) for universal HIV screening in medicine inpatient units in Winnipeg (33). If accepted, testing was administered at the bedside, and confirmatory testing was conducted on reactive or indeterminate results. Uptake was less than 50% (144/308) and no cases of previously undiagnosed HIV were identified during the study. However, 65% of patients who participated had never tested for HIV and post-test survey results found that patients would choose this form of testing again (33). Another study evaluated the efficacy and retention-in-care of individuals diagnosed with HIV or HCV during a six-year POCT salivary HIV testing intervention (the EASY-test project) in a hospital in Italy (34). Retention in care was defined as attending at least two visits after diagnosis, engagement in care was defined as starting treatment within one year of diagnosis. During the study 11,549 patients were tested and 79 (0.7%) had reactive results and confirmed HIV positive. Of the 25 patients (34%) who attended the clinic for their tests results, proportions of engagement, retention, and virological suppression were 96%, 100% and 95.2%, respectively (34).

Rapid initiation/referral

Immediate treatment can significantly improve health outcomes among people living with HIV, and may greatly reduce onward transmission (1). The World Health Organization (WHO) recommends rapid referral be provided as early as the day of diagnosis, unless there are clinical reasons to delay treatment (35).

46. Belza MJ, Hoyos J, Fernandez-Balbuena S, Diaz A, Bravo MJ, de la Fuente L, et al. Assessment of an outreach street-based HIV rapid testing programme as a strategy to promote early diagnosis: A comparison with two surveillance systems in Spain, 2008–2011. *European Communicable Disease Bulletin*. 2015;20(14):09.

47. Miller RL, Boyer CB, Chiaramonte D, Lindeman P, Chutuape K, Cooper-Walker B, et al. Evaluating testing strategies for identifying youths with HIV Infection and linking youths to biomedical and other prevention services. *JAMA Pediatrics*. 2017;171(6):532–7.

48. Correctional Service Canada. Health services quick facts: Human immunodeficiency virus (HIV) age, gender and indigenous ancestry. 2016. Available from: <http://www.csc-scc.gc.ca/publications/005007-3034-eng.shtml> Accessed May 31, 2019.

49. Centers for Disease Control and Prevention. HIV testing implementation guidance for correctional settings. 2009. Available from: https://stacks.cdc.gov/pdfjs/web/viewer.html?file=https://stacks.cdc.gov/view/cdc/5279/cdc_5279_DS1.pdf Accessed June 4, 2019.

50. CATIE. Pilot to offer anonymous, rapid point-of-care HIV testing in prisons. 2014. Available from: <http://www.catie.ca/en/pc/program/poc-prisons?tab=quick-facts> Accessed May 29, 2019.

51. Harawa NT, Brewer R, Buckman V, Ramani S, Khanna A, Fujimoto K, et al. HIV, sexually transmitted infection, and substance use continuum of care interventions among criminal justice-involved black men who have sex with men: A systematic review. *American Journal of Public Health*. 2018;108(S4):e1–e9.

In 2017 two Australian organizations (ACON and Positive Life New South Wales) published an evidence brief that outlined implementation studies and models of service delivery (four from high-income countries) that demonstrated the benefits of rapid initiation for linking the newly HIV diagnosed to care (1). These four studies are briefly summarized below:

The first study described the outcomes of an 18-month demonstration project (RAPID) addressing structural barriers to same-day initiation of antiretroviral treatment introduced by the San Francisco General Hospital in 2013 (36). Education regarding HIV infection, risk education and the benefits of treatment were combined with laboratory testing for treatment contraindications into a single visit on the day of diagnosis. Taxi vouchers were provided to facilitate immediate transport from the testing site to the clinic. Five-day starter packs of antiretroviral drugs were provided, as well as assistance with insurance approval. RAPID nurses followed up with patients within the first seven days of diagnosis to review treatment options. Compared to data from 2006–2009, the time to ART initiation was reduced from an average of 128 days to 24 hours, and time to viral suppression reduced from 218 days to 56 days. Of the 39 patients, 94.9% began ART within 24 hours (36).

The second study was a case note review of 113 individuals diagnosed with acute HIV infection at a sexual health clinic in London (37). Results showed that following HIV diagnosis, median time to initiation of antiretroviral treatment was 20 days and 77% of patients started treatment at their first medical appointment (all men who have sex with men). At 24 weeks, no patient had discontinued treatment, and 99% of patients achieved viral suppression (37).

Outcomes from two sexual health clinics in Vancouver offering rapid referral were assessed over nine months in 2013 in the third study (38). As part of the program, diagnosed patients were offered either counselling and referral-to-care or counselling and referral to same-day connection with an HIV specialist, peers, and social workers. Of 19 patients diagnosed with HIV, a total of 84% chose the rapid referral program and on average linked to care within 24 hours (an average of 14 days for those with chronic infection; all decreasing from a pre-intervention average of 21.5 days) (38).

In the fourth study, outcomes were evaluated from 86 newly HIV diagnosed individuals enrolled in a community-based screening program in San Diego (Early Test) who initiated treatment within 30 days (39). Following diagnosis, a return visit was provided as soon as possible, during which time clinical laboratories were performed and immediate, free of charge testing offered. Routine follow-up visits were also performed. Median time from offer of treatment to starting treatment was eight days and 26% initiated treatment at their intake visits. Viral suppression was reached by 79% of participants by week 12, 82% by week 24, and 88% by week 48 (39).

52. Iroh PA, Mayo H, Nijhawan AE. The HIV care cascade before, during, and after incarceration: A systematic review and data synthesis. *American Journal of Public Health*. 2015;105(7):e5–16.

53. Francis-Graham S, Ekeke NA, Nelson CA, Lee TY, Haj SE, Rhodes T, et al. Understanding how, why, for whom, and under what circumstances opt-out blood-borne virus testing programmes work to increase test engagement and uptake within prison: A rapid-realist review. *BMC Health Services Research*. 2019;19(1):152.

54. de la Flor C, Porsa E, Nijhawan AE. Opt-out HIV and hepatitis C testing at the Dallas County Jail: Uptake, prevalence, and demographic characteristics of testers. *Public Health Reports*. 2017;132(6):617–21.

55. Song W, Mulatu MS, Rorie M, Zhang H, Gilford JW. HIV testing and positivity patterns of partners of HIV-diagnosed people in partner services programs, United States, 2013–2014. *Public Health Reports*. 2017;132(4):455–62.

56. World Health Organization. Guidelines on HIV self-testing and partner notification: Supplement to consolidated guidelines on HIV testing services. 2016. Available from: <https://apps.who.int/iris/bitstream/handle/10665/251655/9789241549868-eng.pdf;jsessionid=5301C1257F9742D8073BF32BF5EF3222?sequence=1> Accessed June 4, 2019.

57. Rayment M, Curtis H, Carne C, McClean H, Bell G, Estcourt C, et al. An effective strategy to diagnose HIV infection: Findings from a national audit of HIV partner notification outcomes in sexual health and infectious disease clinics in the UK. *Sexually Transmitted Infections*. 2017;93(2):94–9.

Reaching the undiagnosed in community settings

By raising awareness of the benefits of HIV testing and facilitating access to testing services, community based organizations (CBOs) may play an important part in the uptake of HIV testing and linkage to care among people at risk for HIV (3). Community sites may be more accessible to populations who do not access medical services regularly and could mitigate barriers to testing experienced at the provider, individual, and clinical levels. This may then prevent missed opportunities and increase early diagnoses of HIV. HIV testing services may be provided on-site at a CBO, through mobile testing units, or through outreach settings. Community-clinical partnerships facilitate this strategy (3).

HIV point-of-care testing and alternative venue testing

Rapid HIV testing, or point-of-care testing (POCT), can provide test results rapidly, be used by trained lay persons, expand testing to communities where infrastructure is limited, and may reduce missed diagnoses by removing the need for return visits (3). POCT has greatly expanded access to HIV testing in some Canadian settings and among target populations such as Indigenous peoples, incarcerated individuals, men who have sex with men, people who inject drugs, and pregnant women (40). Some Canadian jurisdictions are exploring different settings, such as aboriginal health centres, addictions facilities, and indoor commercial sex markets to reach the HIV undiagnosed through targeted strategies, facilitated by POCT (40). The use of peers and non-regulated providers in these sites may increase access and acceptability of testing, but may also raise confidentiality concerns (3).

Some demonstration projects have shown that POCT can reach individuals who have never tested for HIV, while also revealing new HIV diagnoses. For example, one project conducted in Italy offered HIV rapid testing on oral fluid (OraQuick®) to 2,949 individuals in non-government organizations (NGOs), migrant primary care services, and drug services over six months (41). Reactive results were referred to a specialist for confirmatory testing and care. There were a total of 27 (0.9%) preliminary positive test results overall. Of those confirmed as HIV positive, 30% had never been tested before. Linkage to care ranged from 67% at mobile units for people who use drugs, 80% at migrant services, and 100% at NGOs (41).

HIV rapid testing was also offered in retail pharmacies in areas with large racial/ethnic minority communities and high poverty as part of the Care and Prevention in the United States Demonstration Project (CAPUS) in Virginia (42). Clients with reactive results were linked to confirmatory testing and care, and a 24-hour telephone line was used to facilitate this process. During the two-year study 3,630 clients were tested and 46% were either first time testers or unsure of their testing history. Of these, 26 were confirmed

58. Dalal S, Johnson C, Fonner V, Kennedy CE, Siegfried N, Figueroa C, et al. Improving HIV test uptake and case finding with assisted partner notification services. *AIDS*. 2017;31(13):1867–76.

59. McGoy SL, Pettit AC, Morrison M, Alexander LR, Johnson P, Williams B, et al. Use of social network strategy among young black men who have sex with men for HIV testing, linkage to care, and reengagement in care, Tennessee, 2013–2016. *Public Health Reports*. 2018;133(2_suppl):43S–51S.

60. LeViere A, Donovan J, Wilkin A, Keller J, Parnell H, Sampson L, et al. Results of a social network testing intervention for HIV in infectious disease clinics. *AIDS & Behavior*. 2019;23(Suppl 1):48–51.

61. Lightfoot MA, Campbell CK, Moss N, Treves-Kagan S, Agnew E, Kang Dufour MS, et al. Using a social network strategy to distribute HIV self-Test kits to African American and Latino MSM. *Journal of Acquired Immune Deficiency Syndromes*. 2018;79(1):38–45.

62. Dailey Garnes NJ, Moore ZS, Cadwell BL, Fleischauer AT, Leone P. Previously undiagnosed HIV infections identified through cluster investigation, North Carolina, 2002–2007. *AIDS & Behavior*. 2015;19(4):723–31.

63. Nikolopoulos GK, Pavlitina E, Muth SQ, Schneider J, Psychogiou M, Williams LD, et al. A network intervention that locates and intervenes with recently HIV-infected persons: The Transmission Reduction Intervention Project (TRIP). *Scientific Reports*. 2016;6:38100.

positive. Of those with confirmed HIV diagnoses, 85% were linked to care, with the majority linked within 30 days. Rates of HIV reactive results and first-time testing was also higher in this testing program than in other community and clinical testing programs in Virginia during the same time period. This demonstrated that retail pharmacies may be an effective venue to expand HIV testing to reach racial and ethnic minority populations, people who have never been tested, and people with undiagnosed HIV (42). A one-year pilot study conducted by the Island and Vancouver Coastal Health Authorities also administered POCT at four pharmacies in British Columbia (43). While evaluation showed that this type of intervention was feasible, acceptable to clients, and was able to reach large proportions of first-time testers in some sites, no HIV positive cases were identified (43).

Outreach

Outreach HIV testing programs in community settings may be one strategy to target hard-to-reach groups and identify undiagnosed HIV (44). A sexual health clinic in London, UK set up outreach clinics at two of the world's largest adult lifestyle exhibitions (with over 10,000 attendees at each) in 2013 and 2015 (44). A total of 360 individuals were tested for HIV (an uptake of 95%); of this, 31% had never been tested for HIV. One individual (0.3%) was newly diagnosed and referred for follow-up. Authors noted the difficulty of implementing outreach-based projects that lack on-site laboratory support and have high staffing demands and costs. However, uptake of testing at the events was higher than national averages (44).

Other research has demonstrated that HIV testing in outreach settings may reach under-tested populations and reveal undiagnosed HIV infections, but may require a more targeted strategy. One study examining CDC funded HIV testing events in non-healthcare settings in 61 health department jurisdictions across the U.S. between 2011 and 2015 assessed diagnosis and linkage to care outcomes among young men who have sex with men (45). A total of 2.8% of young men who have sex with men were diagnosed with HIV, 74% of which were previously undiagnosed. However, young black men who have sex with men were more likely to be newly diagnosed but less likely to be linked to HIV care within 90 days than young men who have sex with men overall (67% versus 71%) (45). Another study compared outcomes from a multisite street-based rapid HIV testing program to pre-existing STI/HIV clinics and the national surveillance system in Spain (46). Compared to the clinics, HIV positivity rates in the outreach program were lower overall (1.5% versus 2.7%) and among men who have sex with men (3.9% versus 8%). However, the proportion of men who have sex with men among the newly diagnosed was higher at street outreach settings (89%) than at clinics (78%) and in the surveillance system (56%). Linkage to care for newly diagnosed individuals was nearly 80%. Authors concluded that while the

64. Morgan E, Skaathun B, Nikolopoulos GK, Paraskevis D, Williams LD, Smyrnov P, et al. A network intervention to locate newly HIV infected persons within MSM networks in Chicago. *AIDS & Behavior*. 2019;23(1):15–20.

65. Williams LD, Korobchuk A, Pavlitina E, Nikolopoulos GK, Skaathun B, Schneider J, et al. Experiences of stigma and support reported by participants in a network intervention to reduce HIV transmission in Athens, Greece; Odessa, Ukraine; and Chicago, Illinois. *AIDS & Behavior*. 2019;24:24.

66. Malekinejad M, Johnston LG, Kendall C, Kerr LR, Rifkin MR, Rutherford GW. Using respondent-driven sampling methodology for HIV biological and behavioral surveillance in international settings: A systematic review. *AIDS & Behavior*. 2008;12(4 Suppl):S105–30.

67. Hatzakis A, Sypsa V, Paraskevis D, Nikolopoulos G, Tsiara C, Micha K, et al. Design and baseline findings of a large-scale rapid response to an HIV outbreak in people who inject drugs in Athens, Greece: The ARISTOTLE programme. *Addiction*. 2015;110(9):1453–67.

68. Sypsa V, Psychogiou M, Paraskevis D, Nikolopoulos G, Tsiara C, Paraskeva D, et al. Rapid decline in HIV incidence among persons who inject drugs during a fast-track combination prevention program after an HIV outbreak in Athens. *Journal of Infectious Diseases*. 2017;215(10):1496–505.

program reached an under-tested population, performance may be improved by targeting it to locations specific to men who have sex with men, as diagnoses were almost exclusive to this population (46).

Comparing clinical and community settings for reaching the undiagnosed

From the previous sections it is evident that interventions in community and clinical settings can play a role in reaching the HIV undiagnosed, however it is unclear which may be more effective (47). Some researchers believe that these approaches can be combined into one integrated testing strategy that is tailored to meet regional and local needs (3), and some jurisdictions in Canada have begun to implement this approach (3). One study compared strategies in both these settings through a multisite HIV testing program focused on at-risk sexual minority male youths of colour, and found that targeted testing in community settings may be more effective (47). Twelve adolescent medicine HIV primary care programs in the U.S. implemented one of three testing strategies: targeted testing at community-based events, universal testing in community-based and clinical settings, or a combination thereof. During a nine-month period, 3,301 youths were tested for HIV overall. For universal, combination, and targeted strategies the proportion of individuals tested that were sexual minority males was around 4%, 27% and 40%, and the proportion of new HIV positive cases identified was 0.1%, 2.1%, and 3.2%, respectively. However, when type of test was separately analyzed from sites using a combined strategy, rate of newly identified HIV cases was 0.1% for universal testing, and 6.3% for targeted testing. Targeted and combination testing strategies were also more successful at linking HIV-negative youths to prevention services compared with those who underwent universal testing (85% and 67%, compared to 34%). Percentage of HIV-positive youths linked to HIV care was not compared, however authors noted that across all sites, a total of 98% of were linked to care during this study (47).

Reaching the undiagnosed in criminal justice settings

Other non-clinical settings are also being explored to reach the undiagnosed (40). For example, criminal justice settings may be an important gateway for interventions (3), as a high prevalence of HIV has been shown in Canadian custody settings (over 6% among female Indigenous inmates) (48). The CDC also recommends opt-out HIV testing within U.S. prisons, however supports the implementation of alternative approaches (49). One pilot study conducted in Ontario in 2011 demonstrated that anonymous POCT in a Canadian prison setting is feasible, and can fill gaps in testing services for prisoners (50).

69. Franks J, Mannheimer SB, Hirsch-Moverman Y, Hayes-Larson E, Colson PW, Ortega H, et al. Multiple strategies to identify HIV-positive black men who have sex with men and transgender women in New York City: A cross-sectional analysis of recruitment results. *Journal of the International AIDS Society*. 2018;21(3):03.

70. Flores A, Herman J, Gates G, Brown T. How many adults identify as transgender in the United States? 2016. Available from: <https://williamsinstitute.law.ucla.edu/wp-content/uploads/How-Many-Adults-Identify-as-Transgender-in-the-United-States.pdf> Accessed June 4, 2019.

71. Sullivan PS, Wall KM, O'Hara B, Jones J, Barnes J, DiClemente R, et al. The prevalence of undiagnosed HIV serodiscordance among male couples presenting for HIV testing. *Archives of Sexual Behavior*. 2014;43(1):173–80.

72. Boyer CB, Robles-Schrader GM, Li SX, Miller RL, Korelitz J, Price GN, et al. A comparison of network-based strategies for screening at-risk Hispanic/Latino adolescents and young adults for undiagnosed asymptomatic HIV infection. *Journal of Adolescent Health*. 2014;55(6):765–73.

73. Baytop C, Royal S, Hubbard McCree D, Simmons R, Tregerman R, Robinson C, et al. Comparison of strategies to increase HIV testing among African-American gay, bisexual, and other men who have sex with men in Washington, DC. *AIDS Care*. 2014;26(5):608–12.

74. Gwadz M, Cleland CM, Perlman DC, Hagan H, Jenness SM, Leonard NR, et al. Public health benefit of peer-referral strategies for detecting undiagnosed HIV infection among high-risk heterosexuals in New York City. *Journal of Acquired Immune Deficiency Syndromes*. 2017;74(5):499–507.

Two systematic reviews were found assessing HIV-related interventions in criminal justice settings (51, 52). The first described HIV, STI and substance use interventions for criminal justice-involved population in the U.S., with a particular focus on their impact on HIV outcomes among black men who have sex with men (51). Twenty articles examined new programs to increase HIV screening and identify previously undiagnosed infections. Programs involved changes in the type of tests (e.g. from blood sample to oral fluid sample) or in the method of testing offer (e.g. opt-in versus opt-out). Interventions consistently demonstrated an HIV prevalence over 1%. Cost-effectiveness was also demonstrated, including for black men who have sex with men. In all but one study, the majority of individuals diagnosed were provided treatment (51). Studies comparing opt-in to opt-out approaches to HIV testing showed that opt-out testing may result in greater uptake and numbers of new diagnoses. Other strategies showing promise were rapid in-custody treatment and supported referrals to community-based care following release. HIV care engagement results were mixed (51).

The second systematic review identified literature from the U.S. and Canada and examined HIV care cascade outcomes among inmates before, during and after incarceration (52). Among studies and reports citing blinded or mandatory HIV testing (n=22), average HIV positivity rate was 1.39%, and average newly diagnosed positivity rate (reported in three studies) was 0.66%. Studies reporting opt-out testing (n=12; most commonly implemented with rapid testing methods) had an average positivity rate of 1.05%, and average newly diagnosed positivity rate of 0.43%. Opt-in and voluntary approaches (n=26) had an average positive rate of 2.55% and newly diagnosed positivity rate of 1.32%. Review authors stated, however, that it was difficult to draw conclusions about which technique may identify the most HIV-positive individuals. Overall, studies showed that rates of HIV diagnosis, linkage to care, retention in care, antiretroviral treatment adherence, and viral suppression improved substantially during incarceration, often to rates even higher than the national average. However, upon release these rates dropped to levels equal to or lower than those before incarceration. The largest declines were shown in retention in care (from 76% to 30%) and linkage to care (from 76% to 36%). This demonstrated the impact that interventions have on reaching hard-to-reach populations, as well as the need for improved post-incarceration engagement. Successful interventions, according to review authors, addressed barriers to linkage-to-care through opiate replacement therapy, enhanced case management, patient navigation, or combinations of these strategies. Reported facilitators of linkage-to-care included HIV education during incarceration, discharge planning, transportation, and stable housing. Authors recommended establishing partnerships between correctional and health departments be established; increased opt-out HIV testing for inmates and recently released individuals; improved continuity of care after release, particularly for minority inmates;

75. Iribarren SJ, Ghazzawi A, Sheinfil AZ, Frasca T, Brown W, 3rd, Lopez-Rios J, et al. Mixed-method evaluation of social media-based tools and traditional strategies to recruit high-risk and hard-to-reach populations into an HIV prevention intervention study. *AIDS & Behavior*. 2018;22(1):347–57.

76. Centers for Disease Control and Prevention. Implementing HIV testing in nonclinical settings: A guide for HIV testing providers. 2016. Available from: https://www.cdc.gov/hiv/pdf/testing/cdc_hiv_implementing_hiv_testing_in_nonclinical_settings.pdf Accessed June 4, 2019.

77. Centers for Disease Control and Prevention. Home tests. 2019. Available from: <https://www.cdc.gov/hiv/testing/hometests.html> Accessed June 6, 2019.

78. Home Access Health Corporation. HIV-1 test service discontinued. Available from: <https://www.homeaccess.com/hiv-1-test-service-discontinued/> Accessed June 6, 2019.

79. Elliot E, Rossi M, McCormack S, McOwan A. Identifying undiagnosed HIV in men who have sex with men (MSM) by offering HIV home sampling via online gay social media: A service evaluation. *Sexually Transmitted Infections*. 2016;92(6):470–3.

80. Ahmed-Little Y, Bothra V, Cordwell D, Freeman Powell D, Ellis D, Klapper P, et al. Attitudes towards HIV testing via home-sampling kits ordered online (RUClear pilots 2011–12). *Journal of Public Health*. 2016;38(3):585–90.

81. Polilli E, Sozio F, Di Stefano P, Sciacca A, Ursini T, Paoloni M, et al. Web-based HIV testing in Abruzzo, Italy: Analysis of 15-month activity results. *AIDS Patient Care & STDS*. 2016;30(10):471–5.

and continuing to measure virological suppression after release (52).

One review identified important implementation considerations that potentially moderate the effectiveness of opt-out testing programs for HIV, HBV, and HCV in prisons (53). The study authors analyzed data from 60 articles, where the proportion of prison inmates offered testing ranged across studies from 13% to 100%, and found that this was influenced by timing of test offer. Test offer was often hindered by barriers to prisoner access such as inmates not being medically competent to provide consent upon entry. Authors recommended that, where possible, opt-out testing should be conducted on the first night. Other factors that influenced test offer included insufficient/overworked staff, low capacity to run clinics, and inmates refusing to attend clinics. Uptake of HIV testing across studies varied from 22% to 98% and was influenced by confidentiality concerns, fear of positive diagnosis, self-perceived risk, discomfort with testing procedures, the capacity to consent, trust in healthcare, and fidelity of opt-out offer. The provision of supportive or educational information and oral HIV testing may ameliorate some of these issues. Authors also suggested collaboration between health workers and prison officers, educational events in prison to promote testing and incentivizing clinic attendance for prisoners (53).

In contrast to this review, one study found that uptake of testing may increase when integrated into scheduled blood-draws, rather than immediately at intake (54). The study described opt-out HIV and HCV testing at the Dallas County Jail during intake and then integrated into scheduled blood draws. During the study period 3,155 tests were performed. Uptake of testing increased from 12.9% to 80.5%, and HIV was confirmed in 1% (n=30), 6 of which were new diagnoses; all were subsequently linked to care (54).

Reaching the undiagnosed through social networks

Partner notification

Sexual or needle-sharing partners of HIV-infected

people who are not virologically suppressed are at high risk of acquiring HIV infection (55). Partner notification (also called disclosure or contact tracing) involves a voluntary process whereby individuals diagnosed with HIV are interviewed to identify their sexual or drug-injecting partners, partners are notified of their risk of HIV exposure and offered HIV testing, and HIV-positive partners are linked to HIV care (56). Partner notification can be provided using passive or assisted approaches (56). Through passive approaches, HIV-positive individuals are encouraged by a trained provider to disclose their status and suggest testing and counselling to their partners by themselves. Through assisted approaches, HIV-positive individuals are supported by a trained provider in disclosing their status or anonymously notifying partners of their potential exposure to HIV infection. HIV testing and counselling are offered to partners by the provider (56). The WHO strongly recommends that voluntary assisted partner notification services be offered as part of a comprehensive package of testing and care offered to all people with HIV (56). Some studies have suggested that partner notification programs are more effective in identifying a higher proportion of undiagnosed HIV infections compared to targeted or routine HIV testing programs (55). Partner notification services also offer the opportunity to provide HIV prevention services (such as PrEP) to partners who test HIV-negative, but continue to be at risk (55).

Two studies assessed the effectiveness of partner notification services in identifying previously undiagnosed HIV infections among sexual and/or needle-sharing partners of HIV-positive individuals. The first study examined HIV testing and positivity among partners of HIV-positive individuals participating in partner notification service programs of state and local health departments across the U.S. (55). Data from 21,484 partners from 55 health departments were analyzed. Through partner notification services programs a total of 16,275 (75.8%) partners were tested for HIV over the one-year study period. Of those who received a test result, 4,503 (34.9%) were identified as newly HIV positive. Nearly 25% of partners were not tested, however. Noting demographic and regional differences in uptake, authors recommended tailoring partner services

to the unique needs of target populations. Linkage to HIV care data among HIV-positive partners was not collected, but it was recommended that the programs begin this practice (55).

The second study audited HIV outcomes from partner notification programs from 169 clinical services across the UK during 2011 (57). Data was collected from 2,964 HIV-positive individuals, and partner notification had been attempted with 88% of them. Outcomes for 3,211 partners were analysed. A total of 1,399 (44%) contacts were considered at risk of HIV infection, informed of this risk, and had an HIV test. The remaining partners were either not found to be at risk (16%), were informed of their risk but not known to have tested (10%), or not informed of their risk (30%). Of partners tested through partner notification, 293 (21%) were newly diagnosed with HIV. Authors concluded that partner notification is a highly effective diagnostic strategy, however the percentage of missed opportunities highlighted a significant area for improvement. Further analysis showed that non-completion of partner notification varied considerably by partner type: ex-regular and casual partners were harder to reach than regular partners. Applying the HIV prevalence observed in the study, authors estimated that an additional 129 partners remained undiagnosed, with more than half of these consisting of ex-regular or casual partners (despite the prevalence of infection being lower in these groups). Authors felt that this was due to failure to pursue partner notification by healthcare workers, and not due to reluctance to disclose HIV status to partners at risk by HIV-infected individuals (57).

One systematic review assessed the effectiveness of assisted versus passive partner notification approaches in improving HIV testing and diagnosis (58). Ten studies (including four randomized controlled trials and six observational studies from both high- and low- income settings) were included in analysis, representing 5,150 patients. Meta-analysis showed a higher uptake of partner HIV testing, larger proportion of newly identified HIV, and increased linkage to care when HIV-positive patients were offered assistance in notifying partners of their exposure to HIV infection, compared with passive referral. However, uptake of HIV testing among partners was still achievable with passive referral (2%-

65%), and some individual studies found that passive referral reached similar or higher levels as assisted approaches (58).

Social-network strategies

Social network strategies rest on the concept that people who engage in high-risk behaviours connect with people who engage in similar behaviours, and therefore leverage personal connections in social networks to recruit individuals with potentially undiagnosed HIV (59). Social network strategies offer people newly diagnosed with HIV the chance to refer people they know to HIV testing, and may facilitate the detection of HIV through social networks, beyond solely sexual partners (60).

By providing free testing to anyone who accompanied an HIV-infected patient to their clinic appointment, the NC-LINK testing initiative in North Carolina tested 120 partners at two clinics and identified five new cases of HIV infection over two years (60). All five were linked to HIV care within one year, and three within 30 days. All achieved viral suppression within one year of treatment. With the use of existing infrastructure, the social network strategy was low-cost and sustainable. Despite the low number of individuals tested, authors suggested that this intervention could be expanded in other settings (60).

Some studies have also employed social network strategies among individuals who are not HIV-positive to recruit members of their social network for HIV testing. One study tested a social network strategy distributing HIV self-testing kits to African American and Latino men who have sex with men and transgender women in Alameda County, California between 2016 and 2017 (61). Thirty HIV-positive and HIV-negative peers were asked to distribute five self-test kits to their social network members, and support those who tested positive to link to HIV care. Outcomes from this approach were compared to those of targeted community-based testing programs within the area. Individuals recruited through this social network strategy were significantly more likely to have never tested for HIV (3.5% versus 0.4%); test positive for HIV (6.14% versus 1.49%); and be newly diagnosed (4.2% versus 1.2%). A greater

proportion of those who tested HIV positive were recruited by an HIV-positive peer (15.6%) than an HIV-negative peer (2.4%). Linkage to care outcomes could not be assessed in this study (61). Another study, conducted at three agencies in Tennessee, identified young black men who have sex with men (both with and without HIV) to recruit members of their social network for HIV testing between 2013 and 2016 (59). This program tested 1,752 individuals of which 82% (n=1,437) were also young black men who have sex with men. A total of 9% (n=158) tested HIV positive and more than half of these (n=80) were newly diagnosed. This social network strategy-based program also linked 55% of the newly diagnosed to HIV care, as well as 57% of those who were previously diagnosed but not engaged in care. Linkage-to-care rates, however, varied by agency and authors suggested that further evaluation was needed to improve these outcomes (59).

Focusing social network strategies on higher risk populations may be more effective at identifying previously undiagnosed HIV. For example, one study reviewed HIV diagnoses in North Carolina during 2002 and 2005 to compare the likelihood of identifying new HIV infections among the social contacts of men who have sex with men, men who report sex with women only, and women (62). Compared to those named by men who have sex with women, the odds of identifying new HIV diagnosis were greater among the social contacts of men who have sex with men. Analysis showed that identifying one new HIV infection would require: 83 men who have sex with men to be interviewed and 28 contacts named; 271 men who have sex with women to be interviewed and 65 contacts named; and 317 women to be interviewed and 56 contacts named. While the overall HIV prevalence was at least 2% among all social contacts identified in this study, authors concluded that focusing social network strategies on men who have sex with men may be a more cost-effective strategy if resources are limited (62).

Two studies of the network-based Transmission Reduction Intervention Project (TRIP) conducted in Greece (63) and Chicago (64) also found that focusing social network strategies on individuals with recent or long-term HIV infection may impact the identification of cases of newly diagnosed

HIV (63, 64). In both studies, the proportion of previously undiagnosed HIV identified was higher within the networks of recently diagnosed individuals compared to those with long-term HIV infection: 27% compared to 8% (63) and 24% compared to 0% (64). Strategic network tracing, therefore, could potentially support public health efforts to diagnose and treat people earlier in their HIV infection (63, 64). There have been concerns that network-based strategies may increase the risk of exposing participants to stigma if the strategy causes their HIV status to be assumed or disclosed (65). However, a follow-up to these TRIP studies found that the experiences and perceptions of HIV-related stigma among participants did not change significantly, and experiences of HIV-related support increased, between baseline and six-month follow-up for all participants (65). In some cases, these constructs predicted participants' engagement in the intervention; thus, authors suggested further research, as stigma could limit the ability of network-based strategies to reach those in need of HIV testing and care (65).

Respondent-driven sampling

Considered a promising means to engage high-risk populations in HIV research, respondent-driven sampling is a type of chain-referral sampling where individuals from a target population are trained to recruit people from their existing social networks, and recruits are also trained to recruit social contacts, and so on, with all participants given incentives (66).

A “seek, test, treat, retain” intervention implemented by a CBO in response to an HIV outbreak among people who inject drugs in Greece demonstrated that repeat respondent-driven sampling may facilitate rapid identification of a hidden population, and the provision of HIV testing, counselling and linkage to care (67, 68). The intervention involved reaching out to people who inject drugs through five rounds of respondent-driven sampling, engaging them in HIV testing, providing prevention information, and linking individuals who tested positive to antiretroviral and opioid substitution treatment. Within 3,320 individuals recruited through respondent-driven sampling, the overall HIV prevalence was over 16.5% (68). In order to facilitate linkage to care,

a further incentive was given to individuals to collect their HIV test results and dedicated linkage staff arranged treatment appointments when desired (67). Almost half of unlinked individuals were linked to HIV care, and the proportion of those on opioid substitution treatment increased from 12% to 28% (68).

Some research has suggested that combining the peer referral element of respondent-driven sampling with other strategies may be more successful in identifying individuals with HIV than respondent-driven sampling alone (69). Conducted in New York City, the Seek, Test, Treat and Retain (STAR) study compared strategies to recruit black, substance-using men who have sex with men and transgender women with undiagnosed HIV or with previously diagnosed HIV but not in care (69). These were respondent-driven sampling alone, and two additional strategies with integrated incentivized referral: community-based recruitment (in venues frequented by the target population), and online advertising. HIV prevalence overall was 8.7% (n=167), nearly 86% of whom reported no previous diagnosis (though evidence of viral suppression in 44% suggested non-disclosure of previous HIV status). Nonetheless, compared to the referral-enhanced strategies, respondent-driven sampling alone was the least effective at identifying HIV-positive men and transgender women (4% of recruits and 14% of all HIV diagnoses; compared to 10% and 50% with community-based strategy, and 39% and 4% with online strategies). The study was also particularly successful in recruiting transgender women, with the proportion of transgender participants (3.7%) being almost eight times that in the New York State population (0.5%) (69, 70).

Couples voluntary HIV testing and counselling

One randomized trial explored recruiting participants as couples, through Couples Voluntary HIV Testing and Counselling (CHTC) in Atlanta (71). Ninety-five male-male couples (190 men) were tested for HIV, of whom 20 (11%) were newly diagnosed with HIV. Furthermore, 17% (n=16) of couples were newly identified as HIV serodiscordant. Given the high prevalence of undiagnosed HIV and serodiscordance among this sample, authors recommended scale-up of CHTC services for men who have sex with men.

Authors recommended tailoring prevention services based on couples' serostatus. That is, interventions could provide ongoing access to testing for HIV-negative seroconcordant couples, linkage to medical treatment and care for HIV-positive seroconcordant couples and linkage to both treatment and prevention services for serodiscordant couples (71).

Comparing network-based and community-based strategies

One study compared a community-based (alternative venue-based testing) strategy with a network-based (social and sexual network referral) strategy among Hispanic/Latino youth across 11 cities in the U.S. and Puerto Rico (72). Both strategies were highly effective in engaging the target population, with a total of 1,596 participants completing HIV screening. However, newly diagnosed HIV rates were low and did not significantly differ between strategies: 0.51% (n=4) and 0.37% (n=3), respectively. Social and sexual network referral did identify more individuals who were first-time testers, however across both groups, only four individuals were successfully linked to care. Additionally, there were differences in the characteristics of individuals tested by each strategy: social and sexual network referral reached a greater group of at-risk heterosexual men, while alternative venue-based testing primarily reached men who have sex with men. Authors suggested that strategically implementing these strategies may improve identification of undiagnosed HIV among Hispanic and Latino youth (72).

Similar results were found in another study comparing the effectiveness of alternative venue-based testing, social network strategies, and partner notification services for reaching previously undiagnosed, African-American men who have sex with men for HIV testing at a gay-identified CBO in Washington, DC (73). While there were no significant differences in HIV positivity rates or new HIV diagnoses across the three strategies, relative to standard care social network strategies and alternative venue-based testing were more successful at reaching first-time testers. Furthermore, each strategy reached different subgroups of men: heterosexual men

were more likely to be recruited using social network strategies, bisexual men and older men were more likely to be recruited by alternative venue-based testing or social network strategies, and homosexual men and young men were more likely to be recruited by partner notification. Authors concluded that to engage all African-American men who have sex with men in HIV testing, a combination of strategies may be the best approach (73).

One study found that respondent-driven sampling may be more effective at identifying undiagnosed HIV among heterosexuals at high risk for HIV compared to other community-based approaches, particularly if they address issues of perceived stigma through anonymous testing (74). The study compared three approaches in a New York City area with high HIV prevalence and poverty rates. Participants were recruited using the following strategies: respondent-driven sampling and confidential HIV testing in two sessions (n=3,116); respondent-driven sampling and anonymous HIV testing in one session (n=498); and venue-based sampling and HIV testing in a single session (n=403). Overall, uptake of HIV testing was almost 97%, with no statistical difference between strategies. However, compared to other approaches, respondent-driven sampling with anonymous testing and one session was more effective at identifying high-risk heterosexuals with more HIV risk factors and less HIV testing experience. Rates of new HIV diagnoses were also higher using RDS with anonymous testing (4%) and confidential testing (1%) compared to venue-based sampling (0.3%) (74).

Reaching the undiagnosed through self-directed approaches

Self-directed approaches, such as HIV self-testing and web-based screening programs, may be beneficial for all priority populations, and may increase access to HIV testing, diagnosis, and linkage to care (3). As opposed to other approaches where health care providers or the health care system control who is tested for HIV and how they are linked to care, self-directed approaches are patient-centred, providing individuals with more autonomy (3).

However, significant concerns remain regarding potential missed opportunities for counselling, confirmatory testing, partner notification, HIV care, and prevention, in addition to concerns regarding accuracy and cost of testing (3).

HIV self-testing

HIV self-testing allows an individual to perform a diagnostic test (using oral fluid or blood) and to interpret results in private (56). This type of testing is not yet approved in Canada, though its use has been debated (3). Nonetheless, HIV self-testing has the potential to access hard-to-reach-groups by reducing the stigma associated with traditional strategies (75), and the WHO recommends offering HIV self-testing as an additional option for individuals (56). The CDC also supports it as an effective method for reaching otherwise untested individuals, and two HIV self-testing kits have been approved in the U.S. (Home Access HIV-1 Test System and Oraquick®) (76). However, as of January 1, 2019 the Home Access HIV-1 Test System has been discontinued (77, 78). Correspondence with the manufacturer confirmed that this was because of commercial reasons.

Home Testing 3 (HT3), a five-year, randomized controlled trial is currently ongoing in New York City and San Juan, Puerto Rico (75). The study explores access to HIV self-testing kits among men who have sex with men and transgender women. A preliminary analysis published in 2018 assessed the strengths and weaknesses of different strategies for engaging this hard-to-reach population in the use of the HIV self-test kits. Results showed that social media-based strategies were more effective in recruiting participants (except those over 60) when compared to other strategies. However, referrals produced the highest percentage of eligible participants. This also differed by demographics. For example, referral was more likely to recruit Hispanic, African-American and transgender participants than white participants. Of eligible participants, a total of 20 individuals newly tested as HIV positive (ten of whom were recruited using strategies that used either social media or the internet, followed by six recruited using information tables, three recruited through referral or word-of-mouth, one recruited through printed materials, and

none through in-person one-time events). This suggests tailored strategies, as well as social media tools, may be effective at engaging people living with undiagnosed HIV with HIV self-testing (75).

Web-based screening

Web-based screening programs are designed to provide information on and screening for HIV and other STIs using the internet. HIV testing can be offered through a laboratory requisition presented at a designated site, or the mailing of HIV self-testing kits with results analyzed in a laboratory (3).

A study conducted in London, UK found that social media is a successful platform for engaging a high-risk population with HIV testing and care (79). The study described a two-year evaluation of a postal home HIV sampling service (the first of its kind in the UK) provided by a community organization to target hard-to-reach, high-risk men who have sex with men (79). Several gay social networking websites were utilized to offer anonymous assessments of HIV risk and free HIV oral fluid or blood self-sampling kits sent through the mail and analyzed in a clinic. The HIV risk self-assessment was completed by 17,361 individuals, of whom half had an “identifiable risk” for HIV and one third had never been tested. A total of 5,696 test kits were returned and 82 new HIV diagnoses (1.4% of returned samples) were confirmed (along with 14 previously diagnosed, 14 false reactivities, and 11 unconfirmed). Recent infections comprised 20% of new diagnoses. All confirmed newly diagnosed individuals were linked to care, making the linkage to care rate 88% (82 of 93 potential new positives). More individuals chose to receive blood over oral sampling kits, but oral samples were more likely to be returned for testing (79).

RUClear, a pilot study offering HIV home-testing kits in the UK, was also successful at engaging individuals in HIV self-testing using a web-based strategy (80). In this study, testing could be requested using an established, online chlamydia testing service (www.ruclear.co.uk) and HIV home-testing kits using dried blood spots (via finger-prick) could be ordered and mailed to a laboratory. Results could be mailed or texted, and a survey regarding acceptability was provided.

Over 18 months, 3,062 kits were returned for testing (uptake rate of 59%), and 2,447 surveys were completed (80% response rate). Seven new HIV diagnoses were detected, all of which were referred to local medical services and confirmed positive. Surveys revealed that participants found the service to be accessible, convenient, easy-to-use, and anonymous – avoiding the invasive nature of venipuncture, inconvenient hours of health services, and interaction with health care providers. Another 116 individuals who refused testing returned surveys, citing worry about positive results, having tested recently, confidentiality concerns, waiting for results, and disliking the finger-prick method as reasons for not testing (80).

Another study described the evaluation of a web-based tool (www.failtestanchetu.it) developed to provide information on HIV and other STIs, facilitate HIV risk self-assessment, and book HIV testing at one of six sites throughout the Abruzzo region in Italy (81). Between 2014 and 2015, approximately 6,000 users visited the website and 3,046 attended a clinic visit for HIV testing and counselling. A total of 28 individuals tested positive (0.92%), none of which had had previous diagnoses, and 92% were successfully linked to care and antiretroviral treatment by physicians at the site of diagnosis (81).

A demonstration project implementing multiple strategies

The Care and Prevention in the United States (CAPUS) Demonstration Project provided evidence for the feasibility of implementing integrated programs utilizing strategies that identify previously undiagnosed HIV infections, linking or reengaging individuals to care, addressing social and structural barriers, and facilitating access to prevention and support services (2). CAPUS was a CDC-funded project carried out across eight U.S. state health departments, with a primary focus on reaching racial and ethnic minority groups. Processes and outcomes were assessed using an evaluation framework developed by the CDC. Grantees collaborated with 117 organizations, including CBOs, local health departments, non-profit institutions, and businesses to improve their capacity to deliver services, as well as

provide capacity-building assistance and support to their partners.

All grantees implemented strategies to improve their HIV testing capacity (many of which expanded to locations serving minority groups). Strategies included routine opt-out testing in clinical and other health care settings (such as pharmacies, and correctional health clinics), social network testing in the community, and updating HIV testing technologies (e.g. fourth-generation testing) to increase the likelihood of early HIV diagnosis and timely linkage to care. Between 2012 and 2016, a total of 155,343 HIV tests were conducted (67% among non-Hispanic Black and Latino individuals, 55% among women, and 81% in health care settings). Tests revealed 558 (0.36%) newly diagnosed HIV infections. This rate was higher among non-Hispanic Black (0.57%) than White (0.14%), and in non-health care settings (0.54%) than health care settings (0.32%); this rate was 2.26% in community tests by CBOs.

All sites also developed navigation and other linkage, reengagement and retention (NLRR) programs and integrated these into existing care systems. These programs were tailored according to type of staff (e.g. peers, nurses), populations served, and service delivery strategy or setting. The NLRR programs enrolled 10,382 people living with HIV across all sites, and subsequently linked or reengaged 5,425 of the 7,017 (77.3%) of diagnosed individuals who had dropped out of or were never in care. Risk-reduction interventions, partner notification services, and transportation services were also commonly provided. Grantees also implemented activities to improve the use of surveillance by upgrading data reporting systems (e.g. from paper to electronic), integrating surveillance, care and prevention data, developing prompts or data-sharing systems to facilitate linkage to care, and implementing policies to promote data usage. Capacity-building training to improve cultural competency were offered to providers. Many grantees also launched media and social marketing campaigns to raise awareness, increase knowledge and reduce stigma. Some grantees also addressed barriers by co-locating or integrating support services (such as housing or vocational assistance) with care and prevention. The success of CAPUS testing and NLRR programs, therefore, may be attributed to

the use of strategies that are tailored to and known to be effective for these specific populations, addressing multiple barriers to HIV testing and care (2).

Factors That May Impact Local Applicability

As this review focuses on only recent studies from high-income countries, the strategies described may be neither appropriate for nor exhaustive of ways to engage the HIV undiagnosed in other settings. Furthermore, each of the strategies outlined has specific financial, infrastructural and ethical considerations that have been discussed in the literature, as well as barriers and facilitators related to their implementation but this discussion was outside the scope of this review. However, when contemplating implementation, these considerations will be important for decision-makers to account for, in relation to proposed settings and populations. Tailoring and combining strategies to the local context will be important for future implementation of programs to engage people living with undiagnosed HIV.

What We Did

We searched Medline (including Epub Ahead of Print, In-Process & Other Non-Indexed Citations) using a combination of text terms HIV and (undiagnosed or [difficult to reach] or [hard to reach]). Searches were conducted on April 3, 2019 and results limited to English articles published since 2014. Reference lists of identified reviews were also searched. The search yielded 752 references from which 81 were included.

Rapid Response: Evidence into Action

The OHTN Rapid Response Service offers quick access to research evidence to help inform decision making, service delivery and advocacy. In response to a question from the field, the Rapid Response Team reviews the scientific and grey literature, consults with experts, and prepares a review summarizing the current evidence and its implications for policy and practice.

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