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Evaluating effectiveness of syringe exchange programmes: current issues and future prospects

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Abstract

Although a large body of international literature has found syringe exchange programmes (SEPs) to be associated with reduced incidence of blood borne pathogens among injection drug users, recent studies have fuelled controversy surrounding SEP effectiveness. Existing studies are observational in nature and have seldom considered ecologic aspects affecting SEP functioning and evaluation. The authors apply concepts from infectious disease epidemiology to discuss the direct and indirect effects of SEP upon the spread of blood borne pathogens in drug users, their social networks and the broader community. Further, the authors discuss social policies, particularly drug control policies, which have directly and/or indirectly limited SEP functioning at local and national levels. A critical review of the literature suggests that biases common to observational studies can account for higher HIV incidence among SEP attenders relative to non-attenders. Strong selection factors often lead high-risk drug users to be over-represented among SEP attenders. Failure to account for these factors and the indirect effects of SEPs can bias interpretations of programme effectiveness. Future SEP evaluations should consider behavioural data, the local ethnographic context, the prevalence of infectious disease in the groups under study and the structural components of SEP that are most and least effective at reducing incidence of blood borne pathogens. Hierarchical models that take into account the ecological dimensions of SEP are recommended as an approach for future studies. Beyond methodologic concerns, the authors discuss social, legal and programmatic obstacles that must be overcome in order to maximise SEP effectiveness.

Keywords: Syringe-exchange programmes; Injecting drug users; HIV; Blood borne infections; Epidemiology; Ecological studies

Introduction

Injection drug use contributes to a considerable illness burden in both developed and developing countries (Strathdee, van Ameijden & Mesquita, 1998; Bastos, Strathdee, Derrico & Pina, 1999a). Sharing of injection equipment is associated with transmission of blood borne pathogens (HIV, hepatitis viruses, human T-cell lymphotrophic viruses, malaria) and also increases the risk of endocarditis, cellulitis and abscesses. Syringe exchange programmes (SEPs) aim to reduce the negative consequences associated with injection drug use for persons who cannot or will not cease injecting. The first SEP was introduced in Amsterdam, the Netherlands, in 1984 (van den Hoek, van Haas-

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trecht & Coutinho, 1989). An important goal of SEPs is to decrease the circulation of contaminated injection equipment, thereby reducing parenteral transmission of blood borne pathogens (Kaplan, 1994; Kaplan & Heimer, 1994). Through such programmes, injection drug users (IDUs) exchange sterile syringes for potentially contaminated ones, usually on a one-for-one basis. Many SEPs provide other sterile equipment or paraphernalia that facilitates safer injection (e.g. cottons, cookers, water, bleach) as well as condoms. In many settings, SEPs also act as a pivotal entry point for drug treatment and rehabilitation (Heimer, Khoshnood, Bigg, Guydish & Junge, 1998; van Ameijden, van den Hoek & Coutinho, 1994; Strathdee, Celentano, Shah et al., 1999).

Since the mid-1980s, most developed countries and a growing number of developing countries have introduced SEPs as a core component of an overall harm reduction strategy aimed at IDUs (Stimson, 1995; Strathdee et al., 1998; Ball, 1998). A large body of international literature has consistently shown SEPs to be associated with reduced incidence of HIV, hepatitis B virus (HBV) and hepatitis C Virus (HCV; Lurie, Reingold & Bowser, 1993; Keene, Stimson, Jones & Parry-Langdon, 1993; van Ameijden et al., 1994; Des Jarlais, Hagan & Friedman, 1995; Normand, Vlahov & Moses, 1995; Drucker, Lurie, Wodak & Alcabes, 1998). SEPs have been accepted as a cornerstone prevention strategy in the United Kingdom and Australia, where HIV epidemics among IDU have been essentially averted (Stimson, 1995, 1996; Wodak & Lurie, 1997; Des Jarlais et al., 1995). However, in some countries, such as the United States, controversy surrounds the role of SEPs as a harm reduction measure, despite several US studies reporting favourable outcomes (Hagan, Des Jarlais, Friedman et al., 1995; Schoenbaum, Hartel & Gourevitch, 1996; Des Jarlais, Marmor & Paone, 1996; Vlahov, Junge & Brookmeyer, 1997). This debate has been fueled by recent studies suggesting that in some settings, SEP effectiveness may be limited (Bruneau, Lamothe, Franco et al., 1997a; Strathdee, Patrick & Currie, 1997; Hagan, McGough, Thiede et al., 1999). In Vancouver, after years of low, stable HIV prevalence among IDU, an explosive HIV outbreak occurred in the presence of a high volume SEP that had been introduced early (Strathdee et al., 1997). In Montreal, frequent SEP attenders have consistently had higher HIV incidence rates than infrequent or non-attenders, even after adjusting for potential confounding factors (Bruneau et al., 1997a; Bruneau, Lamothe & Franco, 1998). More recently, Hagan and colleagues (1999) reported no benefit of SEP upon incidence rates of HBV and HCV among IDUs in Seattle, Washington. These findings have fanned the flames of controversy surrounding SEP effectiveness (Lurie, 1995, 1997; Lurie & Drucker, 1997; Drucker et al., 1998; Moss & Hahn, 1999).

Evaluations of SEP have seldom discussed the many methodologic shortcomings that compromise the ability to draw causal inferences from observational studies, especially in the field of infectious disease epidemiology. Since SEPs differ considerably between and even within cities with respect to infrastructure, policies and local environmental conditions, these and other contextual factors may affect the extent to which they confer protection against infection. Diffusion of pathogens which are transmitted through parenteral and sexual transmission follow complex behavioural patterns through selective social networks (Morris, 1994, 1997; Valente, 1995; Friedman, Neaigus & Jose, 1997). In this review, we discuss recent literature surrounding SEP effectiveness and discuss ecological aspects affecting SEP functioning and evaluation from a broad public health perspective.

Direct and indirect influences of SEP upon disease transmission

In considering SEPs as a public health intervention, one must take into account not only its direct effect upon the dynamics of infectious disease spread, but also its indirect effects upon the broader community. Any intervention in the field of the infectious diseases has simultaneous direct and indirect effects upon a defined community (Halloran & Struchiner, 1991, 1995; Boily & Masse, 1997). Since each individual attending SEP is a member of a community (however loosely defined), the health status and/or behaviour of these individuals can potentially affect all other individuals with whom they are in contact. This can include persons in their personal network, which refers to an individual and his/her ties, or their social network, which is a constellation of linked personal networks (Neaigus, Friedman, Curtis et al., 1994; Latkin, Mandell, Vlahov et al., 1996; Valente, 1995; Friedman et al., 1997).

The direct and indirect effects of SEP on transmission of blood borne disease are not necessarily straightforward. The most obvious example of direct protection from disease occurs when an individual obtains and consistently uses sterile injection equipment from SEP, thereby avoiding infection with blood borne pathogens. However, SEPs can also confer direct protection from disease through the provision of condoms, HIV counselling and testing, HBV vaccination and referral to drug treatment. The protective effect of condom promotion may be considerable, since condoms can also prevent transmission of STDs that are known cofactors of HIV transmission (Aral, 1993; Leite, Nicolos, Osella et al., 1995).

It is well recognised that SEPs can have an indirect protective effect upon a SEP attender's personal network, by preventing transmission to this individual's sexual partner(s), offspring and receptive needle sharing partner(s). Yet SEPs can also have an indirect effect on transmission risks among IDUs who neither attend SEP, nor share injection equipment with programme attenders. This can occur via "secondary exchange", whereby IDUs obtain syringes from SEP and deliver them to IDU that cannot or choose not to attend (Valente, Foreman, Jungue & Vlahov, 1998a). An important distinction has been made between secondary exchangers who provide sterile needles to IDU in their personal network, and "satellite exchangers" who provide sterile SEP syringes to IDU in a broader social network (Valente et al., 1998a). In Baltimore, satellite exchangers comprised only 10% of SEP attenders, but accounted for 64% of all needles distributed (Valente et al., 1998a). Examples of IDUs who may be reached through satellite exchange are persons who are secretly injecting (e.g. IDUs on parole, in prison, hospital or drug treatment programmes), shooting gallery attenders, persons who do not perceive themselves as IDUs (e.g. steroid injectors; Crampin, Lamagni, Hope et al., 1998) and IDUs who do not live in an area served by a SEP.

It is also theoretically possible that SEP — like any intervention that leads to behaviour change — could inadvertently have a deleterious indirect effect on the spread of blood borne pathogens. For example, if a SEP attender ceases to lend their used syringes to others, this will necessitate a rearrangement of his/her former needle-sharing network. In the case where the SEP attender remains HIV-negative, SEP has a protective effect at the level of the individual, but the effect upon his/her personal syringe-sharing network could be counter-productive. For example, these network members may now acquire used syringes from person(s) infected with HIV or other blood borne pathogens. In this theoretical example, SEP could simultaneously have a protective direct effect upon the individual, a deleterious effect upon his/her personal network, and an unknown effect upon broader social networks in the community.

As a possible explanation for higher HIV incidence observed among SEP attenders relative to non-attenders in Montreal, Canada, Bruneau, Franco and Lamothe, (1997b) suggested that SEPs might unwittingly promote the formation of syringe sharing networks. For example, if high-risk SEP attenders congregate at a SEP where they meet new needle-sharing partners, SEP could indirectly promote HIV transmission among its attenders. However, in subsequently testing this hypothesis, Montreal investigators found no evidence that SEP attenders met new needle-sharing partners at SEP (Lamothe, Bruneau, Franco et al., 1998). Studies of SEP attenders in Vancouver and Baltimore have similarly rejected this hypothesis (Schechter, Strathdee & Cornelisse, 1999; Junge, Valente, Latkin et al., 2000).

The role of syringe coverage in preventing blood borne disease

It has been proposed that an ideal public health goal is to ensure a sterile syringe for each injection among IDU who cannot or will not cease injecting (US Public Health Service, 1997). In the context of preventing infectious diseases (e.g. through vaccination), this is analogous to achieving 100% coverage among an at-risk population. While this is an admirable goal, 100% coverage is not required to prevent most disease outbreaks, due to herd immunity (Halloran, Haber, Longini, Struchiner et al., 1991). Likewise, SEPs need not meet the entire syringe demand in a given IDU community to confer a community-wide protective effect (Des Jarlais et al., 1995). Apart from alternate sources of sterile syringes that can increase coverage when available (e.g. pharmacies, syringe vending machines), a SEP can be considered effective if it significantly reduces the probability that uninfected IDUs come into contact with contaminated syringes in their personal and/or social networks. In more general terms, the protected fraction will consist of persons protected both by direct and indirect effects of SEP (Boily & Anderson, 1996; Boily & Masse, 1997). The dynamic between sterile syringe availability and the probability of infection through use of contaminated syringes depends on the rate at which contaminated syringes are removed from the community, the underlying prevalence and incidence of blood borne infections, the duration of infection (e.g. corresponding to HIV viral load) and the nature of subsequent rearrangements among formal and informal syringe distribution circuits (Kaplan, 1994; Kaplan & Heimer, 1994; Kretzschmar & Wiessing, 1998).

Although SEPs need not achieve full coverage to prevent HIV epidemics from occurring, adequate syringe coverage is nevertheless an important facet that warrants careful evaluation. An evaluation of 16 North American SEP in 1993 reported that syringe coverage seldom exceeded 30% (Lurie et al., 1993). In 1996, less than 10% of 117 SEPs in the US reported exchanging more than 0.5 million syringes per year on an annual basis (Paone, Clarke, Shi, Purchase & Des Jarlais, 1999). This pales in comparison to a national estimate of 1.3 billion injections per year (Lurie, Jones & Foley, 1998). Inadequate syringe coverage may also have contributed to limited SEP effectiveness in Canadian cities. In Montreal, less than 5% of the estimated syringe demand was being met during the period when

HIV incidence was escalating among IDUs (Remis, Bruneau & Hankins, 1998). In Vancouver, where SEP has exchanged approximately two million syringes per year since 1996, it was estimated that five to ten million syringes would be required to attain the goal of a sterile syringe for every injection (Strathdee et al., 1997).

Achieving adequate syringe coverage among an IDU population can be difficult due to the covert and illicit nature of injection drug use that can deter IDUs from accessing services. Local contextual factors and policies can also affect the extent to which SEP can effectively operate (Sorge & Harlow, 1997; Lurie et al., 1998; Remis et al., 1998). In cases where syringes must be purchased from an annual operating budget, funding restrictions may lead to uneven coverage, or imposed limits on the number of syringes IDU can exchange at a given time. Budget constraints limit SEP activities in both developed and developing countries (Bastos et al., 1999a; Telles, 1999). In the US, there is a continued Congressional ban on the use of federal funds to support SEPs, which has had a dramatic effect on syringe coverage (Lurie, 1995; Paone et al., 1999). Recently, Paone et al. (1999) showed that illegal SEPs were significantly less likely to offer ancillary services such as HIV testing and counselling, referrals to drug abuse treatment and screening for sexually transmitted diseases, since these programmes are often operated underground by NGOs and volunteers. Where SEPs are operating in developing countries and regions in transition (e.g. Brazil, India, Bangladesh, the Russian Federation and Newly Independent States), resources and political power of local institutions are very restricted and SEP funds rely on federal sources and multilateral agreements involving international donors (Bastos et al., 1998, 1999a; Rhodes, Stimson & Crofts, 1999; Telles, 1999).

SEP policies can also affect syringe coverage. Strict one-for-one exchange policies are often required by policy makers to placate concerns that SEPs could encourage initiation of injection among youth (Lurie et al., 1993). In an attempt to achieve a "high access" rather than a "high volume" model that focuses on direct contact with each IDU, some SEPs have actively discouraged secondary exchange, a practice which could limit SEP effectiveness since coverage is reduced (Des Jarlais & Friedman, 1998). The persistence of paraphernalia laws in many settings imposes an unusual restriction upon SEP coverage and functioning, and is discussed further below.

The fact that SEPs differ markedly with respect to the above factors, as well as structural components (e.g. hours of operation, location, mobile vs. storefront sites, types of services provided) is seldom recognised or studied. The potentially synergistic effects of SEPs — as part of a combined package of preventive and therapeutic strategies — makes it difficult to compare between SEPs or to separate their effects from other interventions. In Amsterdam, the combined effects of several interventions (e.g. SEP, methadone maintenance, HIV counselling and testing) was associated with reduced HIV incidence among IDU, but these protective effects could not be attributed to a single intervention (van Ameijden et al., 1994). Despite variations between programmes, a recent international comparison showed that in 29 cities with established SEPs, HIV prevalence decreased on average by 5.8% per year, but increased on average by 5.9% per year in 51 cities without SEPs (Hurley, Jolley & Kaldor 1997).

Direct and indirect influences of social policies on SEP functioning

The protective effects of SEPs upon a community can be directly or indirectly affected by local, national and international drug control policies. On a local basis, these effects are often direct and pervasive. Police may undermine SEP activities by confiscating syringes from attenders, or otherwise creating an environment where IDU feel uncomfortable attending SEP (Harvey, Strathdee, Patrick, 1998; Case, Meehan & Jones, 1998; Minayo, Deslandes, Souza et al., 1998; Telles, 1999). Local or national drug enforcement laws (e.g. paraphernalia and drug possession laws) may also discourage IDU from keeping syringes in their possession, thereby causing them to share scarce injection equipment (Grund, Stern, Kaplan et al, 1992; Koester, Booth & Zhang, 1996; Drucker et al., 1998; Gostin, 1998).

Drug control policies may also have an indirect effect on SEP functioning. SEPs often co-exist in a contradictory setting where harm reduction activities are in clear contradiction with the modus operandi of other agencies (e.g. law enforcement agencies, drug control agencies, abstinence-only drug treatment programmes, religious institutions). Recently published reports describe legal challenges faced by SEPs in the states of New York (Sorge & Harlow, 1997) and Massachusetts (Case et al., 1998). In these and other settings, SEP operators have been often embroiled in judicial battles to defend the legal status of these programmes. In many US states, SEP activists and staff continue to be arrested and charged (Gostin, 1998). These legal battles represent precious time and manpower detracting from SEP activities, many of which are underfunded and staffed by volunteers (Sorge & Harlow, 1997).

In New York City, Chicago, Rhode Island and Baltimore, waivers are provided to SEP attenders to protect them from paraphernalia laws (Vlahov et al., 1997; Rich, Dickinson, Liu et al., 1998a). While this

strategy is reportedly effective, it could be interpreted as supporting the contradictory notion of "good IDUs" (i.e. those attending SEPs), and "bad IDUs" who obtain their needles elsewhere. Contradictory policies spread an anti-pedagogic message to IDU, which can only serve to reinforce their mistrust of the "system". From an epidemiological viewpoint, the legal, social and geographic distinctions between IDUs who have access or no access to SEPs represents a bias to be carefully addressed, as discussed below.

Drug control policies can also indirectly effect the risk of blood borne infections among IDU who are arrested and imprisoned. Since injection equipment is in short supply within correctional institutions, even the most conscientious IDU who consistently practices safe syringe hygiene may be forced to share or re-use injection equipment while in jail or prison. Although transmission risks among incarcerated IDU have not been well studied, an outbreak of HIV infection was documented among IDU in a Scottish prison (Taylor, Goldberg, Emslie et al., 1995). There are also widespread concerns regarding intra-prison transmission of HBV and HCV (Dolan, Wodak & Penny, 1995). Only a few pilot studies have evaluated SEPs within the prison setting (Nelles & Harding, 1995). It is counter-intuitive from a legal, public health and human rights perspective that imprisoned IDU who are being rehabilitated for their crime may be placed at higher risk of blood borne infection compared to IDU on the street.

SEPs in developing and transitional countries

SEPs have been introduced in a number of developing countries, including Brazil, India, Nepal and some of the newly independent Baltic States (Strathdee et al., 1998; Rhodes et al., 1999; Telles, 1999). A more comprehensive discussion of harm reduction in developing countries by the authors of the present paper is found in detail elsewhere (Strathdee et al., 1998; Bastos et al., 1999a). Here, we describe briefly some of the issues faced by SEPs in two very different settings: Brazil and Nepal.

Brazil

In Brazil, only a few NGOs and self-help organisations were involved in the development of prevention programmes among IDUs until the mid-1990s, apart from activities which strictly promoted abstinence. The struggle for the implementation of a comprehensive set of harm reduction initiatives directed at IDUs received a boost in Brazil only after 1992, with preliminary studies carried out by a joint Brazilian Ministry of Health/World Bank taskforce. Analysis of epidemiological data made clear to the task force the need to highlight the central role of programmes specifically directed to IDUs and their partners in halting the spread of the epidemic. Since then, the process of implementing SEPs has been erratic, being influenced by strong opposition from local conservative forces and the explicit or implicit legal prohibition to carry out these activities.

Due to its prominent socioeconomic role in South America and the size of its HIV/AIDS epidemic (i.e. second only to the US in terms of numbers of reported AIDS cases), the reformulation of Brazilian HIV/AIDS prevention policies has had a significant impact upon activities in most countries of South America. The first SEP in South America began in Salvador, Bahia State, in 1994. To date, 30 SEPs — including established projects, pilot programmes and underground initiatives — are in operation in different regions of Brazil, supported by a consortium involving the Brazilian Ministry of Health, the World Bank, UNDCP and other international agencies. Unfortunately, such activities have not been spared by recent currency crises that have hindered the implementation of most public health initiatives. No other South American country has officially endorsed SEPs, with an exception made to some underground and pilot projects in Argentina.

The most successful SEPs in Brazil are still considered small-scale projects by international standards. For example, the SEP of Porto Alegre, in southern Brazil exchanges ~10,000 syringes on a monthly basis (Dr. Fernando Marques, personal communication). Projects like the Porto Alegre SEP profit from the fact they have gained the sympathy and support of local authorities, and above all the acceptance of local communities and grassroots organisations, both public and private. In Rio de Janeiro, 3000 syringes are exchanged among IDUs per month, in addition to condom distribution and outreach to sex workers (Telles, 1999).

A common problem in settings where interventions are introduced under severe funding shortages is the lack of a formal evaluative component. Two unpublished evaluations of Brazilian SEPs have been conducted thus far. One such evaluation assessed 13 established projects and was co-ordinated by Oswaldo Cruz Foundation (FIOCRUZ) team. It addressed operational characteristics using qualitative methods (e.g. focus groups and in-depth interviews) and uncovered serious shortcomings such as understaffing, fiscal restraints and lack of technical and managerial local expertise. A second evaluation, co-ordinated by the Federal University of Minas Gerais (UFMG) evaluated epidemiological baseline data of selected SEPs from south and southeastern cities. This study used a variety of approaches such as capture–recapture techniques to estimate IDU population size, and serological surveys to evaluate HIV and viral hepatitis

prevalence. A third evaluation, to be conducted by a UFMG/FIOCRUZ taskforce, is being contracted by the Ministry of Health. This new evaluation will address the effectiveness of selected SEPs from different Brazilian regions, profiting from the data generated by the two former assessments.

To date, available data point to very high prevalence rates of HIV and viral hepatitis in all localities assessed thus far, including a number of southern and southeastern cities and towns (Bastos et al., 1999a; Telles, Bastos, Guydish et al., 1997; Carvalho, Mesquita, Messad et al, 1996). Apart from HIV and hepatitis viruses, Brazil faces additional public health threats due to blood borne transmission of HTLV-I/II and malaria (Bastos, Barcellos, Lowndes & Friedman, 1999b).

Despite funding restrictions, support for harm reduction initiatives, including SEPs, is growing in Brazil. A state bill was recently passed in São Paulo, Brazil's richest state, permitting implementation of SEPs and similar activities. Although federal drug policies still officially prohibit activities related to SEP, the state bill has eased the repressive conditions faced by local activists and fieldworkers. Regional and national networks have become established which function as a forum for ideas and practical experiences with respect to SEPs and other harm reduction initiatives. Support from international agencies such as UNAIDS and the World Bank has been necessary to both introduce and sustain SEPs in Brazil. The task in the future will be to expand these programmes further and to integrate an evaluation framework from the onset.

Nepal

In Kathmandu, Nepal, the Lifegiving and Lifesaving Society introduced a SEP which has been in operation for more than five years (Peak et al., 1995), as well as a methadone maintenance programme (Rhodes et al., 1999). HIV prevalence in Kathmandu was reported to be below 2% in the early years following the introduction of SEP. However, in recent years, HIV prevalence has risen dramatically to 40%, according to national cross-sectional serological surveys and a recent rapid assessment (Dr. Nick Crofts, personal communication). To date, available published reports have only partially documented this apparent outbreak (Rhodes et al., 1999). However, based on the first information obtained by the use of rapid assessment methods, a number of factors may have contributed to a rapid increase in HIV infections despite the presence of a SEP. First, coverage of the Kathmandu SEP was extremely low and uneven; perhaps 700 IDUs out of an estimated 15,000 IDUs were reached. Second, Nepal has experienced a pronounced shift from smoking and injection of heroin, to injection of illicit buprenorphine, as has been noted in India. This was inadvertently facilitated by use of injectable buprenorphine by medical practioners in the treatment of opiate addiction (Ball, 1998). While it is difficult to determine whether this transition may have led to riskier injection practices, the fact that buprenorphine is cheaper and does not require preparation prior to injection may have contributed to increased injection frequency. Regardless, these observations suggest that future interventions should go beyond increased availability of sterile syringes, to include outreach and education to thwart transitions to injection. Support from international agencies will be required to expand prevention activities in this region, and to investigate the underlying determinants responsible for this rapid rise in HIV infection rates.

Selection factors affecting evaluation of needle exchange programmes

Recent analyses have shown that in many cities SEP attract high risk IDUs (Hahn, Vranizan & Moss, 1997; Bruneau et al., 1997a; Vlahov et al., 1997; Archibald, Ofner, Strathdee, et al., 1998; Schechter et al., 1999). Self-selection of high risk IDUs is not unexpected given that most SEP function as low threshold interventions (Drucker et al., 1998). However, what is often overlooked is that these selection factors may help explain why cities such as Montreal and Vancouver have observed higher HIV seroconversion rates among SEP attenders compared to non-attenders (Lowndes & Alary, 1998; Schechter et al., 1999). In such settings, IDUs who subsequently begin attending SEP may have a higher risk of HIV seroconversion before ever attending the programme (Lurie, 1997; Hahn et al., 1997; Lowndes & Alary, 1998). This has been clearly shown in San Francisco, where IDUs who later began attending SEP had higher HIV incidence rates than those who never attended (Hahn et al., 1997). In a recent Vancouver study, the number of HIV seroconversions observed among frequent vs. infrequent SEP attenders could be predicted solely on the basis of their higher baseline risk profile (Schechter et al., 1999). These findings suggest that selection factors could entirely explain the observed disparity in HIV incidence rates based on SEP attendance.

From the standpoint of SEP evaluation, there is a need for more sophisticated analyses that take into account these biases, lest they underestimate or mask a protective effect of SEP or create spurious associations. To date, most evaluations of SEP have merely employed dichotomous categorisations (e.g. SEP attenders vs. non-attenders, frequent vs. infrequent attenders). This simplistic approach overlooks the fact that

non-attenders may have entirely met their need for sterile syringes through other means. A recent analysis of SEP attenders in Amsterdam — a city where sterile syringes are readily available through pharmacies — found that irregular SEP attenders, but not non- or frequent attenders were at highest risk of HIV seroconversion (van Ameijden & Coutinho, 1998). Far from suggesting a deleterious effect of SEP on HIV incidence, these authors concluded that irregular SEP attenders had the least exposure to sterile injection equipment and consistent prevention messages, which placed them at higher risk of infection.

Beyond factors relating to frequency of SEP attendance and the volume of syringes obtained, SEP effectiveness can vary depending on the circulation time of contaminated syringes in the community (Kaplan et al., 1994; Kaplan & Heimer 1994) and whether syringes are obtained directly or indirectly through secondary or satellite exchange. While satellite exchange provides extended coverage of SEPs to IDU in the broader community, its recipients typically do not receive HIV/AIDS education, counselling or referrals to drug treatment that could have been received had they attended SEP themselves (Valente et al., 1998a). Further research is needed to quantify transmission risks for SEP attenders according to the different roles they may have in their personal and social networks.

The need for alternative methods to evaluate SEP effectiveness

One could argue that the ideal study design to examine SEP effectiveness is a randomised clinical trial of individuals in a community that has access or no access to SEP. However, a cogent argument has been made that such a design is unethical, since the overwhelming majority of the international literature supports a protective effect of SEP on the incidence of HIV and viral hepatitis (Lurie, 1998). We agree with this view. Randomisation of communities rather than individuals with access to SEP is not often feasible, since local drug scenes are highly idiosyncratic and residual confounding will undoubtedly persist. Therefore, evaluation of SEPs typically utilises observational study designs. These studies must simultaneously address the aforementioned selection factors influencing SEP attendance, the dynamic nature of infectious disease transmission, mobility within and between IDU communities and measurement of concealed behaviours in a hard-to-reach population.

In settings where SEPs have been attended by virtually all IDU in a given community (e.g. Vancouver), an appropriate comparison group is lacking to facilitate an overall outcome evaluation. However, in these situations it is still possible to undertake process evaluation whereby components of SEP that are most or least effective can be identified. Very few studies have been conducted which evaluate programmatic characteristics of SEP. Without taking into account the various components of SEP and their direct and the indirect effects, observational studies attempting to evaluate SEP will likely continue to produce conflicting findings. Below, we provide two novel approaches to evaluation of SEPs that could be used to circumvent these difficulties in the future.

The use of hierarchical modelling in the analysis of multi-site databases

One of the main caveats in the evaluation of SEPs has been the difficulty finding an optimal balance between an appropriate study design and a statistical analysis that can take into account the many different confounders and levels of analysis (i.e. the level of the individual, his/her networks, operational characteristics of the SEP, unique features of local drug scenes, etc). Such difficulties have been partially addressed by the use of large samples from different sources, made compatible through the use of meta-analytic techniques. This strategy was employed by Des Jarlais et al. (1996) in the evaluation of SEP attenders in New York City, whereby a 70% reduction in HIV incidence was attributed to SEP.

Apart from technical difficulties that arise in such meta-analysis, it must be noted that data being combined are often collected for different purposes and variations can exist between interventions. Although meta-analytic techniques permit broad correlations to be calculated between SEP attendance and specific disease outcomes (e.g. HIV or hepatitis infection rates), it is not possible to ascribe a specific outcome to a specific intervention implemented by an individual SEP in a combined database. In part, these difficulties can be addressed through the implementation of standard research protocols and instruments in multi-centre studies. However, methods are required which take into account the unique characteristics of each SEP and its surrounding setting.

In the authors' view, a thorough evaluation of SEP must combine different strategies, including the assessment of direct and indirect effects of SEP on drug-sharing networks, using both quantitative and qualitative methods. Future SEP evaluations should consider individual behavioural data, the local ethnographic context and the prevalence of disease in the groups under study. Hierarchical models represent a new research methodology that can address the complex nature of these data (Wong & Mason, 1991; Victora, Huttly, Fuchs & Olinto, 1997; Susser, 1994; Diez-Roux, 1998). These models are unique in the sense that they consider the specific epistemological dimen-

sion of their different components, and simultaneously take into account these different dimensions (i.e. individual, micro-social, macro-sociocultural) into multivariate models. Hierarchical modelling can resolve the inherently arbitrary and inconsistent aspects of variable selection (Rothman & Greenland, 1998), which is especially relevant when analysing individual, micro- and macro-social level dimensions (Wong & Mason, 1991). With such procedures, both proximal (e.g. attendance vs. non-attendance of SEP or frequency of needle sharing by individuals) and distal variables (e.g. operational characteristics of SEP) could be entered into a structured conceptual framework.

The use of biological markers in evaluation of SEPs

Most evaluations of SEP have relied on serologic data as outcome measures (e.g. HIV prevalence, incidence). Although a number of studies have reported HIV prevalence among SEP attenders, these data do not indicate whether the infection occurred before or after first attending SEP. While incidence data are clearly preferable, large sample sizes or long follow-up periods are required to accumulate sufficient statistical power to draw meaningful inferences. Prospective cohort studies tend to be time-consuming, very expensive and impractical in many developing countries. Even in the best situation, differential follow-up of high risk individuals can bias estimates of HIV incidence and associated risk factors or protective affects associated with seroconversion (e.g. SEP attendance).

An alternate strategy is to consider behavioural surveillance of SEP attenders. Many studies have relied on self-reports of needle sharing, which are prone to bias. Another alternative is to the use of serologic markers of recent infection to drawn incidence data from cross-sectional studies. In 1995, Brookmeyer and Quinn proposed a strategy to calculate HIV incidence from cross-sectional data, using the interval between P24 antigen seropositivity and the detection of anti-HIV antibodies by standard ELISA tests. However, this approach was limited by the narrow time interval between P24 antigen seropositivity and the detection of HIV-antibodies by standard ELISA (i.e. around 22 days) and the lack of precision of P24 estimation (Brookmeyer, Quinn, Shepherd et al., 1995; Beyrer, Brookmeyer, Natpratan et al., 1996). These shortcomings precluded its use among small samples. More recently, a new strategy of HIV testing called the "detuned" ELISA (Janssen, Satten, Stramer et al., 1998) has been developed. This technique utilises duplicate testing of serum with a sensitive and less sensitive ELISA to enlarge the window period for HIV seroconversion, allowing for the detection of persons who have been recently infected. This technique theoretically enables HIV incidence to be estimated from cross-sectional data using much smaller samples. This technique could have important applications for studying high risk IDU populations in developing countries (Diaz, Kallas, Castelo et al., 1999), provided that adequate laboratory resources are available. It would also lend itself to conducting behavioural surveillance among NEP attenders without the need to rely on a prospective study design.

Attempts have also been made to validate behavioural data among SEP attenders through analysis of blood traces in their syringes. The original testing strategy proposed by New Haven researchers used HIV antibody testing of syringe exudate coupled with syringe tracking using bar-coded SEP syringes to estimate a 33% reduction in HIV incidence associated with SEP attendance (Kaplan & Heimer, 1994; Heimer, Myers, Cadman et al., 1992). More recent studies have used polymerase chain reaction to detect HIV proviral DNA (Menoyo, Lamikiz, Zulaika et al., 1998; Shah et al., 1996; Rich, Dickinson, Carney et al., 1998b) and HIV-1 RNA in blood traces from syringes (Shapshak, Fujimura, Page et al., 1999). Syringe testing has also been used to track HBV and HCV infection (Heimer, Khoshnood, Jariwala-Freeman et al, 1996). Such testing strategies are thus far limited to developed countries due to the expense and levels of technical expertise required. However, these methods represent a novel approach by which researchers can indirectly assess behaviours of IDUs, and inform mathematical models to evaluate SEP.

Summary

The vast international literature has shown that SEP are associated with decreased incidence of HIV and other blood borne pathogens. Studies that report elevated infection rates among SEP attenders relative to non- or infrequent attenders appear to be the exception rather than the rule. Since these studies are based on observational data, their interpretation is difficult due to strong selection factors that lead high risk IDU to be over-represented among SEP attenders. From a public health standpoint, this selection bias can be an asset. By attracting IDU that would otherwise remain out of the reach of other programmes, SEP can play a much broader role in the prevention of HIV and other blood borne infections beyond the sole provision of sterile injection equipment. (Strathdee et al., 1998; Lurie & Drucker, 1997; Hahn et al., 1997; Drucker et al., 1998). In particular, SEP may be an optimal venue for providing HIV/AIDS counselling, condom distribution and referrals to substance abuse treatment, vaccines and HIV therapies. While it has been shown that SEP do not contribute to the formation of high-risk

social networks, their capacity to dismantle high-risk networks in the community should also be explored.

Based on existing literature, SEP should be viewed as one of the core strategies that can prevent infection with HIV and other blood borne infections. However, the effectiveness of a particular SEP may differ according to local environmental, social, legal and programmatic factors. The fact that outbreaks of HIV infection can occur despite the existence of SEP should not necessarily be interpreted as a failure of SEP. Rather, it should be recognised that SEP is necessary but not necessarily sufficient as a sole HIV/AIDS intervention. In addition to providing the services mentioned above, SEP need to be tailored to the specific local conditions that provide maximum syringe coverage for IDU in need.

Further research is required in a number of important areas. Determining which components of SEP are most and least effective at reducing HIV incidence in various local contexts should be a focus of future studies. Ongoing surveillance using both quantitative and qualitative data is needed to inform evaluations of SEP effectiveness. The dynamic between syringe distribution, exchange and removal is an important ecologic component related to the probability of disease transmission that warrants closer study, particularly in settings where sterile syringes are available through pharmacies, vending machines or other outlets. Finally, future studies should make use of exciting technologic advances in terms of HIV incidence estimation using the detuned HIV ELISA, and testing of syringe exudate as a means of conducting behavioural surveillance.

Many social, legal and programmatic obstacles must be overcome in order to maximise SEP effectiveness. In many countries, one of the most daunting challenges is determining what level of syringe coverage is needed to prevent epidemics, and how to achieve this goal in the face of opposing and often contradictory legal and social forces. Beyond methodologic concerns in conducting SEP evaluation studies, these barriers to syringe coverage must be overcome if the protective role of SEP in HIV/AIDS prevention is to be fully recognised and achieved.

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