

# 3.3: Neglected infections, real harms: A global scoping of injection-related bacterial infections and responses

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## Introduction

Injecting drug use has been reported across the globe, with an estimated 16 million people injecting drugs worldwide.<sup>1</sup> Research on infectious diseases related to injecting drug use has focused mainly on blood-borne viral infections such as human immunodeficiency virus (HIV) and hepatitis C virus (HCV), with bacterial infections receiving much less attention.<sup>2</sup> However, these infections are an important contributor to ill health among people who inject drugs and can result in severe and sometimes fatal complications.<sup>3</sup>

Bacterial infections due to injecting drug use can occur at injection sites or elsewhere on the body. Those affecting the skin and soft tissues include bacterial infections that cause the accumulation of pus (abscesses) or tenderness, swelling and redness (cellulitis) at or near injection sites. Infections elsewhere in the body include those infections causing illness away from injection sites (distal infections) such as infection of the heart lining (endocarditis) and infections that are more widespread or affect the body as a whole (systemic illnesses) such as blood poisoning (septicaemia).<sup>3</sup>

The focus of this chapter is on infections around injection sites, principally those infections of the skin and soft tissues that lead to symptoms such as abscesses or cellulitis. These infections most frequently occur at actual injection sites, but they can also develop close to injection sites. As most people who inject drugs do so into their limbs, these infections are often reported on the arms, shoulders (deltoids), legs or buttocks.<sup>3,4</sup>

This chapter will examine the current state of knowledge on the extent, risk factors and responses to bacterial infections at injection sites. As there is little published work on these infections in low- and middle-income countries, the focus will be on developed countries. However, these infections are likely to cause significant problems among people that inject drugs in all countries.

### **Glossary:**

**Inflammation** is an area of redness and swelling that is usually warm and tender.

**Abscesses** are an accumulation of pus in addition to inflammation. Abscesses on the skin often result in lumps that are sometimes called boils.

**Cellulitis** is inflammation of the skin, or the tissue immediately below the skin, which usually begins as a small area of inflammation and then gets bigger.

**Infective endocarditis** is an infection of the lining of the heart and/or valves.

## Causes of injection site infections

Injection site infections are due to infection with a range of aerobic and anaerobic bacteria. The latter are bacteria that grow in the absence of oxygen, and so can infect damaged tissues. They tend to cause more severe infections, with one group of such bacteria, the clostridia, typically producing powerful and potentially lethal toxins. However, infections of injection sites are

mostly due to aerobic bacteria (which need oxygen to grow) such as staphylococcal or streptococcal species or to several types of bacteria (i.e. polymicrobial with a mix of bacteria that may include both aerobes and anaerobes).<sup>3</sup>

Injection site infections arise from contamination of the injecting equipment or the drug solution with bacteria. This usually occurs in one of four ways:

1. Bacteria from an individual's natural skin flora enter the body during the injecting process.
2. Contamination of the injecting equipment whilst preparing the drug(s) for injection.
3. The re-use of injecting equipment.
4. Contamination of the drug(s) with material from the environment containing bacteria, or their spores, during manufacturing, bulking up ('cutting') or distribution. Bacterial spores are small, hardy reproductive bodies that can remain viable for a long time in the environment. They can survive the heating involved in preparing some drugs for injection.<sup>5</sup>

## Complications of bacterial infections of injecting sites

Injection site infections can result in a range of complications, which may cause more serious illnesses and even death. These complications can be either local (at or near the injection site), distal (affecting another part of the body) or systemic (affecting the whole body).

Local complications include the spread of the infection to the surrounding tissues, resulting in, for example, infection of joints (septic arthritis),<sup>3,6</sup> infection of the bone (osteomyelitis)<sup>3,6</sup> or infection of the blood vessels producing blood-filled bulges (aneurysms).<sup>3</sup> Others include the development of persistent skin ulcers.<sup>3</sup>

Reported distal complications of injection site infections include infective endocarditis (infection of the lining of the heart or valves)<sup>7</sup> and abscess of the spine or brain.<sup>6</sup> Others include infections of bones and joints away from the injection site.<sup>3</sup> The most commonly reported and serious complication related to injection site infections is, however, infective endocarditis.<sup>7</sup>

Some species of bacteria produce poisons (known as toxins), some of which cause very severe illnesses. The most commonly reported injecting-related infections that produce powerful toxins are caused by clostridia. Clostridia are anaerobic bacteria that form spores that can survive in the environment for many years. These spores may then contaminate drugs and cause infection. These bacteria cause localised infections, but the powerful neurotoxins they produce cause systemic illnesses, which can be fatal. The two most widely reported are wound botulism (*Clostridium botulinum*) and tetanus (*Clostridium tetani*). The toxins that these organisms produce cause progressive paralysis and may result in respiratory failure and death.<sup>6,8</sup>

Other injection site infections can also produce powerful toxins. These include another serious, often fatal, infection due to a spore-forming bacteria, anthrax, although this is very rare.<sup>9,10</sup>

The complications of injection site infections vary in their severity, however, many could be averted by the prompt diagnosis and management of the initial infection.<sup>8</sup>

## Extent of injection site infections

Studies have found considerable variation in the extent (prevalence) of symptoms of bacterial infections at injection sites. Overall, studies suggest that the prevalence of the common symptoms of these infections, such as abscesses or cellulitis, is in the range of 6% to 36% amongst people who inject drugs.<sup>11,12,13,14,15,16,17,18,19</sup> Some of this variation will reflect the different definitions of infection and the different periods used in these studies.

**Table 3.3.1: Summary of studies reporting on the prevalence of injection site infections**

Study Design	City, Country	Setting	Outcome	Source
Cross-sectional, baseline for cohort	Vancouver, Canada	DCR	22% self-reported abscess(es) during the previous six months	Lloyd-Smith et al. (2005) <sup>12</sup>
Cohort	Vancouver, Canada	DCR	6% to 10% reported a current injection site infection	Lloyd-Smith et al. (2008) <sup>24</sup> ; Lloyd-Smith (2009) <sup>2</sup>
Cross-sectional	Seven locations, England	Community recruited	36% self-reported abscess(es) or open sore(s) during the previous year	Hope et al. (2008) <sup>14</sup>
Repeated cross-sectional, over three years	Multiple sites, England, Wales and Northern Ireland	Recruited through a range of specialist services	35% in 2006, 37% in 2007 and 34% in 2008 self-reported abscess(es) or open sore(s) during the previous year	Hope et al. (2010) <sup>23</sup>
Cross-sectional	Six locations, Australia	NSP and community	7% self-reported abscess(es) and 7% cellulitis during the previous year	Dwyer et al. (2009) <sup>13</sup>
Cross-sectional	Multiple cities, Australia	NSP users	27% self-reported ever having an abscess	Topp et al. (2008) <sup>15</sup>
Cross-sectional	Sydney, Australia	DCR	6% self-reported ever having an abscess or skin infection	Salmon et al. (2009) <sup>18</sup>
Cross-sectional	Tijuana, Mexico	Community recruited	20% self-reported abscess(es) during the previous six months	Pollini et al. (2010) <sup>19</sup>
Cross-sectional	San Francisco, US	Community recruited	32% had a current abscess, 4% had cellulitis and 14% had both	Binswanger et al. (2000) <sup>17</sup>
Cross-sectional (associated with a cohort)	Baltimore, US	Community recruited	11% reported abscess(es) during the previous six months	Vlahov et al. (1992) <sup>25</sup>
Prospective cohort	Amsterdam, Netherlands	Recruited through a range of services	Incidence of self-reported abscess(es) was 33 per 100 person-years	Spijkerman et al. (1996) <sup>16</sup>

The various studies that have reported on the prevalence and the rate of occurrence (incidence) of these infections in people who inject drugs are summarised in Table 3.3.1. The incidence of these infections is not easy to measure, but in a prospective cohort study (a study that followed a group of people who inject drugs over time) undertaken in Amsterdam between 1986 and 1994, the incidence of skin abscesses was reported to be as high as 33 per 100 person-years at risk through injecting.<sup>16</sup>

There has been little examination of trends in the prevalence of injection site infections over time. A US study of records from San Francisco General Hospital found an indication of increased use of hospital services for injection site infections, with Emergency Department use for these rising from 1,292 cases in 1996/7 to 2,619 in 1999/2000.<sup>20</sup>

In the UK there has been a marked rise in the number of hospital admissions of drug users with skin and soft tissue infections. For example, admissions due to skin abscesses of the central part of the body (trunk) and groin increased from 92 in 1997/8 to 613 in 2003/4, an increase of 566%.<sup>21</sup> During this same period, reports of severe group A streptococcal infections among people who inject drugs in the UK increased from less than ten in the mid-1990s to 143 in 2004.<sup>22</sup> More recent studies in England, which looked at the prevalence of symptoms of injection site infections among community-recruited samples of people who inject drugs, indicated little overall change in prevalence, with approximately one-third reporting symptoms in both 2004 and 2008.<sup>14 23</sup>

Canadian examinations of the occurrence of injection site infections among participants in a study in Vancouver during 2004 and 2005 found that the proportion reporting a current infection was fairly consistent over this period, fluctuating between 6% and 10%.<sup>24</sup>

Overall, the data suggest an increase in more severe infections among people who inject drugs in some developed countries.

## Factors associated with infections and symptoms

Injection site infections have been associated with a number of individual, behavioural and environmental factors. The behavioural factors are principally concerned with hygiene, injection practice and the drug solutions injected. These factors include:

- 1. Injection hygiene.** Inadequate cleaning of the hands or the sites used for injection,<sup>11 12 13 25</sup> drawing blood back into the syringe repeatedly,<sup>26</sup> sharing filters<sup>23</sup> and needle and syringe re-use<sup>11 14 18</sup> have all been associated with higher levels of infection. These practices can result in bacterial contamination of the injecting equipment or the drug solution being injected. Bacteria are then able to enter the body through the injection process and cause infection.
- 2. Injection frequency.** More frequent injection<sup>14 15 16 18 23 27</sup> has been associated with infection. This may be because repeated injecting at a single body site causes cumulative damage to skin and soft tissue, and results in increased susceptibility to infection.
- 3. Skin and muscle popping.** Subcutaneous injecting, more commonly referred to as 'skin popping',<sup>11 17</sup> has been associated with infections. Injecting into the skin or

muscle (intramuscular injecting or 'muscle popping') may provide a greater opportunity for infection as it can cause localised tissue damage. This damaged tissue creates a niche environment in which bacteria could grow that would not be created by injecting into a vein.<sup>28</sup> Damaged tissues may well provide an anaerobic environment suited to the growth of toxin-producing bacteria.<sup>29</sup> Some people choose to inject under the skin or into muscle because this is their preferred route or because damage to their veins has made intravenous injection difficult. However, many injections under the skin or into muscle may be accidental as a consequence of missing a vein.<sup>30</sup>

- 4. Body sites used for injection.** The occurrence of injection site infections has been associated with the body site that is used for injection, with sites other than the arms often associated with infection.<sup>12 14 23 27</sup> This might be because some sites, such as the groin (femoral vein), are likely to be harder to clean, or to keep clean, than other sites.
- 5. The drug(s) injected.** The drugs used by people who inject vary in availability, purity, form and across geographical settings. The risk of developing an injection site infection has been found to vary according to drug or drugs being injected.<sup>11 14 16 18 23</sup> Speedball (a combination of heroin and cocaine) injecting has been associated with injection site infections in San Francisco and Amsterdam.<sup>11 16</sup> A similar association has been found with the injection of opiate-stimulant combinations in the UK.<sup>23</sup> Cocaine injecting has been associated with such infections in Vancouver.<sup>12</sup> The injection of black tar heroin has been associated with developing wound botulism in the US.<sup>31</sup> The drugs used and the substances used to dissolve them (including any contaminants present in these) may have damaging effects on the skin and underlying tissues,<sup>3</sup> and so compound the tissue damage from injecting. Cocaine, for example, has been associated with causing the constriction of blood vessels.<sup>32</sup> Heroin base and crack-cocaine, unlike the salt forms, are not readily soluble in water. These are typically prepared for injection by being heated with an organic acid such as ascorbic or citric acid. The use of these compounds to dissolve drugs can result in an acidic drug solution, which can cause tissue damage particularly if injected under the skin or into muscle. The resulting damaged tissue may provide an environment that is especially favourable for the growth of anaerobic bacteria.<sup>29</sup>

Other factors associated with higher levels of bacterial infections include:

- 1. Length of time injecting and age.** The numbers of years injecting and the person's age have both been associated with injection site infections: being older<sup>13 14 15</sup> and injecting for longer<sup>17 18 23</sup> are both linked with higher levels of infection. A possible explanation for this is that veins may become hardened after many years of repeated injecting, resulting in increased occurrences of missing the vein, the need to inject in sites that are difficult to keep clean (such as the groin) or switching to injecting under the skin or into muscle. Conversely it has been suggested that inexperience could lead to a higher level of infections, possibly due to a less developed injecting technique, causing greater tissue damage, or assistance from others, increasing the risk of contamination.<sup>6</sup>

2. **Poor housing conditions and homelessness.** Individuals who are homeless or living in temporary accommodation (such as hostels) have been reported to have higher levels of injection site infections.<sup>24</sup> Injecting in public places, such as the street, has also been associated with the development of these infections.<sup>13 18</sup> The environments in which people live and inject may promote poor hygiene<sup>33</sup> or risky injecting practice, such as rushing the process. For example, people who inject in public places may have no access to clean water or may inject into a higher risk body site (i.e. using the groin for a 'quick fix' when injecting in public places or when it is cold).<sup>34</sup>
3. **Gender.** A number of studies have found that women injectors experience higher levels of injection site infections than men.<sup>8 12 14 15 18 23 24</sup> It has been suggested that this might reflect biological differences between men and women, such as women having smaller, less easily accessible veins, possibly resulting in them more frequently missing the vein and thereby increasing their risk of developing an abscess.<sup>2 15</sup> However, there is little anatomical evidence to support this.<sup>15</sup> There are other factors that may play a role. For example, women are more likely than men to report having assistance with injecting,<sup>35</sup> which may place them at an increased risk of an injection that misses the vein. In addition, the process of assistance itself may result in contamination of the injecting equipment. Gendered social roles and power dynamics within sexual relationships may also play a role, as these have been reported to have an impact on HIV-related risk behaviours.<sup>36</sup>
4. **Sex work.** Several studies have found that involvement in sex work is associated with developing injection site infections.<sup>12 16 18 19</sup> It has been suggested that this association may be due to sex work being a marker of greater social marginalisation or a street-based lifestyle which could increase risk.<sup>18</sup>
5. **Viral infections.** Higher levels of injection site infections have been reported among people living with HIV<sup>12 16</sup> and people living with hepatitis C,<sup>14 15</sup> conditions which increase peoples' susceptibility to other infections or reduce their ability to fight an infection.

A few studies have also reported other associations. For example, recent research from Mexico found associations between having an abscess and smoking methamphetamine, and also with negative experiences of policing.<sup>19</sup> Such associations, which have not been reported in other studies, may be specific to the particular setting.

Whilst the majority of the studies discussed above are from high-income countries, the factors related to these infections in developing and transitional countries are likely to be very similar. Factors such as injection hygiene and poor housing and homelessness may be more of an issue among people who inject drugs in low- and middle-income countries. In addition, the high prevalence rates of viral infections such as HIV and viral hepatitis among injecting populations in many countries may also increase their susceptibility to injection site infections.

## Harm reduction responses and the prevention of injection site infections

The prevalence of injection site infections can be reduced by harm reduction interventions that target key risk factors. These interventions should consider the needs of different groups who may be more vulnerable to harm, such as the homeless, women

and older long-term injectors. Such interventions include needle and syringe programmes (NSP) and opioid substitution therapy (OST), both of which are recommended by United Nations guidelines as part of a key package of interventions for people who inject drugs.<sup>37</sup> Easy access to NSP can prevent infections by providing access to sterile injecting equipment and alcohol wipes for cleaning injection sites and by giving advice on hygienic and safe injection technique. OST has been shown to be effective in preventing transmission of blood-borne viruses.<sup>38</sup> The availability of prescribed oral substitute drugs such as OST can also prevent injection-related infections if the dose given is sufficient to end the need to inject illicit drugs on top.<sup>39</sup> Thus, harm reduction interventions can play a key role in the reduction of these infections among people who inject drugs.

Harm reduction interventions that encourage routes of use other than injecting – known as 'route transition interventions' – have also been proposed and piloted, however, further evaluation is needed to determine whether they will be of benefit.<sup>40</sup> For example, providing sheets of aluminium foil to promote the smoking of drugs such as heroin as an alternative to injecting has been proposed,<sup>41</sup> and foil packs designed for use in such an intervention have been developed.<sup>42</sup> Smoking or inhaling drugs rather than injecting them would prevent bacterial infections of injection sites. However, smoking is closely associated with other well-documented harms, including lung damage. Furthermore, some spore-forming bacteria, including anthrax, can be found in drugs and could cause infection if smoked or inhaled.<sup>9</sup>

Harm reduction and route transition interventions have the potential to reduce the extent of injection-related bacterial infections. However, these interventions, even if extensively adopted, are unlikely to prevent all such infections and health services will still need to respond to these infections.

## Health care utilisation in response to injection site infections

People who inject drugs may find it difficult to access health care due to marginalisation and stigma. Some may attempt to self-treat symptoms, for example incising and draining an abscess.<sup>4</sup> <sup>19</sup> People may also delay accessing health care due to prior bad experiences or difficulties in seeking traditional primary care services. As a result people who inject drugs may be more likely to make use of hospital Emergency Departments, both due to ease of access and because the delay in seeking health care has meant the illness now requires urgent attention.

Treatment for injection site infections often involves a range of procedures, including incision and drainage, application of dressings and administering antibiotics either by intravenous injection or orally.<sup>46</sup> Treatment of people who inject drugs can be complicated by other diseases such as HIV infection.<sup>6</sup> In addition, treating an infection or a complication may require long periods of time in hospital. Lengthy hospital stays may be difficult for people who are regularly injecting drugs and if they do not receive appropriate medical management (i.e. OST) they may leave hospital early, against medical advice, and not complete the treatment.

Studies looking at the health problems that lead to people who inject drugs presenting at Emergency Departments have found that injection site infections are often the most common reason for attending. Studies in North America found that abscesses and

cellulitis, two of the most frequent symptoms of injection-related infections, were the most common diagnoses among people who inject drugs who visited Emergency Departments, and they were also the most common reasons for their hospitalisation.<sup>43,44</sup> For example, a study undertaken in Vancouver found that 17% of all Emergency Department visits and 18% of all hospitalisations among a community-recruited sample of people who inject drugs were due to skin abscesses and cellulitis.<sup>43</sup>

A US cohort study of people who inject drugs who sought treatment between May 2001 and May 2002 from a hospital in Washington State found that 40% of those who attended the Emergency Department for an injection site infection were admitted to the hospital.<sup>45</sup> Two-thirds presented with an abscess (69%), with one-quarter of these abscesses requiring drainage in an operating theatre. One-tenth of the abscesses had been drained previously, either spontaneously (i.e. bursting) or by self-incision and drainage.

The health care costs associated with injection-related bacterial infections are likely to be substantial. A number of US studies have estimated the costs associated with hospital treatment and found these to be high. A 1980s study looking at hospital use for abscess care over a twelve-month interval found that the average length of hospitalisation was 12.4 days, at an average cost of US\$10,651, and that the estimated annual cost of treating abscesses among people who inject drugs at the hospital was US\$6.9 million.<sup>46</sup> A review of patient records from 1998 at Rhode Island Hospital found that 45% of the admissions among a sample of HIV-negative people who inject drugs were due to injection site infections or their complications, with these accounting for almost all the injection-related problems found; the injection-related infections were significantly more costly than the other admissions (US\$13,958 vs US\$7,906).<sup>47</sup> A study of hospital records from San Francisco General Hospital found that skin incision and drainage was the most common primary procedure on all inpatient records of those admitted for injection-related infections, with approximately one-quarter of the cases having multiple admissions within a year; the injection site infections at this hospital resulted in inpatient-related treatment charges that averaged US\$9.9 million per fiscal year between 1996 and 2000.<sup>20</sup>

A community-recruited study of people who inject drugs undertaken at seven locations in England in 2004 found that 36% reported having either an abscess or an open wound at an injection site in the previous year.<sup>14</sup> This study collected data on the use of health services in response to these symptoms, and estimated the national health care burden using standard costs. Injection site infections in England were found to cost between UK£15.5 and UK£47 million per annum in 2006. Overall health care costs related to problematic drug use, both injecting and non-injecting, in England had been estimated to be approximately UK£500 million per annum in the financial year 2003/4, with UK£25 million of this due to blood-borne viruses (HIV, hepatitis B and C) among people who inject drugs.

A study undertaken in three Australian states (Queensland, New South Wales and Victoria) estimated the cost of non-viral injecting-related injuries and disease to be AUS\$19.9 million in the 2005/6 fiscal year.<sup>48</sup> Of this amount, AUS\$8.7 million was incurred by community-based services, AUS\$2.8 million by Emergency Departments (due to over 60,000 visits) and AUS\$8.3 million was due to hospital admissions, accounting for between approximately 8,500 and 14,000 bed days of care.

The existing literature suggests that injection site infections and their complications place a considerable burden on health care systems in high-income countries. Whilst no scientific literature was identified for other countries, these infections are likely to pose a significant challenge to low- and middle-income countries. Preventive activities and supporting prompt access to health care when symptoms appear could substantially reduce bacterial infections of injection sites and the associated costs for health care systems.

## Community-based health care services for injection site infections

As noted above, people who inject drugs often seek medical attention for injection site infections and other health issues at hospital Emergency Departments rather than within a primary care setting, and may even attempt self-treatment. Thus, care may be more costly than necessary.<sup>19</sup> In response, a number of community-based approaches that aim to reduce use of Emergency Departments and hospital inpatient care have been reported. As these services are oriented towards people who inject drugs, they can provide a tailored service responding to their specific needs.

The Integrated Soft Tissue Infection Services Clinic in San Francisco was established to provide coordinated surgical intervention, substance use counselling and social services for those presenting at a public hospital with soft tissue infections.<sup>44</sup> This clinic was found to be valuable and cost effective, resulting in a 47% decrease in surgical service admissions, a 34% reduction in inpatient acute care bed days and a 71% reduction in operating room procedures in its first year of operation. There was also a 34% reduction in Emergency Department visits. Overall, the clinic was estimated to have saved over US\$8.75 million in costs related to injection site infections, which represented a 45% reduction in the costs of treating these infections. This clinic shifted care from a mainly inpatient-based approach to one with a focus on outpatient-based provision that integrated a range of services.

Another example of effective treatment for injection site infections is the community-based Wound and Abscess Clinic located in an NSP in Oakland, US.<sup>49</sup> This clinic is provided by a multidisciplinary team who offer care for injection site infection integrated with referrals to other services in a dedicated space in the service. In 2000 this clinic was reported to have an average cost per individual treated of US\$5 (excluding overhead costs), substantially lower than equivalent hospital costs, which averaged between US\$185 and US\$360 (including overheads, but not including medication and physician fees).

A number of studies on the impact of the Supervised Injection Facility (SIF), a drug consumption room (DCR) in Vancouver, Canada, have looked at injection site infections and health care seeking. One study found that the majority (65%) of visits to the nurse within the SIF were related to care for injection site infections and that those who were subsequently referred to hospital by the nurse were hospitalised for shorter periods than those accessing hospital by other routes.<sup>2</sup> This finding suggests that offering community-based, easily accessible, nurse-provided services may promote more prompt health care seeking and so reduce the levels of severe infections or complications that may result in hospitalisation.

The community-based health care studies reported in the scientific literature have all been undertaken in high-income countries. The barriers (including cost, distance, exclusion criteria, stigma and discrimination) faced by people who inject drugs in accessing health care are often greater in low- and middle-income countries.<sup>50</sup> So although there are very limited data, it may be that the severity of complications, mortality and morbidity associated with injection-related bacterial infections are greater in these settings. The provision of community-based services offering treatment for injection-related bacterial infection has been noted in a number of countries including low- and middle-income countries. For example, it is reported that an abscess management service is provided by the drop-in centres for people who use drugs in Myanmar<sup>51</sup> and by the CARE organisation in Dhaka, Bangladesh.<sup>52</sup>

Published studies on interventions focusing on injection site infections are few in number and further development and evaluation work is clearly needed. The findings of these few studies, however, do indicate that community-based services such as NSPs and DCRs could have a substantial impact on reducing harm from these infections. They also indicate that the development of nurse-led services for injection site injuries and infections can be effective in improving prompt health care seeking and in reducing expensive complications. These services could possibly be integrated with community-based blood-borne virus (i.e. HIV and viral hepatitis) testing and vaccination clinics, and existing community-based clinics providing these services could be developed at relatively low cost to also provide injection site infection care.

## Conclusion

Injection site infections are common among people who inject drugs and can have severe complications that may, albeit infrequently, be fatal. The bacterial contamination leading to these infections may arise from the individual's skin flora during injection, contamination of the injecting equipment during the preparation and injection of the drug, re-use of injecting equipment or contamination of the drug(s) during their manufacture or distribution.

Studies from several high-income countries suggest that the prevalence of these infections varies, with between one in twenty and one in three people who inject drugs reporting injection site infections each year. This variation, in part at least, reflects differences in the methods used by the studies. However, it could also reflect global variations in the patterns of drug use and in the responses to this issue. Higher levels of infections have been associated with a number of factors including poor injection hygiene, frequent injection, injecting under the skin or into muscle, the use of certain body sites for injection, the use of certain drugs, having been injecting for a long time, poor housing conditions and having a blood-borne viral infection. The risk of bacterial infections could be reduced by addressing these factors through, for example, reducing injecting under the skin or into muscle, avoiding use of excessive acid to dissolve drugs, not re-using equipment, and cleaning skin with alcohol before injection. Preventive interventions should aim to address these factors through the provision of advice and the full range of injecting-related equipment. This could be readily achieved through easy-to-access NSPs, as has been recommended.<sup>37,53</sup> Access to OST can also help if a sufficient dose of the substitute drug is

given to prevent the need to inject illicit drugs on top. Route transition interventions to encourage the use of drugs by routes other than injecting may also have a role to play in reducing the harm from bacterial infections of injection sites, although further examination and evaluation is needed.

The excessive costs often associated with injection-related bacterial infections can be prevented by interventions aimed at providing people who inject drugs with timely and appropriate care. A small number of interventions that aim to make accessing such care easier have been assessed and found to be successful in reducing health care costs.<sup>44,49</sup> Whilst further research and intervention trials are needed to identify and evaluate the most appropriate interventions, work undertaken so far suggests that low-threshold community-based interventions, such as nurse-provided clinics in DCRs or NSPs, are likely to be effective.<sup>44,46</sup> The provision of assessments of injection site infections and access to care for these has been recommended as a core component of fixed site needle exchange provision by the National Institute of Health and Clinical Excellence in the UK.<sup>53</sup>

There is a noticeable absence of scientific studies on bacterial infections among people who inject drugs in low- and middle-income countries. This may indicate that little research has been undertaken in this area or that what has been undertaken has not been published or is not easily identified (i.e. in grey literature or from small sections of publications focusing on other topics). Services addressing these infections have been reported in a number of low- and middle-income countries, and these infections will occur among all populations of injectors to varying extents. Infections in countries with less developed health care systems may present an even greater burden than they do in high-income countries.

People who inject drugs are vulnerable to many infections, including those due to a wide range of bacteria. Bacterial infections introduced through the injection process are a common cause of illness among injectors and can result in considerable harm and health care costs. The occurrence of such infections can be reduced by improving injection hygiene and practice using harm reduction approaches, and the complications can be minimised by improving prompt access to health services. The scaling up of harm reduction interventions, such as NSPs and the provision of OST, could have a significant impact in reducing these infections and the harm that they cause.

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