Social network approaches to locating people recently infected with HIV in Odessa, Ukraine

Leslie D Williams1, Ania Korobchuk2, Pavlo Smyrnov2, Yana Sazonova2, Georgios K Nikolopoulos3, Britt Skaathun4,5, Ethan Morgan6, John Schneider6, Tetyana I Vasylyeva7, Yen T Duong8, Svitlana Chernyavska9, Vitaliy Goncharov9, Ludmila Kotlik9 and Samuel R Friedman1,10,11,§

§Corresponding author: Samuel R Friedman, Department of Population Health, NYU School of Medicine, 180 Madison Avenue, New York, NY 10016, USA. Tel: 1 732 979 9420. (samuel.friedman@nyulangone.org)

Abstract

Introduction: This paper examines the extent to which an intervention succeeded in locating people who had recently become infected with HIV in the context of the large-scale Ukrainian epidemic. Locating and intervening with people who recently became infected with HIV (people with recent infection, or PwRI) can reduce forward HIV transmission and help PwRI remain healthy.

Methods: The Transmission Reduction Intervention Project (TRIP) recruited recently-infected and longer-term infected seeds in Odessa, Ukraine, in 2013 to 2016, and asked them to help recruit their extended risk network members. The proportions of network members who were PwRI were compared between TRIP arms (i.e. networks of recently-infected seeds vs. networks of longer-term infected seeds) and to the proportion of participants who were PwRI in an RDS-based Integrated Biobehavioral Surveillance of people who inject drugs in 2013.

Results: The networks of PwRI seeds and those of longer-term infected seeds had similar (2%) proportions who were themselves PwRI. This was higher than the 0.25% proportion in IBBS (OR = 7.80; p = 0.016). The odds ratio among the subset of participants who injected drugs was 11.17 (p = 0.003). Cost comparison analyses using simplified ingredients-based methods found that TRIP spent no more than US $4513 per PwRI located whereas IBBS spent $11,924.

Conclusions: Further research is needed to confirm these results and improve TRIP further, but our findings suggest that interventions that trace the networks of people who test HIV-positive are a cost-effective way to locate PwRI and reduce HIV transmission and should therefore be implemented.

Keywords: HIV; treatment as prevention; social network; intervention; recent HIV infection; PWID; Ukraine

1 | INTRODUCTION

A major part of the global HIV/AIDS prevention strategy focuses on treatment as prevention [1]. Finding and intervening with people soon after they get infected is an important part of this strategy because transmission is relatively frequent during the period of early infection [2–6] due to high viral loads [7–9], relatively low immune response [10], and (possibly temporary) high rates of risky behaviours [11]. The logic for focusing on people with recent infection (PwRI) has been previously described [5,12]. Research from Athens (Greece) provides evidence that recruiting the risk networks of PwRI is a good strategy for finding additional PwRI, since in that study, PwRI were recruited at higher rates in the risk networks of PwRI seeds than in the comparison group risk networks of longer-term infected seeds [13].

The Transmission Reduction Intervention Project (TRIP) conducted risk network-based recruiting and HIV counselling and testing in Odessa, Ukraine. It focused on locating PwRI to prevent additional transmissions by them and their network members.

This paper compares the proportions of PwRI in two arms of TRIP: (1) the risk networks of PwRIs and (2) the risk networks of longer-term-infected people. It also compares the proportions of PwRI in the TRIP networks with the proportions of PwRI located in an independent project that was conducted among people who inject drugs (PWID) in Odessa’s Integrated Biobehavioral Surveillance (IBBS). Finally, since costs can affect the feasibility of interventions, we compare the costs of locating PwRI in TRIP with the costs of locating PwRI using respondent-driven sampling (RDS) in IBBS.

2 | METHODS

2.1 | Geographic setting

Eastern Europe and Central Asia are regions with a growing HIV-epidemic in which the majority of cases are concentrated...
among people who inject drugs (PWID) and their sexual partners [14,15]. In 2018, Ukraine had an estimated 243,000 people living with HIV (PLHIV), reflecting 0.64% HIV-prevalence among the adult population [16]. The Ukrainian epidemic is primarily concentrated among three key populations: PWID, sex workers (SWs), and men who have sex with men (MSM), with HIV-prevalence 22.6%, 5.2% and 7.5% respectively. There is some evidence that political upheaval and subsequent war may have reversed the beginnings of a decline in the epidemic [17].

Odessa city is located in southern Ukraine. The estimated 29,500 PLHIV in the Odessa region constitute almost 12% of the national total [18]. Official supervision of PLHIV by the AIDS Center provides evidence about HIV indicators in the Odessa region, where 2593 newly detected HIV cases were officially registered in 2018, a rate of 109 cases per 100,000 population [19]. HIV in the Odessa region is also concentrated among key populations, with an estimated prevalence of 18.7% among PWID; an estimated prevalence of 13.0% among MSM; and an estimated 3.0% among sex workers [20,21].

2.2 | TRIP methods

2.2.1 | TRIP eligibility criteria and arms

TRIP was a two-arm network intervention study in Odessa, Ukraine, from November 2013 to March 2016: (1) An intervention arm comprised of members of extended risk networks of recently infected seeds, and (2) A comparison arm composed of longer-term HIV-positive seeds’ extended risk network members of longer-term positive seeds. Potential “seeds” (initial participants) were people referred to TRIP by AIDS Centers and NGOs because they were thought to be relatively likely to have been recently infected with HIV. Those who met the criteria described below were classified as “recently infected seeds” (N = 24). Those who were not recently infected were classified as “longer-term infected seeds” (N = 18).

Seeds’ risk network members were eligible for TRIP. We operationalized “risk networks” as people with whom participants injected drugs, people with whom they had sex, people who were present while participants were having sex or using drugs, and people recruited from small-size ‘venues’ where participants injected drugs or located sex partners. This definition of risk networks was used since it seemed likely to include people who were part of an infection chain that included the participant. (See [12] for a fuller explanation of this.) Eligibility criteria included ability to answer the questionnaire; age ≥18 years; and being qualified for one of the project arms.

Potential seeds were recruited by referral from the Odessa Regional Laboratory Center of the Ministry of Health of Ukraine, the Odessa AIDS Center, or the Way Home (a collaborating community organization). They were classified as “recently infected seeds” if they were newly HIV-diagnosed drug injectors or others who had LAg ODn >1.5 without any evidence of seroconversion in the last six months. Longer-term infected seeds were matched to recent seeds for risk group, age (±5 years) and gender. The comparison arm consisted only of risk network members of these seeds.

2.2.2 | TRIP HIV assays

Blood samples were tested for HIV by New Vision Diagnostics Profitest Combo tests (Intec Products Inc.) and confirmed by re-testing with Profitest. HIV-positive specimens were tested for viral load using HIV-1 Abbott RealTime™ assay and were also tested for recent infection with the Limiting Antigen Avidity (LAg) assay (Sedia™ Biosciences Corporation). The LAg assay is based on antibody avidity maturation and categorizes HIV infection as recent or long-term based on a normalized optical density (ODn) cut-off of 1.5 [22], corresponding to a recency window period of 130 days [23,24]. All samples with ODn<0.4 were confirmed as HIV seropositive by re-testing with either HIV-1/2 Ag + Ab Ultra MBA 0416/5 assay (Med-BioAklance, Ukraine) or with Genscreen Ultra Ag/Ab, 6E0720 assay (France). Samples were considered to be recently infected if found HIV positive by either test, unless they had a viral load of ≤1000 copies/mL.

2.2.3 | TRIP questionnaire

The TRIP face-to-face interview included questions about socio-demographic characteristics, sexual orientation, sexual and injection risk behaviours (including numbers of same- and opposite-sex sex partners) in the last six months, and treatment history. It also asked participants to name risk network members in the following categories: people they injected drugs or had sex with in the past six months; people who injected or had sex in their presence in the past six months; and people who injected, used drugs or had sex with people with whom the participants had injected or had sex. Respondents also were asked about “venues” they usually visited to use drugs, to have sex or to meet new sex partners.

2.2.4 | TRIP network tracing

Risk network members (including participants recruited from ‘venues’ that participants named) of recently infected and longer-term infected seeds were recruited regardless of their infection status, as were the risk partners and venue members of these network members. In other words, network members were recruited for at least two “steps” from seeds. If a PwRI was found in networks of seeds (including those recruited through venues), the network members of this newly identified recently infected network member were recruited for two additional steps.

2.2.5 | TRIP dependent variable

The dependent variable in the analyses was the proportion of network members in each study arm who were PwRI. Network members were tested for HIV. If they were HIV positive,
we carried out LAg tests and quantified plasma HIV-RNA. Recently infected network members were defined as people with LAg ODn≤1.5 (and viral load >1000 copies/mL) since we had only self-reports of network members’ testing history. Longer-term infected network members were infected members of seeds’ networks who were not classified as recently infected.

### 2.2.6 Incentives and benefits of participation in TRIP

TRIP participants received 50 hryvnia (approximately US$6 in 2013; US$2 in 2016) for baseline interviews and follow-up interviews; 20 hryvnia (approximately US$2.50 in 2013; approximately $0.80 in 2016) for every named network member who brought in a referral coupon from the participant; and 10 hryvnia (approximately US$1.25 in 2013; approximately $0.40 in 2016) for every person recruited from a venue the participant named during the interview. The number of nominated network members and of venue members (to whom our staff social worker recruited) was not limited.

Project staff educated affected participants and communities about recent/acute HIV infection, and about the importance of avoiding stigma. As discussed in other articles [25,26], neither project staff nor participants in our project and a precursor pilot study in Ukraine reported any increases in stigma-related problems, but participants did report significantly higher levels of experienced social support at follow-up than at baseline. Participants were provided with standard counselling and were actively linked to care if appropriate.

### 2.3 IBBS methods

#### 2.3.1 IBBS overview and questionnaire

IBBS among people who inject drugs (PWID) in 2013 was a cross-sectional Respondent-Driven Sampling (RDS) study in 29 Ukrainian cities (including Odessa, for which N = 400) [27]) designed to estimate the parameters of the HIV epidemic (rather than to locate PWRI for intervention). Trained experienced interviewers conducted face-to-face interviews using an adapted version of a previous IBBS questionnaire for PWID (2007 to 2011). Questions included socio-demographic characteristics, sexual and injection behaviour in the last 12 months, including whether men had sex with men in the last 12 months, and previous HIV-testing experience. Experienced medical workers conducted HIV rapid tests after the interview for all participants.

#### 2.3.2 IBBS eligibility and recruitment

Participants were enrolled in IBBS after preliminary screening based on the following criteria: that they had injected drugs within the last 30 days, were at least 13 years old, currently resided in Odessa and had not participated in any other surveys within the last six months. A medical worker checked veins for signs of punctures. Only PWID with visible punctures were allowed to participate.

Seeds in Odessa, as well as in other IBBS cities, were people who met the above criteria. They were selected to make sure that the seeds selected from each city had unknown or negative HIV status and varied in terms of age and other important characteristics. Specifically, they were selected such that they included at least one 14 to 19 years old, at least one woman, and at least one with each of the following characteristics: less than two years of injection experience; exclusive stimulants user; exclusive opioid user; stimulant and opioid mixed user; NGO client; and non-NGO client. Odessa IBBS had four seeds. Two were recruited from The Way Home (the NGO where TRIP also recruited seeds), one was recruited from another NGO in another part of the city, and one was recruited independently of NGOs.

Seeds were given three coupons to give to other PWID who could then take part in the study and receive compensation, as described below.

#### 2.3.3 IBBS assays

All participants were tested for HIV using CITO TEST HIV-1/2/0 rapid test kit. Dry blood spot specimens were collected from all participants who had HIV-positive rapid test results and sent for laboratory testing at the United States Centers for Disease Control and Prevention (CDC) by two third-generation HIV diagnostic ELISAs to confirm the presence of HIV antibodies (Abbott ARCHITECT HIV Ag/Ab Combo (USA) and Bio-Rad Genscreen Ag/Ab HIV Ultra (USA)). Samples that tested reactive on both ELISAs were confirmed for HIV seropositivity using Western blot (Inno-licia HIV-1/2 Score, Innogenetics, Belgium).

HIV-positive specimens were tested by the Sedia LAg assay to determine if the infection had been recently acquired. Specimens with LAg ODn ≤1.5 were considered possible recent HIV-1 infections. All specimens with ODn >1.5 were classified as long-term infection.

All specimens with ODn ≤1.5 were tested for viral RNA using an adapted SOP for DBS on the Abbott m2000rt Real Time HIV Test. Similar to TRIP, specimens with VL ≥1000 copies/mL were considered to be confirmed recent HIV-1 infection cases. Specimens with VL <1000 copies/mL were classified as long-term infections.

#### 2.3.4 IBBS dependent variable

The dependent variable for IBBS was the proportion of participants who were PWRI. IBBS participants were defined as PWRI, longer-term infected, or uninfected by the above assays.

#### 2.3.5 Incentives and benefits of participation in IBBS

IBBS participants received compensation for their participation with 30 hryvnia (US$4 in 2013), plus 20 hryvnia (US $2.50) for the recruitment of each secondary participant according to RDS methodology.

Cost comparison analyses used simplified ingredients-based methods [28]. Recruitment cost, staffing cost, and assay-processing cost data were available through Alliance for Public Health administrative records. These were compared between TRIP and IBBS to calculate the costs for each project. These totals were divided by the numbers of PWRI located by each project to calculate their cost per PWRI located. Both IBBS and TRIP involved large research components whose costs were excluded for these comparisons since they were not part
of the intervention. Costs for IBBS were calculated on the basis of the exchange rate in 2013 when IBBS was conducted. At that time, the hryvnia (UAH) was valued at US$0.125. Costs for TRIP were estimated both using the same exchange rate and also on the basis of the exchange rate (<US$0.04 per UAH) at the time TRIP ended data collection (2016).

Analyses
Cross-tabulations and frequencies were calculated using SPSS version 21. Odds ratios were used as a measure of association in cross-tabulations; the statistical significance of these odds ratios was assessed using both \( \chi^2 \) and Fisher’s Exact Test, which was necessary in most cases since there was only one recently infected participant in IBBS. In other words, we used the more conservative Fisher’s exact test to test the null hypothesis that each sample had equal proportions of recently infected persons as a way to deal with this issue of data sparseness [29]. Since the data are not based on probability samples, these \( p \)-values should be viewed as heuristic estimates. Furthermore, since there was only one recently infected participant in IBBS, this sparse data problem meant that we could not compute meaningful confidence intervals for the odds ratios comparing the yields of TRIP and IBBS. We thus used exact statistics to test the null hypothesis that each sample had equal proportions of recently infected persons. Since TRIP recruited non-PWID, additional analyses were conducted to compare the PWID subset of TRIP with IBBS. The sparseness issue meant that we could not confi-
dence intervals overlapped unity. (Table 2).

The 2% proportion of PWID in TRIP networks was higher than the 0.25% proportion in IBBS. The odds ratios for comparisons of the TRIP PWID seeds’ networks, the TRIP longer-term infected seeds’ networks, and the combination of the two arms, as compared to IBBS, were all greater than 8.0, and the 95% confidence intervals for each odds ratio remained above 1.5.

Among PWID, approximately 3% of network members from each arm were PWID. The odds ratios’ confidence intervals overlapped unity. (Table 2).

4 | DISCUSSION

Both arms of TRIP located and recruited a considerably larger proportion of PWID than did IBBS. This was also true when comparisons were restricted to PWID. Furthermore, cost comparisons indicate that TRIP techniques locate PWID less expensively than does IBBS. These findings support the conclusions of a TRIP-related study in Athens, Greece [13], which concluded that “efforts to seek, test, and treat PWID...
can be accelerated using strategic, network-based approaches.” The results in this paper show that, in Odessa, the risk network recruitment approach used in TRIP, together with recruiting seeds who were HIV positive, located more PwRI (at less expense) than a standard RDS epidemiologic study.

Table 1. Characteristics of participants in TRIP networks and IBBS in Odessa

|                      | TRIP networks total | TRIP networks PWID only | IBBS (unweighted) | TRIP PWID versus IBBS (difference) | TRIP networks of PwRI | TRIP networks of long-term infected |
|----------------------|---------------------|-------------------------|-------------------|------------------------------------|-----------------------|-------------------------------------|
| Total                | 1252                | 551                     | 400               |                                    | 735                   | 517                                 |
| Males                | 993 (79.3%)         | 471 (85.5%)             | 328 (82.0%)       | $\chi^2 = 2.09; p = 0.148$         | 579 (78.8%)           | 414 (80.1%)                         |
| Median age in years (IQR) | 34 (27 to 41)       | 35 (29 to 41)           | 35 (29 to 42)     | $t = 1.08; p = 0.280$              | 34 (28 to 41)         | 34 (27 to 41)                       |
| Education–at least high school (11 years) completed | 980 (78.3%)         | 434 (78.8%)             | 315 (78.8%)       | $\chi^2 = 0.03; p = 0.867$         | 558 (75.9%)           | 422 (81.6%)                         |
| Homeless             | 168 (13.4%)         | 54 (9.8%)               | 1 (0.3%)          | $\chi^2 = 39.10; p < 0.0005$       | 110 (15.0%)           | 58 (11.2%)                          |
| PWID* (injecting over the last six months) | 551 (44.0%)         | 551 (100%)              | 400* (100%)       | N/A                                | 303 (41.5%)           | 248 (48.0%)                         |
| Duration of injection in years | Not applicable, see next column | 14.7 (7 to 21.25)       | 16.5 (10 to 22)   | $t = 2.79; p = 0.005$              | 15 (8 to 22)          | 15 (7 to 21)                        |
| On drug/alcohol treatment at enrollment | 102 (8.1%)         | 54 (9.8%)               | 9 (2.3%)          | $\chi^2 = 21.36; p < 0.0005$       | 35 (4.8%)             | 67 (13.0%)                          |
| Unemployed/unable to work | 496 (39.6%)         | 256 (46.5%)             | 89 (22.3%)        | $\chi^2 = 59.11; p < 0.0005$       | 264 (35.9%)           | 232 (44.9%)                         |
| Sex workers          | 4 (0.3%)            | 2 (0.4%)                | 0%                | $\chi^2 = 1.46; p = 0.228$         | 3 (0.4%)             | 1 (0.2%)                            |
| Male sex workers (% of males) | 1 (0.1%)          | 1 (0.2%)                | 0%                |                                    | 1 (0.2%)             | 0 (0.0%)                            |
| Female sex workers (% of females) | 3 (1.2%)         | 1 (1.3%)                | 0%                |                                    | 2 (1.3%)             | 1 (1.0%)                            |
| Engaged in male/male sex (% of men in last six months (TRIP) or last 12 months (IBBS) | 18 (1.4%)         | 2 (0.4%)                | 0%                | $\chi^2 = 1.46; p = 0.228$         | 3 (0.4%)             | 15 (2.9%)                           |

*IBBS participants were all PWID.

Table 2. Percent of recently HIV infected people in the TRIP network-recruited participants and their Arms as compared with IBBS2013 surveillance programme

|                                | N     | N recently infected in networks | % Recently infected in networks |
|--------------------------------|-------|---------------------------------|--------------------------------|
| Network of recent seeds        | 735   | 13                              | 1.8%                           |
| Networks of long-term HIV-positive seeds | 517   | 11                              | 2.1%                           |
| Total networks (adding Recents’ networks together with long-term positives’ networks) | 1252 | 24                              | 1.9%                           |
| IBBS 2013                      | 400   | 1                               | 0.25%                          |
| Comparison of network of recent seeds to network of long term HIV-positive seeds | OR 0.83 | CI 0.37, 1.86      | $\chi^2 = 0.21; p = 0.648$; Fisher’s Exact Test p = 0.679 |
| Comparison of network of recent seeds to IBBS Odessa | OR 7.18 |                | $\chi^2 = 4.90; p = 0.027$; Fisher’s Exact Test p = 0.025 |
| Comparison of network of longer-term HIV-positive seeds to IBBS Odessa | OR 8.67 |                | $\chi^2 = 6.16; p = 0.013$; Fisher’s Exact Test p = 0.016 |
| Comparison of both networks to IBBS Odessa | OR 7.80 |                | $\chi^2 = 5.65; p = 0.017$; Fisher’s Exact Test p = 0.016 |
Contrary to our expectations, the two arms of TRIP recruited similar proportions of PwRI in Odessa. In Athens TRIP, the networks of PwRI contained higher proportions of PwRI than did the networks of longer-term HIV-positives [13]. These different results may well be due to the different percentages in the two cities of risk network members who were recruited from venues as opposed to from among named risk network members. It seems likely that many of these venue recruits did not engage often, if at all, in risk behaviours with those who nominated their venues as places from which to recruit, so their probability of being recently infected would be likely to have a weaker relationship to the infection status of the seed or network member from whose venue they were recruited. However, our sample size was unfortunately too small to let us test for a possible effect on PwRI recruitment rate of the interaction between recruitment type (venue vs. direct risk partner recruitment) and TRIP arm (networks of PwRI seeds vs. longer-term HIV-positive seeds).

This paper is subject to a number of limitations. First, networks may have been under-recruited in TRIP due to under-reporting of risk partners’ names or of venues that participants frequented, or due to our being able to recruit only some of those named (since some participants were unwilling or unable to recruit some of their named network members). Second, in TRIP, but not in IBBS, seronegative network members could be re-interviewed and re-tested after six months if they were recruited as a network member again—which might have slightly increased the number of PwRI recruited by TRIP. Third, both TRIP and IBBS relied on monetary incentives to increase participation. This led to some participants incorrectly taking part more than once. Fourth, IBBS excluded seeds who were already aware (and self-reported) that they were HIV positive, whereas TRIP sought out and tested seeds who were already tested and confirmed to be HIV positive. Although this might have biased TRIP networks to include more HIV-positives, it is unclear whether this difference would bias TRIP or IBBS to recruit more recently infected network members. This is because HIV negatives are the only people who can get infected and thus become recently infected, so IBBS seeds (who self-reported that they were HIV negative...
### Table 5. Cost comparison

| Items | Comments | Cost, US$ using exchange rate of 25.59 UAH per US dollar | Total cost, $ |
|-------|----------|--------------------------------------------------------|---------------|
| a. TRIP November 2013 to March 2016 | | | |
| Staff costs storefront | | | |
| Interviewer | 53 interviews per month; 33 hours per week per person; two persons | 10.55 | 1452 | 15320.05 |
| Social worker per month | 25 hours per week | 136.77 | 28 | 3829.62 |
| Medical staff | | | |
| Nurse per month | 4 per day | 117.23 | 28 | 3282.53 |
| Recruitment costs | | | |
| Interview | | 1.95 | 1452 | 2837.05 |
| Contact | | 0.78 | 1452 | 1134.82 |
| Place | | 0.39 | | |
| Test procurement | | | |
| Rapid test | For detection | 1.00 | 1452 | 1452.00 |
| Rapid test | In Lab for HIV positive | 1.00 | 356 | 356.00 |
| LAg | Per test | 10.89 | 356 | 3878.30 |
| Viral load | Per test | 22.26 | 356 | 7926.38 |
| Lab labour | | | |
| LAg | Per test conducted | 3.13 | 356 | 1112.93 |
| Viral load | Per test conducted | 5.86 | 356 | 2086.75 |
| Total cost | | | 43,216.43 |
| Number of people tested | | | 1452 |
| Number of HIV positive | | | 356 |
| Number of recently infected participants detected | | | 24 |
| **Cost per recently infected participant detected if exchange rate is valued at time TRIP stopped collecting data** | | | 1800.69 |
| **Cost per recently infected participant detected if exchange rate were 8 UAH per dollar** | | | 4512.82 |
| b. IBBS (38 days of actual data collection) | | | |
| Site staff | | | |
| Interviewer | | 4.25 | 400 | 1700.00 |
| Coupon manager | | 410.25 | 1 | 410.25 |
| Regional supervision | | 512.88 | 1 | 512.88 |
| Medical staff | | | |
| Nurse | Per test | 1.71 | 400 | 685.00 |
| Doctor | Pre- and post-test counseling | 1.71 | 400 | 685.00 |
| Nurse | Per dried blood spot | 1.71 | 108 | 184.95 |
| Supervision of biological aspects | | 307.75 | 1 | 307.75 |
| Recruitment cost | | | |
| Interview | | 4.25 | 400 | 1700.00 |
| Recruiting | | 2.56 | 400 | 1025.00 |
| Test procurement | | | |
| Rapid test | For detection | 1.00 | 400 | 400.00 |
| Dried blood spot | For all HIV positive | 1 | 108.00 | 108 |
| LAg | Per test | 10.89 | 108 | 1176.12 |
| Viral load | Per test | 22.26 | 108 | 2404.08 |
| Training the staff | Per training | 357.00 | 1 | 312.50 |
and were therefore likely to be either uninfected or HIV-positive unaware) might be more likely to be in networks with recently infected people. Fifth, the seeds for both arms of TRIP were clients of the same community service organization, so their networks often overlapped. This may have contributed to making their yields of PwRI similar. Sixth, TRIP recruitment occurred after IBBS recruitment, with most TRIP recruitment taking place after the beginning of widespread protests in late 2013 and the subsequent governmental changes. Russian take-over of Crimea, insurgency in eastern Ukraine, and ensuing large-scale migration of refugees. If these “Big Events” and their corresponding social and structural instability increased HIV incidence, this could have contributed to a portion of the measured TRIP/IBBS differences [30,31]. Seventh, the fact that only one IBBS participant was recently infected created a problem of sparseness, which means that the accuracy of the magnitude of the odds ratios is limited. This same problem prevented adjusted analyses to control for confounding covariates. As Greenland et al. [29] suggest, we analysed the bivariate associations between yields for IBBS and TRIP both for the whole TRIP sample and for the subsample of people who inject drugs using the (conservative) Fisher’s Exact Test. In both cases, the comparisons had significance levels below 0.05. A final limitation is that TRIP was designed to recruit PwRI for intervention purposes, whereas IBBS had an epidemiologic focus, which might have influenced their relative yields of PwRI.

Past research on injectors’ networks in Athens by Nikolaopoulos et al. [13] and research by Green et al. in San Diego [32] showed that partner services that traced the sexual contacts of the recently infected are effective at finding other PwRI. Taken together with this paper, this pattern of results suggests that risk network (although perhaps not venue tracing) methods starting with either recently- or longer-term HIV-infected people are effective ways to locate PwRI. As discussed above, PwRI are a strategically important group and were therefore likely to be either uninfected or HIV-positive unaware) might be more likely to be in networks with recently infected people. Fifth, the seeds for both arms of TRIP were clients of the same community service organization, so their networks often overlapped. This may have contributed to making their yields of PwRI similar. Sixth, TRIP recruitment occurred after IBBS recruitment, with most TRIP recruitment taking place after the beginning of widespread protests in late 2013 and the subsequent governmental changes. Russian take-over of Crimea, insurgency in eastern Ukraine, and ensuing large-scale migration of refugees. If these “Big Events” and their corresponding social and structural instability increased HIV incidence, this could have contributed to a portion of the measured TRIP/IBBS differences [30,31]. Seventh, the fact that only one IBBS participant was recently infected created a problem of sparseness, which means that the accuracy of the magnitude of the odds ratios is limited. This same problem prevented adjusted analyses to control for confounding covariates. As Greenland et al. [29] suggest, we analysed the bivariate associations between yields for IBBS and TRIP both for the whole TRIP sample and for the subsample of people who inject drugs using the (conservative) Fisher’s Exact Test. In both cases, the comparisons had significance levels below 0.05. A final limitation is that TRIP was designed to recruit PwRI for intervention purposes, whereas IBBS had an epidemiologic focus, which might have influenced their relative yields of PwRI.

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Further research is needed to confirm these results and to understand what epidemiologic and sociocultural circumstances and/or intervention techniques affect the relative proportions of PwRI found in the networks of recently infected seeds and those of seeds with longer-term infection. Future research should also make direct statistical comparisons between venue-based recruitment and recruitment of direct risk partners. Research might also develop easier-to-implement ways to recruit risk network members and to search for PwRI.

5 | CONCLUSIONS

Locating people soon after they become infected is an important goal both for patient care and for HIV prevention. The present findings suggest that network approaches may cost-effectively identify PwRI at higher rates than does RDS. Network-tracing interventions that start with people who test HIV positive are a cost-effective way to locate PwRI and should be widely implemented.

AUTHORS’ AFFILIATIONS

1National Development and Research Institutes, New York, NY, USA; 2Alliance for Public Health, Kyiv, Ukraine; 3Medical School, University of Cyprus, Nicosia, Cyprus; 4Division of Global Public Health, University of California San Diego, San Diego, CA, USA; 5University of Chicago, Chicago, IL, USA; 6Department of Medicine and Center for HIV Elimination, University of Chicago, Chicago, IL, USA; 7New College, University of Oxford, Oxford, UK; 8ICAP-NY, Columbia University, New York, NY, USA; 9Odessa Regional Laboratory Center of the Ministry of Health of Ukraine, Odessa, Ukraine; 10Center for Drug Use and HIV Research, New York, NY, USA; 11Department of Population Health, New York University Medical School, New York, NY, USA

COMPETING INTERESTS

None to declare.

AUTHORS’ CONTRIBUTIONS

LDW Together with SRF, did most of the writing of the paper; helped conceptualize this paper; conducted most of the statistical analyses; contributed to TRIP field operations; helped resolve complex data issues; and approved the final version. AK Managed day to day TRIP field operations during much of the project; organized and maintained complex data files; helped conceptualize this paper; helped resolve complex data issues; contributed to the analyses; helped write the paper; and approved the final version. PS Helped write the funding proposal; oversaw and contributed to all TRIP field operations; helped conceptualize this paper; conducted the analyses of costs; helped write the paper; and approved the final version. YS Conducted analyses of the IBBS and Outreach Testing data; helped write the paper; and approved the final version. GKN Helped conceptualize this paper; helped design the analysis plan; helped write the paper; and approved the final version. BS Helped conceptualize this paper;
helped write the paper; and approved the final version. EM Helped conceptualize this paper; helped write the paper; and approved the final version. JS Helped write the proposal; helped conceptualize this paper; helped write the paper; and approved the final version. TVY Helped write the proposal funding; managed day to day field operations during much of the project start-up; set up and organized complex data files; helped write the paper; and approved the final version. YTD Trained and oversaw Odessa laboratory staff on LAg test; conducted LAg analyses at CDC for IBBS; helped write the paper; and approved the final version. SC, VC. LC conducted the operations of the Odessa Regional Laboratory Center of the Ministry of Health of Ukraine which conducted the LAg analyses and provided other information that help determine which participants had recently been infected; approved the paper. SRF Overall project principal investigator; oversaw all field operations in some detail; wrote funding proposal help with from PS, JS and TVY; led in conceptualizing and directing this paper; conducted some analyses; helped write the paper; approved the final version.

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