Skin and soft tissue infections among injection drug users

by

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Abstract

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This thesis examines the literature on skin and soft tissue infections (abscesses and cellulitis) among injection drug users (IDUs) and describes a cross-sectional study of active, street-recruited IDUs in the Tenderloin neighborhood of San Francisco in May of 1997. Participants (N=169) were interviewed regarding demographic characteristics, drug use, and injection-related behaviors; HIV antibody testing was performed; and a clinical history was used to identify participants with symptoms of skin and soft tissue infection. IDUs with a positive clinical history underwent a physical exam by a physician or nurse practitioner. The prevalence of abscesses, cellulitis or both was 32%. Twenty-seven percent had lanced their own abscesses in the past; 16% used antibiotics they bought on the street. Ten percent of the sample used the neck as one of the three most commonly used injection sites. IDUs who injected subcutaneously (skin popping) or intramuscularly (muscling) once or more in the prior 30 days were 5-fold more likely to have an abscess and/or cellulitis than IDUs who injected only intravenously (OR 5.2, 95% CI 2.4, 11.5). IDUs who skin popped or muscled more than they injected intravenously had a greater than 10-fold likelihood of having a skin and soft tissue infection (OR 10.7, 95% CI 3.1, 36.8). Race, age, education, homelessness and HIV status were not significantly associated with the presence of a skin and soft tissue infection in bivariate analysis. Frequency of injection, drug injected, skin cleaning prior to injection, hand washing, use of brand new

syringes, sharing syringes, using a syringe exchange program, rotating limbs and licking needles did not significantly alter the odds of having an abscess or cellulitis. The practice of skin popping or muscling is the major risk factor for skin and soft tissue infection in IDUs. Further work is needed to develop safe and appropriate prevention and early treatment programs to reduce the prevalence of skin and soft tissue infections among IDUs.

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In memory of Aaron Blue

1971-1991

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The research team included Alex Kral, MS, Daniel Rybold, MD, Ricky Bluthenthal, MA, Brian Edlin, MD, and Jonathan Rodnick, MD at the Urban Health Study and Barry Zevin, MD of the Tom Waddell Health Center.

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PREFACE: My interest in the health of injection drug users

In July of 1991, at nine o'clock on a Saturday morning, some four members of ACT-UP/DC and I carried a table, sixty packets containing two syringes each, bleach, cotton balls, condoms, and some informational brochures to a corner of Washington, DC where drug users were known to spend time. We also brought a Bio-hazard bucket, a sign, and some chairs. Within about one hour, all 60 packets had been distributed to injection drug users who stopped by the table and raced off to get their friends to pick up packets. The next week, we were 10 minutes late and a line of users were waiting for us. Within an hour, 200 packets were gone. This incredible experience with the start of the first street-based syringe exchange in Washington, DC, taught me that drug users care about their health and are willing and eager to take personal steps to prevent the spread of HIV.

I continued volunteering at a far more established and larger program in San Francisco a few years later. From the first day at HIV Prevention Project/Prevention Point, I observed that exchangers always requested alcohol pads among the range of supplies available. We received more requests for additional alcohol pads than any other supply item, including condoms. It was not unusual for exchangers to request additional alcohol pads one to three times after receiving a stack. Clearly, alcohol wipes were important to users. I asked myself why these supplies were in high demand and what purpose they really served.

While in my first-year Health Policy class at the UCB/UCSF Joint Medical Program, I contacted the Urban Health Study, whose work on syringe exchange I had admired. Ricky Bluthenthal indicated that there had been some interest in exploring infections other than HIV that affect injection drug users, such as endocarditis, sepsis, and abscesses. The goal was initially to produce a brochure that could be distributed to IDUs in the Bay Area, and perhaps nationally, to educate them about these common illnesses.

Finding information regarding concrete and clear ways to prevent abscesses, however, was difficult. I set out, with the help of many people, to both develop a useful brochure and to examine the prevalence and risk factors for injection-related skin and soft tissue infections.

The work of this thesis leaves out the emotional experience of working with injection drug users, who are sometimes stereotyped and shunned by medical professionals. Working with injection drug users regarding their health was rewarding once I established appropriate personal boundaries and abandoned the hope of rescuing the individuals I worked with from addiction.

CHAPTER I

General introduction to the health problems of injection drug users

Goals and Objectives

This thesis, which includes a literature review and an empirical study of active injection drug users, is intended to expand our understanding of a currently neglected health risk among injection drug users (IDUs), skin and soft tissue infections. It is an attempt to discover ways to reduce the risk of abscesses and cellulitis among IDUs. This project aims to answer the question: *How can skin and soft tissue infections among IDUs be prevented?*

The primary objectives of the study described in this paper are to estimate the prevalence of abscesses and cellulitis among street-recruited, active injection drug users in the Tenderloin neighborhood of San Francisco and to examine the risk factors for skin and soft tissue infections among IDUs in order to guide prevention efforts. To these ends, a sample of 169 IDUs were interviewed with regard to potential risk and protective factors for skin and soft tissue infections such as rotating injection sites, cleaning the skin, licking of needles, using sterile syringes, injecting subcutaneously or intramuscularly, and being homeless. They were also tested for the presence of HIV antibodies. In addition, participants were asked about symptoms of active skin and soft tissue infections and underwent a physical exam if they had any related symptoms or thought they had a skin and soft tissue infection at the time of the interview.

The secondary objectives included describing the population with skin and soft tissue infections and determining the characteristics and severity of their infections. Another objective was to ascertain whether IDUs self-treat with antibiotics bought on the street and whether they lance their own abscesses, as many anecdotal reports have suggested. Another objective was to make recommendations regarding prevention and early treatment and skin and soft tissue infections based on risk factor data. Finally, the

cooperative effort between researchers at the Urban Health Study (UHS) and clinicians at Tom Waddell Health Center was designed to benefit the participants with active skin and soft tissue infections with on site-treatment and appointments to the health center in their neighborhood.

The underlying assumptions guiding this research

One of the guiding philosophies from which this work stems is harm reduction, an approach to the problems associated with drug use that is designed to save lives and promote the health of IDUs.[1] A wide range of goals of harm reduction have been proposed, but overall, the approach seeks to minimize the adverse effects of drug use. This framework requires a non-punitive and non-judgmental perspective on drug use itself, a belief in incremental change, and an acceptance of the inevitability of drug use in society. Harm reduction has developed with particular vigor in the realm of AIDS prevention efforts,[2, 3] but it is relevant to a number of issues relating to drug use that range from drug education[4] to criminal law[1] to public health policy. In the case of HIV prevention, harm reduction efforts may involve making drug treatment programs more accessible to users, encouraging users to use drugs without injecting, providing low cost or free sterile injecting equipment, and providing bleach to clean shared equipment.[3] Harm reduction is a framework in which to view public health measures aimed at reducing the negative health effects associated with drug use.

Harm reduction guided policy in other nations long before it had an effect in the United States. In Amsterdam, an organization of drug users called Junky Union started a syringe exchange program (SEP) as early as 1984 with the financial support of the Amsterdam Municipal Health Service. England and Scotland were piloting SEPs in 1986.[5] In Switzerland, the city of Zürich implemented harm reduction policies in Needle Park in 1987.[6] These have been followed in other Swiss cities on a smaller scale. Now, the

Swiss government is piloting a heroin prescription program for some of its addicted citizens and syringe exchange in jails and prisons. All these government-sponsored programs implement the philosophies of harm reduction rather than relying on a policy named by a military metaphor, "The War on Drugs," to address the problems associated with drug use.

In the US, harm reduction and related syringe exchange programs had not gained national acceptance, even though individual states, cities and counties have made steps to legalize or tolerate SEPs. In the District of Columbia, an ACT-UP SEP was initially illegal but permitted to operate by law enforcement, which did nothing to intervene. Since then, a syringe exchange in the District of Columbia has acquired formal legal authorization. In Oakland, California, syringe exchange volunteers were arrested 18 times before a jury acquitted[7] them one the grounds of a "necessity" defense. The police then stopped arresting volunteers, despite the fact that there has been no formal legal authorization for the SEP.[8] In San Francisco, the largest SEP in the nation operates because the mayor declares a public health emergency every two weeks. Meanwhile, California state drug paraphernalia laws continue to prohibit SEPs.[7, 9] Thus, harm reduction has influenced local interpretations of public health laws and some states have legalized SEPs, but harm reduction approaches have not been adopted uniformly nor nationally.

Harm reduction has been opposed not only by politicians and by corrections officials, but also by some substance counselors and people in the recovery movement. It may be argued that harm reduction is in opposition to a recovery perspective and the tenets of Alcoholics Anonymous (AA) because harm reduction de-emphasizes addiction as the primary problem associated with drug use. Others could argue that harm reduction involves "giving up" on society's most vulnerable because the expectation of full recovery from addiction is dropped. AA and the recovery movement have proven successful at dealing with addiction among some IDUs but the majority of heroin users do not quit. It is estimated that 1% of heroin addicts die each year from overdoses[10] and other

complications of drug use.[11] Harm reduction does not exclude reducing and quitting drug use[1] as solutions to the dangers associated with drug use, but also attempts to address the dangers experienced by drug users who do not quit. Harm reduction can empower drug users to take control of their own health and validate small changes that may eventually lead to recovery from addiction.

The work described in this paper is also founded on a public health emphasis on prevention. For IDUs, prevention of disease has included distributing supplies such as sterile injection equipment; using HIV testing as a means to change risky behavior; dispensing condoms, lubricants and dental dams to encourage safer sex; and providing educational materials and referrals. These approaches should be guided by sound epidemiological research and be evaluated for their effectiveness.

In light of its emphasis on prevention, this work assumes that there are modifiable risk factors that influence the poor health outcomes seen among IDUs. Once identified, these risk factors could be altered so as to reduce the morbidity and mortality associated with injection drug use. Effective intervention efforts aimed at modifiable risk factors could lower the societal and health care costs associated with injection drug use. Watters,[12] for example, showed a stabilization of HIV seroprevalence in San Francisco which was coincident with a substantial increase in bleach use that began in 1986. The increase in bleach use followed the implementation of a community health outreach program and the distribution of bleach in numerous locations throughout the city.[13] Within six months, self-reported bleach use increased from 3% to a peak of 59% among people who reported needle sharing. Condom use among heterosexual male IDUs also increased in the same time period, but by a lesser amount, so it is difficult to ascertain which of these or other factors may explain the stabilization of HIV seroprevalence. Nonetheless, Watters suggested that, among the risk factors for HIV infection, drug using practices were easier to alter than sexual practices.[12] Drug injection practice is an example of a modifiable risk

factor for infections among IDUs and is a reasonable domain in which to attempt public health interventions to improve health outcomes among IDUs.

The third conceptual underpinning of this work is Community Oriented Primary Care (COPC). COPC is an idealized model of health care delivery that emphasizes utilizing epidemiological studies of the health needs of a community to shape clinical practice and preventive services aimed at a community as a whole. This approach requires community-based needs analysis, as opposed to clinic-based investigations. Health promotion and access to health care services are priorities. COPC also demands community involvement in its operations. "Community Oriented primary health care brings together elements of individual, family, and community health care. It involves integration of health education, preventive and promotive health care, early detection, treatment, alleviation and rehabilitation."[14]

In San Francisco, public health centers such as the Tom Waddell Health Center fulfill some of the tenets of COPC by having multidisciplinary teams, by inter-agency cooperation, and by providing services that meet both the health needs of the community and broader human needs. The public health centers vary in their ability to get community input about programs, and by and large fail to get funding for epidemiological needs assessments of the community.[15] Thus, they operate largely within a traditional medical service model, by addressing the immediate needs of people who seek services. Community-based epidemiological studies could help set the agenda for disease prevention efforts in the communities served by public health centers.

IDUs may be viewed as a community vulnerable to poor health outcomes as a result of health practices within the context of socioeconomic influences and law enforcement. Improving the health of this community could result from educational interventions, access to sterile and sterilizing equipment and products, the removal of legal barriers to public health interventions, and preventive health care. This study is intended to help guide interventions to prevent skin and soft tissue infections among IDUs by assessing the extent

of the problem in an IDU community in San Francisco and identifying the risk factors for such infections.

The health problems facing injection drug users as a group

Injection drug users face a variety of health risks as a result of penetrating the skin with a needle and the socioeconomic conditions that can accompany drug dependency. The most widely publicized and recognized health risk is infection with the human immunodeficiency virus (HIV). The number of AIDS cases in the United States in 1996 was approximately 235,500,[16] of which 20% were attributed to injection drug use in heterosexual men. An additional 6% of the cases were IDUs who have sex with men. Women IDUs accounted for another 8% of the AIDS cases. Thus, approximately one third of the cases of AIDS in the United States are related to injection drug use.[16] IDUs are also at high risk for hepatitis B and hepatitis C virus infection[17] and face a higher than average risk for other community-acquired infections such as tuberculosis[18] and pneumonia.[19] Systemic infections, including bacterial endocarditis, bacteremia and septic shock disproportionately take the lives of IDUs. Skin and soft tissue infections including abscesses, cellulitis, and, occasionally, fasciitis, account for significant morbidity among IDUs. Sex work, homelessness, and poverty also increase the risk of health problems among IDUs. Finally, drug overdose is considered the most common cause of death among IDUs.[20]

Why is providing health care for injection drug users complicated?

Despite the many serious health concerns that face IDUs, providing them with basic preventive and medical health services is mired in political, legal and social conflict.[5] Syringe exchange programs (SEPs) are thought to be responsible for a decline in the use of syringes previously used by someone else in Washington State[21] and partially responsible

for stabilization of HIV seroprevalence rates in San Francisco[22] and New York City.[23] Furthermore, participating in an SEP was associated with a significantly lowered risk of hepatitis B and hepatitis C infection among IDUs.[17] In the United States, there is no federal funding for SEPs.[7] SEPs are still illegal in many cities, counties, and states. Many SEPs carry on despite their official illegal status, but volunteers and clients risk arrest. Sale and possession syringes without a prescription are prohibited in many states. Possession of syringes intended for drug injection is illegal in 46 states under drug paraphernalia laws,[9] preventing users from carrying clean syringes for use.[24] Thus, a potentially effective means of preventing the spread of infection among IDUs are encumbered by legal restrictions.

While it may be difficult to determine the extent of injection drug use in our population, and, therefore, difficult to define the injecting population, some generalizations may be made about the urban poor IDUs who frequently come to the attention of public health service providers and are the focus of this study. This population is likely to face compound barriers to receiving adequate health care services because of low socioeconomic status, inadequate housing, and other factors. For example, transient housing may make continuous primary care difficult, if not impossible, for IDUs. IDUs may be homeless, live in shelters, stay at single occupancy hotels and sleep on the streets, frequently moving among these settings. Because drug use and possession are illegal, IDUs rotate through jails and prisons and back to the streets. While health care is constitutionally guaranteed in prisons and jails, access to health information and preventive services in the correctional system is severely limited and the quality of health care may be poor. Time in correctional facilities also interrupts continuous care in primary health settings.

Providing medical services to IDUs is further complicated by disclosure and social stigma issues, mutual mistrust between providers and IDUs, and psychiatric issues. Wallace and colleagues described how negative attitudes towards treating drug users for

abscesses can lead to increased morbidity, inadequate treatment, and further injury.[25] IDUs may hesitate to reveal their habits and providers may fail to recognize or address obvious signs of drug use. Providers may feel that their efforts are in vain when the same IDUs appear repeatedly at hospitals with serious and life-threatening diseases without changing their drug use habits, when IDUs do not comply with treatment regimens, and when they miss appointments. IDUs may have a history of mistreatment, real or perceived, by health care providers. Providers may be wary of being asked to write pain prescriptions for a known or suspected IDU. Abscesses and other painful wounds may be treated surgically with inadequate local anesthesia and pain relief. Thus, the doctor-patient relationships when the patient is an IDU can be complicated and strained.

Psychiatric issues can further complicate doctor-patient relationships when the patient has "multiple diagnoses" (i.e. a diagnosis of substance abuse and one or more additional psychiatric illnesses). Opioid abusers have a high incidence of depression and anxiety and an elevated suicide rate.[11] Some psychiatric conditions may be lifelong, while others are the result of traumatic experiences associated with difficult living conditions, crime and police brutality. Thus, providing effective preventive services and health care to IDUs is challenging at both individual and social levels.

CHAPTER II

Background: Skin and soft tissue infections among IDUs

What are skin and soft tissue infections?

Skin and soft tissue infections of greatest concern to IDUs are abscesses and cellulitis. Wound botulism, necrotizing fasciitis, and pyomyositis are serious and life-threatening infections occasionally seen in IDUs, but far less frequently than abscesses and cellulitis. An abscess is a collection of pus formed by bacteria, tissue fluid, dead cells, and white blood cells fighting a bacterial infection within the skin, subcutis or deeper structures such as the fascia, muscles, and central vessels. Microbiological reports show that Streptococcus species [*Streptococcus pyogenes* (Group A β-hemolytic), *Streptococcus milleri, Streptococcus viridans*] are the most common pathogens cultured from abscesses,[20, 26-30] while other reports suggest that *Staphylococcus aureus* is most commonly isolated.[10, 25, 31] Most infections are polymicrobial.[29, 30, 32] The majority of soft tissue abscesses associated with injection drug use have been the result of mixed infections that contained both anaerobic and aerobic bacteria.[27, 30]

Abscesses can produce local symptoms and signs including swelling, pain/tenderness, redness, and fluctuance. In addition, abscesses can produce systemic symptoms and signs of infection including fever, leukocytosis and lymphadenopathy.[27] Some abscesses come to a head and drain on their own, while others must be incised and drained so that the tissue can heal from the deeper parts of the tissue up to the skin. In some cases, incision and drainage is not sufficient and radical débridement is required. Skin grafting several days after surgery is sometimes necessary, as are repeat procedures. Antibiotic treatment is an important adjunct to surgical therapy for abscesses, shortening recovery time and decreasing associated morbidity.[26] Antibiotic therapy alone, however, cannot reliably cure large abscesses in the absence of surgical incision and drainage. The

body tends to wall off areas of acute infection, preventing antibiotics and the body's own immune cells from penetrating an abscess and destroying the infecting organisms.

Abscesses have local and systemic consequences. Locally, abscesses can extend into surrounding tissues and blood vessels. While limb loss is one of the possible sequelae of a serious localized infection, smaller and sensitive structures may also be lost. As veins are lost due to thrombosis and scarring of peripheral veins, IDUs may move to inject into deeper veins in the neck and groin. The groin may also be used as an injection site to avoid visible signs of drug use. The neural, respiratory and vascular structures of the neck make abscesses in this area particularly dangerous. Abscesses have been reported to cause erosion of the carotid artery,[31] osteomyelitis,[28] necrosis of major thigh muscles,[33] and thrombosis of the femoral vessels[33] with resultant amputation.[29] Other complications of abscesses include necrotizing fasciitis, flexor tenosynovitis,[28] deep venous thrombosis,[29] and gangrene of the fingers.[31] These serious complications permanently disable and threaten the lives of IDUs.

Cellulitis is serious, spreading, diffuse subcutaneous or muscular tissue infection, often caused by Group A *Streptococci*, *Staphylococcus aureus* and other bacteria. Because the infection is not localized, pus cannot be drained from cellulitis. Cellulitis can be associated with an abscess or can occur on its own. Cellulitis tends to spread and destroy surrounding tissues and is identifiable by a warm, edematous, and tender area below the skin. Cellulitis may spread to the lymphatic system as evidenced by local lymph node enlargement and red linear streaks on the skin (lymphangitis). In general, cellulitis responds to antibiotic therapy. Both abscesses and cellulitis can spread organisms into the bloodstream via damaged vessels, causing bacteremia. In a bacteremic person, abscesses and cellulitis may result from metastatic seeding of tissues with organisms from the blood.

Bacteremia is the presence of bacteria in the blood, while sepsis is a host response to the growth of pathogenic microorganisms in the blood or to their toxins. These infections are not uncommon among IDUs and can complicate the hospital course of IDUs

with skin and soft tissue infections.[29] Sepsis is manifested by a high respiratory rate, tachycardia, and hyper- or hypothermia. Bacteria produce toxic products that elicit host responses that can lead to septic shock, which is a state of particularly low blood pressure in the setting of bacteremia. Associated multiple organ failure and refractory hypotension make septic shock a life-threatening condition. The same organisms cultured from the blood have been cultured from active abscesses.[27] It is not clear whether the organism was introduced to the bloodstream and the site of the abscess at the time of injection or whether bacteremia resulted from vascular damage caused by a growing abscess. Alternatively, bacteremia can spread bacteria to deep soft tissue sites,[34] explaining the presence of abscesses and cellulitis in regions of the body distant from injection sites. Nonetheless, bacteremia, sepsis and septic shock are associated with skin and soft tissue infections. In a study of all narcotic users admitted to the Detroit Medical Center with bacteremia in a one year period (1982-1983), 32% (62/180) of bacteremia cases were associated with skin and soft tissue infection, while the others were mostly attributed to endocarditis and mycotic aneurysm.[35]

Infective endocarditis, inflammation of the endocardium of the heart, typically due to infection of the heart valves, is another condition potentially associated with skin and soft tissue infections. Infective endocarditis is generally caused by a bacterial or a fungal infection, with regional variability as to the species of microorganisms causing disease among IDUs.[31] Like sepsis, infective endocarditis may be a sequel to a skin and soft tissue infection or be a related process involving the introduction of organisms at the time of injection. Tuazon *et al.* found that in 12 of 20 cases of endocarditis seen at the DC General Hospital-Howard University Medical Service, the phage type of the organism in the blood matched the phage group of the organism carried in the nose or in the throat or on the skin. It appeared that, based on the tests available in the mid-1970s, the source of infection was largely the patient him or herself. *Staphylococcus aureus*, one of the main

species causing endocarditis in IDUs,[35] can lodge on previously normal heart valves, on heart valves with congenital damage, or on valves damaged by fibrous reactions to injected foreign substances. IDUs develop tricuspid valve endocarditis in 50% of the cases,[36] although left-sided endocarditis may also occur in users with[31] or without underlying heart disease.[35] However, the left side of the heart is more commonly involved when *Streptococci* are the causative organisms.[35] Right sided endocarditis may be complicated by septic pulmonary emboli[35] and pneumonia. Subacute and acute endocarditis can be life-threatening if not given intensive treatment.

IDUs may be particularly susceptible to skin and soft tissue infections because of co-existing conditions and the environment in which IDUs live. For example, immunodeficiency and pneumonia are risk factors for sepsis in addition to intravenous drug use.[37] Community-acquired infections such as tuberculosis and pneumonia may be more frequent among IDUs living in homeless shelters. Poor nutrition and inadequate housing may predispose to infection. Compromise of the immune system caused by alcohol, AIDS and, perhaps, long term drug use may increase the severity or likelihood of infectious conditions. Thus, the environment in which IDUs live can predispose them to infection while their immunological constitution may further weaken their ability to fight infections.

Why are skin and soft tissue infections important to IDUs?

Skin and soft tissue infections (abscesses and cellulitis) are painful and disfiguring infections of frequent concern to injection drug users. Abscesses may extend directly into adjacent structures or may lead to other life-threatening illnesses, such as endocarditis and sepsis. IDUs lose work days as a result of hospital admissions for an abscess or cellulitis.[26] Such infections can also lead to lasting discomfort and disability.

Anecdotally, substance abuse counselors, medical professionals, social workers, outreach workers, and SEP volunteers frequently have questions about abscesses and their prevention. There is minimal literature on this topic to guide public health workers about how to educate IDUs about abscesses. Having an accurate picture of prevalence and risk factors for abscesses could allow dissemination of consistent and accurate information to the IDU community and the people who serve them.

Why are skin and soft tissue infections important locally and nationally?

In 1973, White recorded the major reasons drug addicts (not necessarily IDUs) were admitted to the Bernstein Institute Medical Inpatient Unit at the Beth Israel Medical Center. Abscesses and cellulitis accounted for 12% (24/200) of consecutive drug-related admissions, second only to acute hepatitis as the major reason for admission. White anecdotally suggested that these admissions were overwhelmingly related to skin popping, the practice of injecting subcutaneously, as opposed to injecting intravenously.[38]

Skin and soft tissue infections represent a particularly large problem in San Francisco. Today, skin and soft tissue infection is the most frequent admitting diagnosis at San Francisco General Hospital (SFGH). It accounts for 4% of all admissions. Ninety percent of skin and soft tissue infections at SFGH are related to injection drug use. These infections represent a significant economic problem for the hospital, as 5-7 new cases are admitted per day[39] and many IDUs are not insured and are not enrolled in Medi-Cal. Skin and soft tissue infections are a drain on an over-burdened and busy pubic hospital. It may be more cost-effective to prevent and treat these infections before they lead to hospital admissions.

In San Francisco, over 40,000 syringes are exchanged weekly by the HIV Prevention Project, the city's principal SEP.[40] Approximately 40,000 alcohol wipes are

distributed to IDUs per week when they exchange syringes. The question remains whether distributing alcohol wipes is an effective way to prevent abscesses, whether it is cost-effective and whether there are other strategies that could be employed in lieu of or in addition to dispensing alcohol wipes.

Skin and soft tissue infections could become particularly problematic in the future if antibiotic-resistant strains of common pathogens continue to appear and spread. Strains of *Staphylococcus aureus* (*S. aureus*) with reduced susceptibility to vancomycin[41] are particularly worrisome both because they are resistant to all other antibiotics and because *S. aureus* is commonly isolated from abscesses. Antibiotic resistance already influences treatment recommendations for skin and soft tissue infections and bacteremia in IDUs. Methicillin-resistant strains of *S. aureus* accounted for 42% of the isolates from bacteremic IDUs infected with *S. aureus* admitted to the Detroit Medical Center between 1982 and 1983.[42] Treating IDUs without doing cultures and antibiotic sensitivity studies for isolated organisms can lead to treatment failures and can promote the evolution of antibiotic-resistant strains. Antibiotics may also be used by IDUs without a prescription. Orangio and colleagues found that 41% (14/34) of the IDUs presenting to the Emergency Room at the Queens Hospital Center for soft tissue infections had been self-medicating with antibiotics.[20]

Possible sources of abscesses and cellulitis

There are three broad sources of infection with viruses and bacteria in IDUs: the user him- or herself, other users, and fomites.[31] While HIV and hepatitis B and hepatitis C viruses are spread principally by person-to-person transmission, many of the bacterial species causing skin and soft tissue infections may be found among the skin and oral flora of IDUs. Previously used syringes, non-sterile drug preparation and injection techniques, and the inoculation of skin and oral flora through needle trauma are the means of infection. The principal source of infection for skin and soft tissue infections may be the user him- or

herself and the infection is likely to be due to non-sterile preparation and injection of the drugs rather than contamination of previously used needles and syringes. However, the pathogenesis of skin and soft tissue infections among IDUs has not yet been fully elucidated. Why do IDUs appear to be at greater risk than insulin dependent diabetics, for instance? Whether reducing the introduction of skin and oral organisms via a sterile technique, for instance, would significantly diminish the risk of abscesses or cellulitis is not yet known.

There are at least six sources of foreign particles and microorganisms that can be introduced via a syringe into the tissues or bloodstream of an IDU: the cooker, the dissolving water, the filter, the drug and its contaminants, the syringe -- needle, barrel and plunger -- and the IDU's skin or mouth. The cooker -- a spoon, bottle cap or other container used to heat and dissolve the drug, may contain foreign particles. Cookers may be dirty from previous use or from the environment, and sometimes standard cookers such as spoons cannot be located so alternative containers are used. While clean cookers are not distributed to IDUs attending the SEP in San Francisco, distribution of clean cookers occurs at other SEPs such as the Tacoma, Washington SEP.[17] Many educational materials on HIV prevention among IDUs dissuade users from sharing cookers because of the risk of HIV transmission.

Second, the water used to dissolve the drug may be contaminated. For homeless IDUs, obtaining clean water can be a problem. Levine and Sobel reported that saliva may be used as a diluent if no water is available.[31] Saliva contains microorganisms that could be pathogenic when injected. Stein, who extensively reviewed the literature on the medical complication of injection drug use, indicated that solid drugs may be dissolved in toilet water,[19] an obvious source of contamination. Tap water is not sterile, and if water is taken from the toilet bowl instead of the tank, the risk of contamination is even higher.

Third, the filter type -- cloth, cotton or cigarette filter -- used to draw the drug into the syringe may be a source of particles that can damage veins, soft tissues and heart

valves. In addition, granulomatous pulmonary reactions may result from embolization of cotton fibers to the pulmonary vessels.[19] Anecdotally, concern has been raised in the harm reduction community about the potentially caustic effects aluminum or fiberglass in cigarette filters and nylon in synthetic or synthetic-blend cotton balls. If users are dope sick (in withdrawal) they may reuse the cotton balls or other filters to get a hit. Sometimes users will give each other used cottons, increasing the chance of person-to-person transmission of pathogens. Cottons may therefore be a source infecting microorganisms and damaging particles. The San Francisco SEP and others distribute pure cotton balls to reduce the chance of contamination and fiber damage. The effectiveness of this intervention in preventing blood vessel damage, endocardial damage, and granulomatous pulmonary reactions has not been studied.

Person-to-person transmission of microorganisms may take place when syringes are passed from one person to another without sterilization. The needle, the barrel, and the plunger of a syringe may be contaminated by microorganisms. Bleach may not thoroughly disinfect syringes if used improperly and the "proper" way to sterilize a syringe with bleach has been debated[43-45] and may not always be practical.[46] Syringes may also be re-used by the same person, putting an IDU at risk for infection with the organisms that normally inhabit the colonized areas with which the syringe has come into contact. After 20-30 uses, disposable insulin syringes, the most common type of syringe at SEPs, are likely to break and needle foreign bodies can stay in the body. Needle foreign bodies can be complicated by an abscess or cellulitis,[47] especially because foreign bodies generally increase the likelihood of infection.

Auto-infection occurs at the site of needle injection. In this case, commensal microorganisms that normally inhabit the skin such as *S. aureus* are end up being injected into the bloodstream, dermis, hypodermis or muscle through non-sterile skin preparation prior to injection. Subcutaneous injection (skin popping), intramuscular injection and "missing" a vein are anecdotally believed to place people at particular risk of skin and soft

tissue infections. Abscesses can be caused by normal oral flora, particularly when needles are licked prior to injection,[31] when IDUs blow through the needle to clear clots from them prior to reuse,[29] and when spit is used in preparation of the drug. Hemingway *et al.*, hypothesized that infection with *Streptococcus milleri*, an oral commensal organism commonly isolated from abscesses among IDUs in Glasgow, resulted from using the teeth to crush tablets of buprenorphine and temazepam prior to their injection and using saliva to clean the skin .[33] However, a study of the prevalence of injection practices that involve the mouth and saliva has not been published.

The presence in the body of the drug itself may predispose individuals to infection. One study[48] of morphine administered subcutaneously to mice and rabbits showed that it significantly depressed the phagocytic and killing properties of polymorphonuclear cells and macrophages well below toxic doses and in morphine-tolerant animals. The results also showed that the animals on low doses of morphine had significantly higher kidney loads of *Candida albicans* 12 hours after equivalent challenges with the organism intravenously. These results suggest that opioids may suppress the immune system by inhibiting the ability of white blood cells to clear infection.

Contaminants in drugs are of great concern to IDUs. Recent cases of wound botulism were attributed to the presence of *Clostridium botulinum* (a gram-positive bacterium) toxin in drugs.[49] Bacterial or fungal contamination could occur when a drug is first made, when it is cut or altered, and during its transport and handling. Filtering and boiling drugs in clean water may reduce the concentrations of organisms but is unlikely to eliminate them. Surprisingly, the few microbiologic studies of heroin conducted in the 1970s showed that street samples had lower amounts of pathogenic organisms than expected. In 1972, Tuazon *et al.*, analyzed 100 samples of heroin and 100 samples of injection paraphernalia, particularly syringes and cookers. The striking result of their investigation was that organisms of the *Bacillus* genus (species not specified) were the

most common species isolated from heroin and paraphernalia; *S. aureus* was not isolated from a single sample of heroin or paraphernalia. Some *Bacillus* species are ubiquitous, found in soil, water, air and dust, and are largely non-pathogenic. They are only occasionally isolated from abscesses or cellulitis. Alpha-streptococci (*Streptococcus viridans* is an alpha-hemolytic) were isolated from only three samples of paraphernalia and two samples of heroin.[50] These findings were largely supported by those of Moustoukas *et al.*, who analyzed 31 samples of street heroin and found various species of *Bacilli* (including occasional *Bacillus cereus*, which is a known cause of food poisoning) in 79% of the samples, no *Staphylococcus* species and only one sample with gamma-*Streptococcus* (*Streptococcus milleri* are a part of this group).[30]

The absence of bacterial contamination of street heroin with pathogenic species in the 1970's may be partially explained by the bactericidal effect of the fillers used in heroin mixtures. In 1979 and 1980, Moustoukas *et al.*, with the help of the US Department of Law Enforcement, found that common fillers of heroin were quinine, procaine, caffeine, lactose, and mannitol. Heroin accounted for 0.79-12% of the samples.[30] An investigation into Scopolamine poisonings, recently identified as a heroin adulterant in the Northeastern United States, revealed that quinine, mannitol, dextromethorphan, lidocaine, and starch were also used as a fillers.[51] Street heroin samples have been shown to have bactericidal activity against *Bacillus cereus* and *S. aureus*.[52] Quinine, normally prescribed as a malaria suppressant, is probably responsible for the bactericidal effect. Fillers may also contain antibiotics, for unknown reasons. Based on the limited information available, street drugs are not the likely source of the organisms found in skin and soft tissue infections.

While drug fillers may have bactericidal effects, the fillers can also have profound consequences on body tissues. Quinine injected intramuscularly at high concentrations (300 mg/mL) causes sterile abscesses. Thus, for malaria treatment purposes, it is administered at doses of 50-100 mg/mL is it is given intramuscularly.[53] It would not be

surprising if the doses of quinine found in street heroin caused sterile abscesses in IDUs. These abscesses may become infected when the IDU injects again at the same site. A sterile abscess could provide a lush and protected environment for the multiplication of pathogenic organisms. Cherubin[54] and Stein[19] suggested that quinine could facilitate anaerobic growth because of its high redox potential. Louria and colleagues suspected that three unusual cases of multiple necrotic abscesses among skin-poppers who presented to the Bellevue Hospital in New York in 1966 were the result of heroin contaminated by a quinine substitute.[10] Without further analysis of street drug samples, we cannot know at what concentrations this potential abscess-provoking substance is found in street drugs.

Procaine (Novocain), another filler, is a short-acting local anesthetic. Caffeine raises peripheral vascular resistance in low doses, although it decreases it in high doses.[53] Vasoconstriction in response to low doses of caffeine at the injection site may decrease the ability of the surrounding tissues to clear infection and decrease the local oxygen tension. Cocaine is also a potent vasoconstrictor. Cocaine-containing anesthetics and cocaine alone have been shown to damage local wound defenses and enhance the development of infection. In animal models, wounds treated with cocaine develop infection and necrosis at significantly higher rates than seen in controls.[55] Procaine and caffeine may have local effects similar to those of cocaine, facilitating the growth of pathogenic organisms and reducing the ability of the body to fight infection.

What impact the wide range of pharmaceutical and non-pharmaceutical fillers have on the tissues surrounding an injection site is unclear, but further biological research could advance our understanding of the processes that predispose IDUs to the development of local infections. Furthermore, the anecdotal reports that some people are particularly prone to infection would support the theory that certain fillers produce tissue reactions conducive to abscess formation. Individual IDUs may have consistent sources of drugs, which consistently have the same potentially destructive fillers.

Laboratory techniques are undoubtedly becoming more sensitive and specific and the quality and contents of street drugs are probably changing. Continuing investigations into the microbiology and filler content of street drugs are necessary. The results of those studies that have been conducted point to two hypotheses regarding the development of abscesses and cellulitis: street drugs are not the main source of pathogens but they are the source of fillers which have destructive and infection-facilitating tissue effects.

Related Findings

The journal articles regarding skin and soft tissue infections in IDUs is based principally on hospital records, including surgical and neurologic case descriptions, microbiological descriptions, and case control studies. A number of the results have been discussed earlier.

The first category of related literature includes reviews of the hospital records of IDUs seen in the emergency room or admitted for drug-related injuries and infections. Wallace *et al.*,[25] conducted a study of every eighth patient admitted for a drug-related abscess at the Detroit Receiving Hospital from 1981 to 1982. *Staphylococcus aureus* was the organism most commonly isolated from abscesses. Forty-one percent of the *S. aureus* isolates were methicillin-resistant. The mean pharmaceutical charges were $1,370 per hospital stay. The average length of stay was 12 days and the average cost of hospitalization that year was $10,651. One patient admitted for cellulitis in the right groin required leg amputation as a result of distal ischemia and was hospitalized for 37 days at a cost of $52,466. Treating drug related abscesses required an average of 22 beds out of an average of 90 beds for the surgical service -- 10% of the total hospital beds.[25] This study, completed over 15 years ago, points to the huge costs associated with hospitalization for drug-related abscesses. Because many of these patients are uninsured or have public insurance, the cost is largely borne by the state.

A retrospective review of the medical records of IDUs admitted to the hospital for drug-related illnesses was completed by Gonzalez and colleagues[28] at the Cook County Hospital in Chicago, IL. This study was a review of the location, pathology, bacteriology and treatment of all upper extremity abscesses in a four year period. The average length of hospital stay for abscesses was 15 days (range 2-65 days) and multiple surgical procedures were required for one-third of the abscesses. Two important complications of abscesses were osteomyelitis (3/59 cases) and necrotizing fasciitis (3/59) cases. Eight-eight percent (50/57) of the patients had injected cocaine, 61% (35/57) had injected heroin and 58% (33/57) drank more than a pint of alcohol per day. However, medical records may not have been complete in all cases and the authors did not indicate that the questions asked to elicit information about drug and alcohol use and practices were standardized. The lack of standardization is a limitation of retrospective behavioral data based on hospital records. The treatment information, however, is likely to be accurate because of the strict medical recording procedures used by most hospitals regarding surgery and medication. The bacteriological results, discussed earlier, are also likely to be accurate because laboratory procedures are generally standardized for a given hospital.

Henriksen *et al.*[29] conducted a similar retrospective study of the records of all IDUs with acute soft tissue infections admitted to the Department of Orthopedics at a hospital in Copenhagen from 1985 to 1989. They found no association between the drug injected and the clinical diagnosis (i.e. what kind of skin and soft tissue infection), although this finding is questionable because they used medical records to determine drug used. It is probably unwise to assume that IDUs inject only one drug.[20] Serious complications occurred in 19% of the patients with skin and soft tissue infections. From one to seven bacterial species were cultured from each abscess, with 58% of the cultures being polymicrobial. When antibiotic treatment was begun prior to hospitalization, twelve cases were treated with incorrect antibiotic treatment because of resistant *Staphylococcus aureus* and *Bacteroides* species. Nearly all (29/30) of the *S. aureus* isolates were resistant

to penicillin and nearly all (14/15) of the *Bacteroides* species were resistant to penicillin and cephalosporin. The authors recommended treatment with dicloxacillin (a penicillinase-stable penicillin active against Staphylococcus and Streptococcus) and metronidazole (active against Bacteroides and other anaerobic species) for abscesses and cellulitis. These results indicate that culturing bacteria from abscesses and, if possible, from cellulitis, doing sensitivity tests and carefully choosing antibiotic therapy is critical to caring for IDUs with serious skin and soft tissue infections.

Scheidegger and Zimmerli[56] used hospital records to review drug-related admissions to the Department of Medicine at the University Hospital in Basel, Switzerland from 1980 to 1986. They found that injection drug users accounted for 262 (0.8%) admissions in that seven year period. Most of the admissions were related to lower respiratory tract infections, viral hepatitis, and HIV infection. Once HIV-antibody testing was initiated among all hospitalized drug users in 1986, half of them were found to be HIV-positive, which represented a strikingly high prevalence and may reflect the rapid propagation of HIV infection in Switzerland prior to instituting harm reduction efforts. However, there were only seven cases of soft tissue infections in the seven year period, and, of these, two were related to crush injuries sustained while intoxicated, not injection itself. Thrombophlebitis accounted for six additional cases. This unusually low number of skin and soft tissue infections was attributed to the rarity of subcutaneous injection among their population of drug users.[56] In addition, nearly 95% of their patients were "principally heroin addicts." This pattern of drug use may not be reflected in US IDU populations. Methicillin-resistant strains of *S. aureus* were rarely isolated in their hospital. Based on unpublished interviews, the authors suggested that methicillin-resistant *S. aureus* was rare because Swiss IDUs do not use self-medicate with antibiotics, unlike IDUs in the US.[56]

Scheidegger and Zimmerli[56] failed to note that low numbers of hospital admissions for skin and soft tissue infections and fewer isolates of antibiotic-resistant strains of

bacteria may point to increased access to health care for IDUs in a country with nationalized health care. A pragmatic rather than stigmatizing approach to the health of IDUs, as reflected in Switzerland's national policies, may make IDUs more willing to seek early care for minor infections, reducing hospital admissions rates for skin and soft tissue infections. However, comparing hospital-based proportions of skin and soft tissue infections in different cities and countries cannot conclusively identify injection practices as the major risk factor of skin and soft tissue infections. Such comparisons may merely point to the failure of outpatient health care systems in some areas to identify and treat early infections.

Bergstein, *et al.*,[27] reviewed the medical charts of all patients treated for abscesses by the Department of Surgery at the John L. Doyne Hospital, Medical College of Wisconsin, over a 21-month period. They described the presentation, microbiologic findings and treatment of drug use-related abscesses. The investigators found 243 bacterial isolates from the soft tissue abscesses of 57 patients. The most frequent isolates were Streptococcus species (aerobic), isolated from 74% of the patients, and *Propionibacteria* (anaerobic) found in 46% of the patients. *Peptostreptococcus micros* (an anaerobe) was also a common isolate. They found that 61% of the abscesses were "mixed" infections containing both anaerobic and aerobic organisms. The authors attributed the finding of frequent mixed infections to the vasoconstrictive effects of cocaine on tissues. Cocaine is a powerful vasoconstrictor, and therefore reduces the oxygen tension in surrounding tissues. Reduced oxygen tension would favor the growth of anaerobic organisms. Reduced oxygen tension also diminishes the bacterial killing power of polymorphonuclear cells,[27] cells we normally rely on to fight infection. This is a biologically plausible mechanism to explain the high incidence of abscesses among cocaine-injecting IDUs. Biological mechanisms are key to understanding the pathogenesis of skin and soft tissue infections in IDUs and will be necessary adjuncts to epidemiological studies regarding the risk factors for these infections.

Bergstein and colleagues also found that classic signs and symptoms of abscesses were often absent in the hospitalized IDUs and that the clinical presentations were remarkably varied. They recommended that "the physician should presume that any soft tissue infection in a parenteral drug abuser is likely to harbor an abscess."[27] Patients were all treated with incision and drainage and 86% were given perioperative antibiotics. Bergstein *et al.* also emphasized the need for appropriate antibiotic treatment for abscesses related to drug use. Clearly, institutions must conduct bacteriologic surveillance of the infections in IDUs to correctly treat their patient population.[27] Their recommendations for institutional bacteriologic surveillance of admitted IDUs are supported by Orangio *et al* ., who conducted a hospital-based study of IDUs who had soft tissue infections from 1981 to 1982 in Queens, New York.[20]

The results of the Wisconsin study conducted by Bergstein, *et al.*,[27] may have been skewed due to the severity of infections in IDUs who require treatment in a surgery service. In other words, the presentation, microbiologic findings and treatment of IDUs with abscesses in the community may not be as diverse as those represented in their study.

Hemingway *et al.* also searched a hospital database to identify 14 IDUs with abscesses from whom *Streptococcus milleri* was isolated.[33] This organism is important because it can elaborate the enzyme hyaluronidase. Hyaluronidase is thought to digest the connective tissue matrix, which is partially composed of hyaluronic acid, contributing to the tissue destruction involved in abscesses.[57] *Streptococcus milleri* causes extensive tissue destruction and multiple abscesses as well as severe sepsis. Hemingway and colleagues concluded that *Streptococcus milleri* is becoming more prominent among IDUs in part because of oral contamination of the drugs injected and skin cleaning with saliva.

Richter[34] reviewed the complications of injection drug use that could have neurologic sequelae -- infective endocarditis, tetanus, meningitis and brain abscesses and tuberculosis, among others. Richter included the possible effects of deep soft tissue

infections on the neurologic system. For example, pyomyositis, an infection of the large muscle groups, can affect lumbosacral and brachial plexuses of nerves as well as peripheral nerves. Necrotizing fasciitis, an infection that spreads quickly along fascial planes, can also destroy nerves.

Cherubin and Sapira[58] described the medical complications of drug users, including skin and soft tissues infections. They suggested that that skin and soft tissue infections result from "...nonsterile injections, sharing of equipment, poor personal hygiene, subcutaneous injection into the deltoid muscles and thighs in the absence of an available vein, or injection into the veins of the neck or groin."[58] However, no data nor references were provided to support these ideas.

Williams, *et al.*,[47] used a computerized data bank at Johns Hopkins Hospital to search all chest and neck x-ray reports with the word "needle" in them. Linking these to medical records, they found 50 cases of neck needle foreign bodies in injection drug users over a 5-year period. Complications of neck needle foreign bodies occurred in 10% of the cases, including cellulitis, abscesses, pneumothorax, and septic thrombosis of the jugular and subclavian veins.[47] Neck needle foreign bodies are rare and do not constitute an important risk factor for skin and soft tissue infections. Yet, the report does point to the serious risks associated with injecting in the neck area, namely thrombosis of neck vessels and pneumothorax.

Four studies examined the associations between abscesses and potential risk factors. Batki, *et al.*[59] matched 96 patients enrolled in San Francisco General Hospital's methadone maintenance clinic with themselves prior to methadone treatment and compared their rates of hospital admissions. They found a significant reduction in hospital admissions related to skin and soft tissue infections while in methadone treatment enriched with on-site available HIV medical care.[59] The study findings may not be generalizable because the participants were IDUs who were HIV-positive or had other medical illnesses

and complications. Nevertheless, these findings suggest that methadone treatment may be one way to prevent skin and soft tissue infections. Presumably, methadone maintenance decreases the incidence of skin and soft tissue infections by reducing the frequency of injection. Methadone maintenance as a strategy to prevent abscesses could be effective for those IDUs motivated to be in treatment. However, in 1994, Watters reported that there were an estimated 1.2 million injection drug users and only 180,000 available treatment slots,[12] leaving many injection drug users without the option of drug treatment even if they wanted it. Anecdotally, lengthy waiting lists and cost prevent many injection drug users who want treatment from getting it. Allowing physicians to prescribe methadone and provide follow-up care could eliminate some of the barriers associated with methadone maintenance.

Vlahov *et al.*,[60] interviewed 1,057 IDUs recruited through community outreach who injected drugs in the six months prior to the interview. Approximately 11% reported at least one abscess at a site of injection in the preceding six months. Fifty-three percent reported ever doing anything to disinfect their skin at the point of injection, such as wiping or washing (skin cleaning), while only 31% reported always cleaning their skin. The authors found that the rate of abscesses was significantly lower in people who reported always cleaning their skin than in people who reported that they did not clean their skin all the time or ever. The study results suggest that distributing alcohol wipes and other antiseptic materials could reduce the frequency of abscesses.[60] The authors did not report what skin cleaning techniques and materials were used by what proportion of their sample.

Vlahov and colleagues suggested alcohol wipes or other antiseptic products ought to be distributed to IDUs to reduce the incidence of abscesses. They recommended that IDUs ought to be given clear instructions to clean their skin *prior* to injecting.[60] Some IDUs clean their skin after injecting to wipe up blood. Whether cleaning skin *hours* prior to the next injection can significantly reduce the risk of introducing potentially pathogenic organisms into tissue is not clear, especially given the rapid multiplication of commensal

organisms on the skin. Also, the alcohol concentration in wipes may have little quantitative effect on the bacterial population at the site of injection. Cleaning skin after injecting may, however, reduce the amount of dirt and foreign particles on the skin, and might be better than never or rarely cleaning one's skin.

Vlahov and co-workers[60] compared self-report to observed "recent" abscesses in a subset (453) of IDUs who had a physical exam, most of whom were HIV-positive (399). Using their method of determining "recent" abscesses, Vlahov, *et al.* claimed 89% concordance with self-report of an abscess in the last six months. How clinicians could identify abscesses prevalent up to six months prior to the exam is not specified. Since only 11% of the sample reported an abscess, the concordance was based primarily on the absence of findings that suggested a "recent" abscess, so that 89 percent agreement is not impressive. Finally, 96% of their sample were black, 77% were male, and 36% were HIV positive, raising the question of how generalizable their results are to other drug using populations, such as those in mixed, Latino or white neighborhoods.

Herb and colleagues[61] interviewed 110 active IDUs in San Francisco's Mission District recruited by a modified chain-referral method into the Urban Health Study. Forty-four percent of their sample reported at least occasionally cleaning their skin at the injection site. Thirty-eight percent of the sample reported a prior history of subcutaneous abscess. They found a statistically significant relationship between self-report of never cleaning the skin and self-reported history of subcutaneous abscess, although it is not clear if this relationship was examined using a multivariate model. IDUs who never cleaned their skin were also more likely to report a prior history of endocarditis than those who reporting cleaning their skin. Female sex and white race (vs. black) were also associated with reporting a history of an abscess. Based on these results, the investigators recommended that health educators, drug treatment programs, and health professionals incorporate skin cleaning guidelines into hygiene messages directed towards IDUs.[61] These data provide some support for the hypothesis that skin cleaning may prevent abscesses, but the data use

self-report of a history of endocarditis and abscess as the dependent variables without evidence that these measures are accurate proxies for physical diagnosis of such infections.

Spijkerman, *et al.*,[62] conducted a study in Amsterdam of IDUs recruited at methadone outposts, at an sexually transmitted disease clinic, and by word-of-mouth to examine the risk factors for abscesses. They used self-report data to calculate an incidence of abscesses in 269 IDUs with 1640 person-years of 33/100 person-years. This is likely to be a conservative estimate of the incidence of abscesses because participants could only report one abscess every six months. In a multivariate model, they found that HIV-positivity, female gender in combination with prostitution, foreign nationality (i.e. non-Dutch), injection of both heroin and cocaine as the "main drug injected," injection frequency of once or more than once a day (vs. less than once a day), and obtaining syringes via the SEP were independent risk factors for skin abscesses. While frequency of injection was associated with report of an abscess, borrowing used syringes and the number of times a syringe was used were not associated with report of an abscess. The authors concluded that the source of infection in abscesses is the skin, not contaminated syringes. They recommended gearing prevention efforts, such as promoting skin cleaning, to the high-risk groups as defined by the associations referred to above.

While HIV infection is predominantly thought to affect cell-mediated immunity, Spijkerman, *et al.*,[62] suggested that diminished humoral immunity in HIV-positive individuals increased their chance of having an abscess. Cell-mediated and humoral immunity are not independent of one another, so that a defect in cell-mediated immunity may alter humoral immunity via cytokines. On the other hand, Spijkerman and colleagues found that *lower* CD4+ cell counts among HIV+ individuals were associated with *fewer* abscesses in univariate analysis.[62] The authors explained this unexpected finding by suggesting that IDUs begin to use more hygienic injection behaviors during the course of their HIV infection and that adjusting for general and behavioral variables made the difference insignificant statistically.

The study by Spijkerman and colleagues[62] raises concern about using self-report of an abscess as the dependent variable for risk factor identification. For example, reporting a skin abscess was strongly associated with reporting endocarditis in the previous six months. The authors suggested that this finding supports the hypothesis that abscesses can be the source of endocarditis. However, the authors found that 29% of the reports of endocarditis could not be verified by the medical specialists at the hospital, even though medical records were available for all participants. This result calls into question self-report data as the basis for incidence measurements of clinical diagnoses. The self-report data on abscesses were not verified, and by the authors' own speculation, skin abscesses are more likely to be subject to recall bias than endocarditis. In addition to relying on self-report to identify risk factors, they did not report negative or positive findings for modifiable risk factors that could be useful for prevention.

O'Malley and colleagues[63] reported on the 27 cases of tetanus among IDUs that occurred in California from 1987 to 1997. They found that 18 (69%) IDUs had abscesses at the injection site. For 14 of the IDUs with abscesses, information was available regarding injection practices; all 14 reported subcutaneous injection. Eighty-nine percent (24/27) of the IDUs with tetanus were Hispanic. However, as suggested by the editorial comment accompanying the report, cases and risk factors may be underreported because of nature of the reporting system to local and state health department.[63] Furthermore, the quality of the risk factor data may be inconsistent and the sample is clearly a skewed sample of IDUs, as reflected by the predominance of Hispanics.

Despite the limitations of the recent study by O'Malley and colleagues,[63] the association between skin popping and tetanus is supported in a review of the medical complication of injection drug use at Bellevue Hospital in New York in the mid-1960s. Fifteen out of 17 reported cases of tetanus in IDUs were among skin-poppers. The authors suggested that "the subcutaneous administration of several bags a day of heroin plus its many, often irritating, adulterants produces induration and interconnecting abscesses that

provide an ideal milieu for *Clostridium tetani*."[10] Similarly, Cherubin argued, in an article published in 1967, that tetanus occurs most among African-American American women who "had been using subcutaneous injections and had multiple abscesses on the thighs."[54] The more recent information on tetanus among IDUs in California[63] suggests that medical practitioners treating abscesses should take into account whether their drug injecting patients have had tetanus vaccines and boosters when they present with abscesses. Tetanus should be prevented with vaccination and appropriate wound care, with the possible administration of tetanus immunoglobulin.[63]

A case control study published by Passaro and colleagues[49] is intriguing because wound botulism is a rare soft tissue infection that may occur at the site of an abscess or may have risk factors that are similar to those of abscesses. Passaro, *et al.*[49] compared responses to questions regarding drug injection-related practices among 26 patients with wound botulism to responses from 110 controls recruited from methadone detoxification centers. The questions referred to the period one month prior developing wound botulism in cases or to one month prior to enrolling in methadone treatment in controls. The investigators found a dose-response relationship between the monthly dose of black tar heroin, the type of heroin frequently used by IDUs in California, and the risk of developing wound botulism. The amount of black tar heroin that was injected subcutaneously or intramuscularly was greater in IDUs with wound botulism than the amount injected by those routes by drug treatment enrollees. Case patients were statistically more likely to report subcutaneous or intramuscular injection than control participants using both bivariate (92% vs. 44%, $p<0.001$) and multivariate analyses (odds ratio 13.7, 95% confidence interval 3.0, 63.0). Skin cleaning prior to injection was not significantly associated with being a case or control, nor were the number of alcoholic drinks consumed per month, sharing injection paraphernalia or using needle exchange programs. The number of abscesses that required medical attention or antibiotic therapy in the previous year was

higher in cases than in controls, and the authors stated, without presenting the data, that "cleaning the skin before injection may have protected against developing soft tissue abscesses (P=0.07)."[49]

The relationship between skin cleaning at the injection site and abscesses in the study by Passaro *et al.*[49] is clearly inconclusive. The questions regarding abscess history are different than those used by previous studies that examine abscesses among IDUs because the investigators asked specifically about abscesses that required medical attention or antibiotic therapy. Nonetheless, the history of abscesses is a self-report measure, with the same limitations as the self-report measures used in the studies referred to above.[60, 62] Case control studies such as this one may be subject to recall bias. Control participants were recruited from methadone treatment centers and were not matched by age, sex or HIV status. Methadone treatment clients may not resemble the IDUs who developed wound botulism with respect to injection practices, particularly during the month prior to enrolling into treatment. Despite these limitations, the strength of the associations in their study of wound botulism suggests that injecting subcutaneously or intramuscularly greatly increases the risk that under-vaccinated IDUs exposed to *Clostridium botulinum* toxin will develop of clinically evident disease compared with injecting intravenously.

What is now being done to prevent abscesses?

Skin and soft tissue infections continue to be a problem among IDUs. Other than skin cleaning and methadone maintenance, the literature does not provide convincing evidence that skin and soft tissue infections can be prevented. Despite the paucity of literature on this subject, some measures have been taken in an attempt to prevent abscesses among IDUs. SEPs promote the health of local IDUs. In addition to exchanging syringes, the HIV Prevention Project in San Francisco distributes alcohol pads, cotton balls, bleach, condoms, and an informational brochure on the use of bleach. Alcohol wipes are a convenient way for IDUs without regular access to soap and water to clean their skin. That

they are sterile before the packages are opened may be an advantage over other cleaning methods. The Seattle-King County Department of Public Health published a brochure on how to prevent abscesses.[64] An Internet site[65] with detailed information on vein care has been posted. It suggests using an anti-bacterial soap to clean the skin, dental cottons to filer drugs, and sterile water to dissolve drugs. Masson[66] and colleagues are planning a randomized control trial of an educational intervention for IDUs who present to the hospital. Batki *et al.* [59] suggest expanding access to methadone maintenance to reduce hospitalization for abscesses. Clear guidelines regarding the prevention of skin and soft tissue infections are still needed.

Chapter III

Methods

Study site

Data for the abscess study were collected in the Tenderloin neighborhood of San Francisco during one week in May of 1997. Participants were initially recruited for participation in the Urban Health Study (UHS), Institute for Health Policy Studies, University of California, San Francisco as part of an open cohort of IDUs in the community. UHS conducts interviews and HIV testing of IDUs in a total of twelve neighborhoods in San Francisco, Oakland, Richmond, and East Palo Alto each year. UHS returns to each neighborhood, including the Tenderloin, once every six months as part of an open cohort longitudinal study design. The study neighborhood was chosen because of its high concentration of IDUs and the proximity of a San Francisco Department of Public Health Center that would provide physician and nurse practitioner time, supplies and appointments as part of clinic's outreach programs.

The Tenderloin has a diverse population of IDUs who are likely to demographically resemble IDUs in other major urban areas. We do not know how the population of IDUs who spend their time in the Tenderloin neighborhood compares to IDUs in other regions with regard to specific injection practices and the prevalence of skin and soft tissue infections. The types and grades of drugs available to users in the Tenderloin may differ from those available in other cities as a result of drug trade routes. The form of heroin (black tar heroin) commonly used by IDUs west of the Mississippi[49] may differ from the form used by IDUs on the East Coast. Physicians at the San Francisco General Hospital believe that there are more skin and soft tissue infections among IDUs in San Francisco than in other major cities,[39] but this supposition has yet to be confirmed by other prevalence studies. The time of year that data were collected, late spring, may also have implications for generalizability of the prevalence results. Anecdotally, the rates of skin

and soft tissue infections are said to increase in the winter months and decrease in the summer.

All interviews, clinical histories, and physical exams were conducted in private rooms in a hotel to preserve confidentiality. Separate waiting rooms, a phlebotomy room and an HIV education room were available. Security personnel were available to escort participants to their destinations. A van parked outside the hotel marked the location where IDUs presented themselves to receive appointments with UHS study staff that day.

Recruitment, eligibility, response rate and potential for bias

Participants were recruited for the UHS by trained outreach workers from the street, from syringe exchange sites, and by "word of mouth" in the Tenderloin neighborhood during the week prior to the study. The targeted sampling technique employed avoids the bias resulting from recruitment of IDUs from service agencies and drug treatment centers[67] but is unlikely to produce a random sample of IDUs. Taking a random sample of IDUs is virtually impossible given the clandestine nature of drug use and the lack of data bases that could be used to identify drug users. Because UHS has recruited IDUs from this neighborhood since 1986, many of the participants were familiar with the study staff and eager to participate. Repeated recruitment from this neighborhood promotes a sense of trust in the study staff and procedures that facilitates the collection of accurate data about sensitive information.

IDUs presented themselves at the designated field location in the morning for an appointment that day. Eligibility criteria for the UHS were the presence of multiple needle marks from injection drug use within the prior 30 days by visual inspection or previous participation in the UHS, which was verified using a personal computer containing with records of unique codes for each participant. Participation was limited to IDUs greater than 18 years of age. IDUs who arrived late in the morning and could not be accommodated with an appointment that day were asked to return the following day.

All participants in the UHS during second week of May were invited to participate in the abscess study at the time informed consent for the UHS was being obtained. The abscess study was introduced after IDUs presented themselves for their UHS appointments so that street sampling would not be biased in favor of IDUs with abscesses, those particularly concerned about abscesses or those who wanted to see a doctor. During the second week of May, two hundred and twenty-one participants were enrolled in the UHS and invited to participate in the abscess study. Of these, 192 (87%) gave informed consent to participate in the abscess study and were screened for possible abscesses and/or cellulitis by clinical history. If IDUs declined to participate it was generally because they did not have the time to do the abscess study. UHS procedures take over an hour and IDUs are occasionally in a hurry to leave. Two people who gave consent to participate and had a clinical history of current symptoms or self-report of an abscess could not wait for the clinician because they had conflicting appointments (work and a General Assistance appointment). Six people who consented to participate and had a clinical history of symptoms or self-report of an abscess were not seen by the clinician because he or she was unavailable at that time. Two additional people were excluded because of missing data regarding their physical exam. Thus, a total of ten people enrolled in the abscess study did not complete the study and were excluded from bivariate and multivariate analyses. Thirteen additional individuals reported that they had not injected drugs in the previous 30 days but had participated in the UHS on previous occasions were excluded from analysis because there would not be data available on their injection behaviors in the time frame thought to be relevant to the development of a skin and soft tissue infection.

The IDUs who refused to participate, did not complete the study or were excluded from analysis were compared to the final sample with regards to sex, HIV status, homelessness, race, education, whether they stayed on the street in April, and whether they were enrolled in treatment for drug addiction in the prior 30 days. The two groups differed

significantly in drug treatment status only using Chi Square analysis, which was expected given that IDUs in drug treatment may not be injecting drugs.

Procedures

After obtaining informed consent, participants were interviewed by trained interviewers about their medical history, drug injection habits, exposure to HIV risk factors, and exposures to potential risk factors for skin and soft tissue infections using a standardized UHS questionnaire with an abscess-related supplement. Demographic information was also collected at that time. Participants received pre-test counseling and participated in an HIV prevention educational component. Serum samples were drawn for HIV-1 antibody testing using ELISA. Samples that were repeatedly positive on ELISA testing were re-tested by Western blot assay. Criteria for seropositivity on Western blot included the presence of reactive bands at two of the following locations: p24 or gp41 and gp120/160, as described by the CDC.[68] Participants were paid $15 for their participation in UHS procedures and asked to return two weeks later for their results and post-test counseling.

Those participants who gave consent to participate in the abscess study were interviewed using a standardized questionnaire to determine if they had current symptoms of skin and soft tissue infections. They were asked if they were experiencing pain, swelling, redness, hardness under their skin, heat, pus, or oozing and if they thought they had an abscess or related infection at or near a place they injected drugs. If the answer to any of these questions was yes, the clinical history was considered positive. If the answers to all of the questions were no, the participant was considered to have a negative clinical history, given education about skin cleaning and paid $5 for participation.

In addition to the questions regarding symptoms, participants were asked if they were currently taking medications that could be weaken the immune system (i.e. oral corticosteroids, cancer chemotherapy).

Participants with a positive clinical history, as defined above, were sent into an adjacent private room to see a physician or nurse practitioner. They were examined for the presence of abscesses and cellulitis. The medical professional completed a data collection form concerning the characteristics of any prevalent infections, and systemic signs noted on examination, and any recommendations and treatment given. The clinician was asked to measure and record the participant's temperature, blood pressure, and respiratory rate. The clinician was asked to record the note the presence of certain characteristics of abscesses, including heat, erythema, tenderness, fluctuance, crepitus, drainage, and foul odor. Likewise, they were asked to record the presence of characteristics of cellulitis: heat, erythema, drainage, and streaking lines. They were also asked to record the location, size, duration, of abscesses and cellulitis. Clinicians were asked to record the number of abscesses present, whether the most severe abscess was open or closed, and whether it had been lanced. If more than one abscess was present, clinicians were asked to record the size, duration and characteristics of the most severe abscess. They were also asked record any additional information regarding the abscess or cellulitis that they considered descriptive.

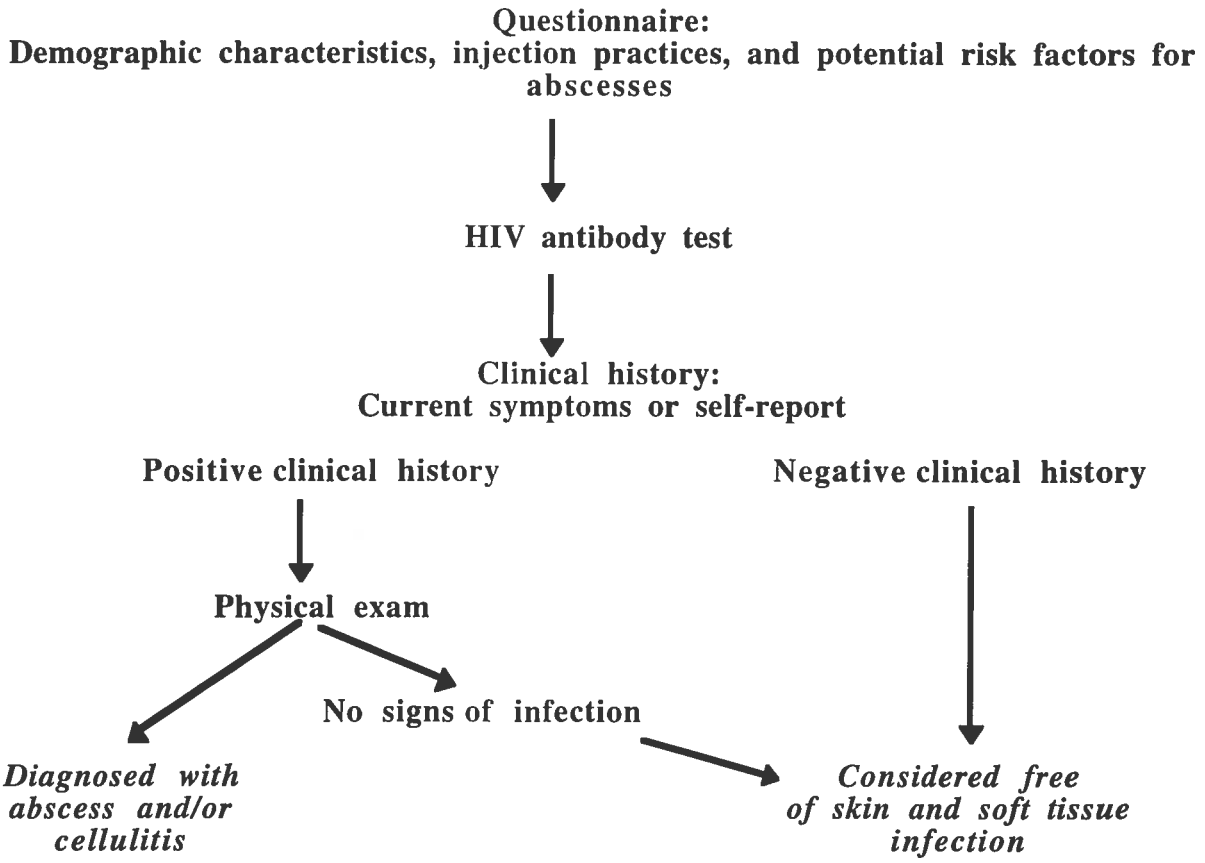
Clinicians cleaned the wound, dispensed oral antibiotics, and provided an appointment for incision and drainage, if needed. Same day appointments were provided at the Tom Waddell Health Center, a San Francisco Department of Public Health clinic located only eight blocks from the study site. If the participant required emergency or urgent care, he/she were provided with immediate transportation to the health center for evaluation and possible transport to San Francisco General Hospital. Clinicians also counseled participants about basic care of their infections. On concluding the study, participants were paid $5 for their participation.

Some participants had incidental but serious health needs not directly related to skin and soft tissue infections. These participants were referred to the local health center or other appropriate setting. All participants received counseling about skin hygiene including

both verbal and written instructions about skin cleaning options. Participants also received cotton balls and hygienic cleansing towelettes.

Participants returned two weeks later for HIV antibody test results and post-test counseling. At this time, physicians from Tom Waddell Health Center were available if participants were interested in learning about HIV treatment options and health department services.

Figure 1 - Identification of cases.



Dependent/Independent variables

The dependent variable was the presence of an abscess and/or cellulitis, as diagnosed by a clinician. Participants who had a negative history or did not have an abscess or cellulitis by physical examination were considered free of skin or soft tissue infections. The clinical history was intended to identify all possible cases of skin and soft tissue infections by using report of symptoms of infection (i.e. redness, swelling, heat, pain) and self-report. Approximately half of the sample had a positive history and underwent a physical exam.

The study was designed to examine potential risk factors for skin and soft tissue infection. Three categories of independent variables were examined: (1) participant's demographic characteristics and living environment, (2) HIV infection and drug use characteristics, (3) hygiene and injection behavior. We hypothesized that exposures in each of these three categories could facilitate the introduction and/or growth of organisms into the skin and soft tissues of an IDU via needle penetration through the protective layer of the skin.

Demographic variables and living situation were hypothesized to affect the likelihood of skin and soft tissue infections. The independent variables sex, age, race, and education were examined. Participants were asked whether they considered themselves homeless and whether they lived on the streets the prior month, April. Participants were also asked whether they had health benefits.

Drug use characteristics and HIV infection were expected to affect the risk that IDUs acquired a skin and soft tissue infection, in part because they could influence the immune status of the host. To examine these relationships, the following variables were analyzed: HIV status by HIV antibody test, number of years since first injection experience, drugs injected in the past 30 days, alcohol consumption in the past week, current use of immunosuppressing medication, diagnosis of diabetes, and prior abscess. We also examined poly-drug use, which was defined as use of more than one of injection

speedballs, heroin, cocaine, and speed, and use of crack and alcohol (more than 21 drinks per week) in the last 30 days.

Finally, potentially modifiable reported injection behaviors and hygiene practices were examined. These behavior variables included the following: washing hands with soap and water prior to injecting, cleaning injection site prior to injection, re-using syringes (previously by the IDU him/herself or by another user), sharing syringes (previously used by another user), exchanging syringes at an SEP, licking needles before injecting, using spit to prepare drugs, rotating injection sites, injecting subcutaneously/intramuscularly, injection frequency, and being injected by another person or injecting other people. Being injected by another person or injecting others was thought to reflect a pattern of riskier injection-related behaviors. We also asked about being in drug treatment.

Recall was limited to the previous 30 days for the following exposures: living situation, licking needles, using spit, muscling/skin popping, washing hands, SEP use, drugs injected, drug treatment, frequency of injection, re-using syringes, sharing syringes, and anatomic site of injection. Participants were asked about alcohol consumption "In a typical week." Participants were also asked about the type of filter "usually" used. Pattern of injection (i.e. same spot, inching along a vein or rotating limbs) and skin cleaning questions referred to general practice in the prior six months. In some instances, participants were asked to recall if they had ever had a given health condition or engaged in a certain practice and they were asked to report the year and month of that event (previous abscess, lancing own abscesses, taking street-bought antibiotics). Route of injection was asked about in two ways in order to check reliability of the question. In one part of the questionnaire, participants were asked, "In the last 30 days, with any kind of drug, how many different times have you injected a drug IV? Skin popping, muscling?" Another question asked, "In the last 30 days where have you injected most commonly? Second most commonly? Third most commonly?" With the help of a diagram of the human body, participants were asked to report whether they injected intravenously or by muscling/skin

popping in each location they identified. Both ways of obtaining information about the most commonly used method of injecting were compared for reliability. No discrepancy was found.

Statistical methods

Data were examined using bivariate and multivariate analysis techniques. The unit of analysis was the IDU sample person. IDUs with both an abscess and cellulitis or with multiple sites of infection were counted once in the analysis. Participants who had not injected drugs in the past 30 days were excluded from the analysis. The ten participants who did not complete the study (who had a positive clinical history but did not have a physical exam) were also excluded.

Data were double entered by an independent data entry firm *Four Winds* (San Francisco, California). The demographic characteristics of the study population, the frequencies of skin and soft tissue infection, and the frequencies of injection behaviors were examined. Continuous variables (frequency of injection, age, number of past abscesses, number of drinks per week, number of years injecting, and percentages of injections by intravenous/intramuscular/subcutaneous routes) were converted into dichotomous or trichotomous categories because the distribution of most independent variables was nonparametric. Bivariate relationships between potential risk factors and the dependent variable were initially examined using the Mantel Haenszel Chi Square test. Multivariate analyses were conducted using logistic regression. Independent variables that were significantly associated with the dependent variable in the Chi Square tests, reported to be associated with self-reported abscesses in previous studies, or whose effects could be confounded by other variables were included in logistic regression models, primarily to explore confounding and co-linearity. Odds ratios (OR) and 95% confidence intervals (CI) were used to determine whether participant (1) participant demographic characteristics and living environment (sex, age, race, education, housing status, and health benefits), (2) HIV

status and drug use characteristics (years since first injection, HIV antibody test results, alcohol use, drugs injected), (3) hygiene and injection behavior (washing hands, muscling/skin popping, SEP use, licking needles, re-using syringes, cleaning the skin prior to injection, frequency of injection, rotating sites) were associated with infection. Data analysis was performed using the *Statistical Package for the Social Sciences* (Chicago, IL, USA) and *Stata 5.0* (College Station, Texas, USA).

Chapter IV

Results

Sample

Table 1 displays the demographic profile of the sample (N=169). Seventy-five percent of the sample was male (biological sex) and the majority of participants (54%) were between the ages of 40 and 49. Fifty-two percent of the sample identified themselves as white, 36% as African-American, 7% as Latino and 5% as another ethnicity. Seventy percent of the sample had completed high school, obtained a GED, or been in college; 30% of the sample never completed high school. Forty-three percent of the participants considered themselves homeless. Twenty-eight percent of the participants lived on the streets in the preceding month, April. The remainder (72%) of the IDUs had other living arrangements such as staying in temporary shelters, in a hotel, in a permanent situation, in a jail or prison, or with relatives and friends. HIV status was ascertained in all participants by HIV-antibody testing. Twelve individuals (7%) were HIV seropositive.

Prevalent Infections

Of the 176 participants screened for symptoms of an infection and asked to report whether they had an infection, 96 (54%) had a positive clinical history for an abscess or related infection (table 2). When the ten participants who did not complete the study were excluded, 51% of the final sample had a positive clinical history for current symptoms. Thirty-two percent (54/169) of the IDUs had a skin and soft tissue infection on physical exam. Forty-nine participants (29% of the sample) had abscesses and nineteen (11% of the sample) had cellulitis. Fourteen IDUs (8% of the sample) had both an abscess and cellulitis; only five participants had cellulitis alone. Eleven percent (19/169) of the sample had multiple abscesses, ranging from 2 to 20 abscesses (median=2).

The median duration of symptoms of prevalent abscesses was 14 days (range 1 to over 99 days) while the median duration of cellulitis was six days (range 2 to 21 days) at the time of data collection (table 3). Cellulitis surrounded an abscess in eight cases. The median diameter of prevalent abscesses was 3 cm. (range 0.5 to 25 cm.) while the median size of cellulitis was 6 cm. (range 1 to 15 cm.). Abscesses had already been lanced in 15 cases. Six participants had undergone an incision and drainage procedure from two days to one month prior to data collection. One abscess was lanced by a nonsterile syringe. How the other eight abscesses were lanced was not recorded.

Table 4 shows the characteristics of prevalent abscesses and cellulitis. Of all signs, tenderness could be elicited in the most participants with abscesses. No single sign was present in all cases of abscesses, but at least one of the following was present in each case: tenderness (59%), erythema (53%), heat (43%), drainage of pus (39%), fluctuance (24%), foul odor (6%), and crepitus (2%). Clinicians noted induration in 18% of the examined participants, although they were not specifically asked to record information about this sign. Erythema was present in all but one case of cellulitis, which had streaking red lines on the skin. Sixty-three percent of cellulitis infections were hot to touch and 32% were draining pus.

Table 5 shows the prevalence of skin and soft tissue infections that required medical treatment according to the diagnosing physician or nurse practitioner. Thirteen participants with abscesses (8% of the sample) were judged to require an incision and drainage procedure. Abscesses were already open in 20 cases. A total of 21% of the sample (36/169) required antibiotic treatment. Nineteen percent of the sample required antibiotic treatment for an abscess and 10% required antibiotic treatment for cellulitis (13 participants required antibiotic treatment for both abscesses and cellulitis). Two participants with cellulitis were not given antibiotics by the clinician on site but were instead referred to the nearby health center for treatment. Cephalexin (Keflex), a first generation cephalosporin, was the antibiotic most commonly prescribed on site.

According to the diagnosing clinicians, 20% (34/169) of the IDUs required a health center visit. Three participants required emergency treatment because they had systemic signs of severe infection (e.g. fever). The remainder of the sample with active skin and soft tissue infections were treated on site or had infections that the clinician thought would heal without further medical intervention. In many instances, infections were cleaned and instructions on how to care for the infection (e.g. elevation, dressing changes, and warm compresses) were provided.

Injection practices

Sixty-eight percent of active IDUs (115/168) reported that they had had at least one abscess ever (table 6). The median number of times IDUs reported having had an abscess was three (range 1 to 20 times). Thirty-one percent of the sample reported having had three of more abscesses ever. One participant reported having had 200 abscesses. This participant was considered an outlier and excluded from the analysis of self-reported abscess history. Of the participants who had had abscesses, 77% (89/115) had seen a doctor to have an abscess treated on at least one occasion. Fifty-five individuals (33% of the sample) reported at least one abscess (median=2) for which they had not sought treatment.

Twenty seven percent of the sample have lanced their own abscess, outside a medical setting at some time. Sixteen percent of the sample had treated their own abscess with antibiotics they acquired on the street, that were not prescribed to them for that purpose.

Twenty-eight percent of active IDUs had licked their needles before injecting in the 30 days prior to data collection. On the other hand, only three participants reported using spit to prepare their drugs in the same time period.

Over the six months prior to the data collection, 30% of the IDUs generally injected in the same location on their bodies while 45% changed locations by rotating limbs when

injecting. The remainder (26%) inched along a vein without rotating limbs. Fifteen percent of the sample usually used cigarette filters to filter their drugs before injecting in the previous six months. Skin popping or muscling was the most common method of injecting for 9% of the sample while injecting intravenously was the most common method employed by the remainder (91%). The participants who reported skin popping or muscling as their most common method of injection were the same participants who reported skin popping or muscling for more than 50% of their total injections in the 30 days prior to data collection.

Sixty-nine percent of the sample did not always clean their skin prior to injecting in the six months prior to interview. Thirty-five percent never washed their hands before injecting and 62% used at least one syringe that had already been used by themselves or another person in the 30 days prior to data collection. Twenty-seven percent (46/169) of the sample had used a syringe previously used by another person in the prior 30 days.

Sensitivity and specificity of the self-reported abscesses

Using the clinical history and physical exam as the "gold standard" for the diagnosis of an abscess or cellulitis, we determined the sensitivity of self-report data (table 7). Prior to the physical exam, participants were asked, "Do you have an abscess or other infection at or near a place where you inject?" If they answered yes, they were categorized as having a positive self-report of a skin and soft tissue infection. Six people reported that they did not know if they had an abscess or other local infection and were excluded from this analysis. Using this method, the sensitivity of self-report of a skin and soft tissue infection was 79% (33/42). The specificity was 87% (105/121). The positive predictive value was 67%, while the negative predictive value was 92%.

Prevalence of skin and soft tissue infections by demographic variables

Table 8 shows the demographic characteristics of the sample and the percent of participants diagnosed with a skin and soft tissue infection in each category, with odds ratios and 95% confidence intervals. None of the relationships between demographic variables and the presence of a skin or soft tissue infection by physical diagnosis were significant at the 0.05 level. Forty percent of women had a skin and soft tissue infection compared with 29% of men, but this difference was not statistically significant. Age and homelessness did not significantly alter the likelihood of having a skin and soft tissue infection. Participants who lived on the streets in the month prior to data collection did not have a significantly increased odds of having an abscess or cellulitis. Whites and African-Americans had identical odds of being diagnosed with an abscess and or cellulitis. Participants with a high school diploma or GED had approximately the same odds of having an infection as those who did not graduate from high school.

Drug-related characteristics and hygiene-related injection practices

Table 9 shows the prevalence of drug-related characteristics and the percent of participants described by each variable who were diagnosed with an abscess and/or cellulitis. The only significant relationship between a behavioral variable and having a skin and soft tissue infection was the practice of skin popping or muscling. IDUs who had skin popped or muscled once or more in the preceding 30 days had a 5-fold increase in the prevalence of abscesses and cellulitis compared with IDUs who only injected intravenously (OR 5.2, 95% CI 2.4, 11.5). IDUs who skin popped or muscled as their most frequent method of injection had a greater than 10-fold increase in skin and soft tissue infections (OR 10.7, 95% CI 3.1, 36.8) compared with IDUs who injected intravenously 50% of the time or more. Eighty percent of IDUs who had skin popped or muscled for more than 50% of injections in the last 30 days had a skin and soft tissue infection while 27% of IDUs who had injected intravenously for 50% or more of their injections had an abscess or cellulitis.

IDUs who had injected for 20 or more years were less likely to have a skin and soft tissue infection than IDUs who had injected for fewer years, but this relationship was not quite statistically significant in this sample. Only 32 participants had injected for less than 10 years; 44% of them had a skin and soft tissue infection (OR 1.0). Thirty-seven percent of the IDUs who had injected from 10 to 19 years had skin and soft tissue infections (OR 0.75, 95% CI 0.89, 1.9) and 26% of the IDUs who had injected for 20 or more years had an infection (OR 0.46, 95% CI 0.20, 1.0).

No other independent variables were significantly associated with skin and soft tissue infections, but values consistent with the possibility of small associations were noted. For example, 17% of IDUs who were HIV-positive by HIV-antibody testing had a skin and soft tissue infection, while 33% of the participants who tested HIV-negative had a skin and soft tissue infection. Among IDUs who had injected drugs in the last 30 days, 17% of IDUs who were in treatment programs for drug addiction had a skin and soft tissue infection (OR 1.0). Thirty-four percent of IDUs who had not been in drug treatment in the prior 30 days had a skin and soft tissue infection (OR 0.39, 95% CI 0.12, 1.3). Participants in drug treatment who had not injected in 30 days were excluded from analysis.

There were no significant associations between the type of drug injected in the 30 days prior to data collection (heroin, cocaine, methamphetamine, or a mix of cocaine or methamphetamine plus heroin in the form of a "speedball ") or alcohol consumption and the presence of a skin and soft tissue infection. The categories of drug injected were not mutually exclusive (i.e. some heroin injectors also injected cocaine at a different time). Drinking more than 35 drinks per week did not increase the odds of having an infection. Increasing frequency of injection over the preceding 30 days (<30 injections, 30-89 infections, ≥90 injections) increased the odds of having an infection but, again, the relationships were not significant. Whether an IDU injected in the same spot on the same

side of the body, inched along a vein on the same side of the body, or rotated sites and limbs did not significantly alter the likelihood of infection.

Hygiene-related behaviors were not significantly associated with the presence of a skin and soft tissue infection. Table 10 shows hygiene-related variables and the percent of participants described by each variable who were diagnosed with an abscess and/or cellulitis. IDUs who always cleaned their skin prior to injection in the preceding six months, those who always washed their hands with soap and water prior to injection in the past 30 days, and those who used *all* brand new, never used syringes in preceding 30 days had odds ratios that were consistent with a slightly decreased odds of having a skin and soft tissue infection, but the relationships were not statistically significant at the 0.05 level. IDUs who licked their needles prior to injecting in the preceding 30 days did not have a significantly increased odds of having a skin and soft tissue infection. Using a syringe exchange program in the preceding 30 days did not alter the odds of having an infection.

IDUs were asked about the three most common locations they injected on their bodies in the prior 30 days (table 11). Ten percent of the sample had used the neck as one of the three most common places they injected. The same percentage used their groin or buttocks. Twenty-one percent used their thigh or leg. The site of injection was not significantly associated with the presence of an infection, but 44% of IDUs who injected into their leg or thigh had a skin or soft tissue infection while 28% who did not use their leg or thigh had an infection (OR 2.1, 95% CI 0.97, 4.4).

Evaluation of confounding and effect modification

The correlates of skin popping or muscling were examined using odds ratios and 95% confidence intervals. IDUs who had skin popped or muscled at least once in the prior 30 days (n=34) had a significantly increased odds of reporting a history of three or more abscesses (OR 6.8, 95% CI 3.0, 15). This variable may have included report of a current abscess. Female sex was associated with a significantly increased odds of skin popping

(OR 2.5, 95% CI 1.1, 5.4). Heroin injectors were also more likely to skin pop (OR 7.4, 95% CI 1.22, ∞). IDUs who skin popped or muscled were more likely to have injected into the groin or buttocks (OR 7.4, 95% CI 2.5, 22), injected into the leg or thigh (OR 3.0, 95% CI 1.3, 6.9), and injected 90 or more times (OR 2.2, 95% CI 1.0, 4.7) in the 30 days prior to data collection. IDUs who skin popped or muscled were more likely to want treatment for drug addiction if it was available (OR 2.4, 95% CI 1.0, 5.4). Skin poppers were more likely to rotate limbs than to inject into the same spot (OR 2.6, 95% CI 1.1, 6.3). IDUs who licked their syringes prior to injecting were less likely to skin pop (OR 0.37, 95% CI 0.14, 1.0). This study was not designed to examine the correlates of skin popping and other variables and, therefore, they are not included in tabular form.

Because only one variable, skin popping or muscling was significantly associated with the outcome variable, multivariate analysis was used only to rule out confounding of other relationships with the outcome variable by skin popping/muscling. Independent variables that we hypothesized could be associated with skin popping were entered (frequency of injection, years of injection, and types of drugs injected). Independent variables that were convincingly associated with abscesses in the literature (HIV status, sex, skin cleaning, drug treatment) and one variable that we hypothesized to be related with abscesses from a biological standpoint (re-using already used syringes) were entered. None of these variables had a correlation coefficient with the dependent variable or with other independent variables greater than 0.25. The adjusted odds ratio of the skin popping variable did not change by more than 0.05 with the addition of years of injection in forwards stepwise logistic regression. The adjusted odds ratio between skin popping and the outcome variable did not change by more than ±0.36 in backwards stepwise logistic regression. None of the other variables showed a significant independent relationship with the outcome except for injecting for more than 20 years. When skin popping and years of injecting were entered into a logistic regression model, the adjusted odds ratio for skin

popping once or more in the prior 30 days was 5.4 (95% CI 2.4, 12) compared with not skin popping (OR 1.0) and the adjusted odds ratio for injecting for 20 or more years was 0.48 (95% CI 0.24, 0.98) compared with IDUs who injected less than 20 years (OR 1.0). The multivariate model ultimately did not contribute to the analysis and is therefore not included in tabular form.

Stratified analysis was limited by small numbers of observations and wide 95% confidence intervals but showed that the relationship between key variables and the presence of an abscess may be different for IDUs who skin pop than IDUs who do not skin pop. In addition, stratifying a behavioral variable by another simultaneous behavioral variable is problematic because behaviors may be grouped as a result of a third unmeasured factor. When the group that had not skin popped in the prior 30 days was examined separately, no relationships between key variables and the outcome variable were statistically significant, but the point estimate suggested that never cleaning the skin may be a greater risk for skin and soft tissue infection among IDUs who inject exclusively by intravenous routes (OR 1.4, 95% CI 0.54, 3.8) than among IDUs who skin pop or muscle (OR 0.07, 95% CI 0.01, 0.36). The crude odds ratio was 0.85 (95% CI 0.39, 1.9). Rotating sites appeared protective in intravenous injectors (OR 0.55, 95% CI 0.23, 1.3) compared with skin poppers (OR 1.1, 95% 0.25, 4.8) but the confidence intervals were wide and included 1.0.

Seven participants (4% of the sample) reported that they have been diagnosed with diabetes mellitus (NIDDM or IDDM), of whom four (57%) had an abscess and/or cellulitis at the time of data collection. This relationship was not statistically significant (OR 3.0, 95% CI 0.72, 12).

Seven participants were taking medications that could weaken the immune system (i.e. corticosteroids for asthma). Of the participants taking immunocompromising medications, two (29%) had skin and soft tissue infections. The relationship between

taking medications that could weaken the immune system and the presence of a skin and soft tissue infection was not statistically significant (OR 0.84, 95% CI 0, 3.9).

Risk factors using self-report data as the dependent variable

Bivariate analysis was repeated using a self-report of an abscess or other local infection as the dependent variable. This analysis showed that the association between skin popping or muscling once or more and report of an abscess was strong (OR 4.3 95% CI 1.9, 9.7) as was the relationship between skin popping most and report of an abscess (OR 5.5 95% CI 1.8, 17). However, a number of independent variables were associated with self-report of an abscess that were not associated with the diagnosis of an abscess or cellulitis, including injecting 90 or more times (OR 3.6, 95% CI 1.6, 8.3) compared with injecting less than 30 times (OR 1.0), and re-using used syringes (OR 2.0, 95% CI 0.93, 4.3) in the prior 30 days. The absence of health benefits was associated with a significantly increased odds of reporting an abscess (OR 2.2, 95% CI 1.1, 4.7), a finding which was not true of diagnosed skin and soft tissue infection. Wanting treatment for drug addiction if it was available was also associated with an increased odds of reporting an abscess (OR 2.4, 95% CI 1.1, 5.1), but was not associated with the diagnosis of an abscess.

Table 1: Demographic characteristics of street-recruited IDUs who injected drugs within the prior 30 days, Tenderloin, San Francisco, May 1997 (N=169).

Characteristic (# missing data)	**No. of Study Participants**	**%**
Biological Sex		
Male	126	75
Female	43	25
Age		
18-39	51	30
40-49	91	54
50+	27	16
Race		
White	88	52
African-American	61	36
Latino	11	7
Other	9	5
Education (12)		
Less than High School	47	30
GED, High School diploma or greater	110	70
Housing Status(1)		
Not homeless	96	57
Consider Self Homeless	72	43
Living situation in April(4)		
Did not live on street	118	72
Lived on street	47	28
HIV Status		
Antibody negative	157	93
Antibody positive	12	7

Table 2: Prevalence of abscesses and cellulitis among participants who injected drugs within the prior 30 days, Tenderloin, San Francisco, May 1997 (N=169).

Characteristic	Number	Percent
Positive clinical history for current symptoms of abscess or related infection	86	51
Abscess and/or cellulitis on physical exam	54	32
Abscess on physical exam	49	29
Multiple abscesses on physical exam	19	11
Cellulitis on physical exam	19	11

Table 3: Features of prevalent skin and soft tissue infections found on physical exam, Tenderloin, May 1997 (N=169).

Median duration of symptoms of abscess *	14 days (range 2-99+)
Median duration of symptoms of cellulitis	6 days (range 2-21)
Median size of abscess *	3 cm (range 0.5-10)
Median size of cellulitis	6 cm (range 1-15)

* If multiple abscesses were present, the size and duration of the largest abscess were recorded by the diagnosing clinician.

Table 4: Signs of current abscesses and cellulitis, Tenderloin, May 1997 (n=49).

Sign	Number	Percent
Abscess Cases	**49**	
Tender to touch	29	59
Erythema	26	53
Heat	21	43
Open lesion	20	41
Draining pus	19	39
Fluctuance	12	24
Foul odor	3	6
Crepitus	1	2
Abscess been lanced	15	31
Cellulitis Cases	**19**	
Erythema	18	95
Heat	12	63
Draining	6	32
Streaking Lines	2	11

Table 5: Prevalence of skin and soft tissue infections that required medical treatment among IDUs in the Tenderloin, May, 1997 (N=169).

Characteristic	Number	Percent
Required * incision and drainage of prevalent abscess	13	8
Required antibiotics treatment for abscess	32	19
Required antibiotics for treatment cellulitis	17**	10
Provided with health center appointment	34	20
Required emergency treatment	3	1.8

* By physician/nurse practitioner judgment

** Two cases of cellulitis were not given antibiotic treatment on site but were given an appointment for treatment at the health center that day.

Table 6: Prevalence of prior abscesses, self-treatment, and injection practices among study participants, Tenderloin, San Francisco, May, 1997 (N=169).

Reported Injection Practice (# missing data)	**No. of Study Participants**	**Percent**
Self-treatment of abscesses		
Ever had an abscess (1)	115	68
Ever seen a doctor for an abscess (1)	89	53
Ever lanced own abscess	45	27
Ever self-treated with antibiotics acquired on the street (2)	26	16
Oral Contamination (in the prior 30 days)		
Licked needles before injecting (2)	46	28
Used spit to prepare drugs (2)	3	2
Injecting method		
Generally injected in the same spot/6 mos. (3)	49	30
Usually used cigarette filters to filter drugs/30 d. (5)	24	15
Muscling/skin popping as most common method of injecting/30 d. (1)	15	9
Hygiene (in prior 30 days)		
Did not always clean skin prior to injecting	116	69
Never washed hands before injecting (4)	59	35
Used a used syringe (4)	102	62

Table 7: Sensitivity and specificity of self-report of "an abscess or other infection near where you inject" compared with diagnosis of an abscess or cellulitis by the clinical history and physical exam process (N=169).

	Skin and soft tissue infection (SSTI) by clinical history and physical exam		
	Diagnosed with		
Self-report	SSTI	No SSTI	Total
Reported abscess	33	16	49
No report of abscess	9	105	114
Total	42	121	163*

* Six people reported that they did not know.

Sensitivity: 33/42 = 79%

Specificity: 105/121 = 87%

Positive predictive value: 33/49 = 67%

Negative predictive value: 105/114= 92%

Table 8: Prevalence of abscess and/or cellulitis on physical examination with odds ratios (OR) and 95% confidence intervals (CI), by demographic characteristics, Tenderloin, May 1997 (N=169)

Characteristic (# Missing data)	**No. IDUs**	**% with abscess/ cellulitis**	**OR**	**(95% CI)**
Biological sex				
Male	129	29	1.00	
Female	43	40	1.63	(0.74, 3.55)
Age				
18-39	51	39	1.00	
40-49	91	30	0.65	(0.32, 1.33)
50+	27	26	0.54	(0.20, 1.49)
Race				
White	88	33	1.00	
African-American	61	33	0.99	(0.50, 1.98)
Latino and other	20	25	0.68	(0.24, 1.92)
Education (12)				
Less than high school	47	32	1.00	
GED, high school graduate or greater	110	34	1.08	(0.52, 2.22)
Housing status (1)				
Not homeless	96	29	1.00	
Consider self homeless	72	36	1.37	(0.72, 2.62)
Living situation in April(4)				
Did not live on street	118	30	1.00	
Lived on street	47	38	1.47	(0.73, 2.97)

Table 9: Prevalence of abscess and/or cellulitis on physical examination with odds ratios and 95% confidence intervals, by drug-related characteristics, Tenderloin, May 1997 (N=169).

Variable (# missing data)	**No. of IDUs**	**% with abscess/ cellulitis**	**OR**	**(95% CI)**
HIV antibody status				
Antibody neg.	157	33	1.00	
Antibody pos.	12	17	0.40	(0, 1.71)
Years since started injecting				
0-9	32	44	1.00	
10-19	38	37	0.75	(0.29, 1.94)
20+	99	26	0.46	(0.20, 1.04)
Heroin injection/30 d				
No heroin	25	28	1.00	
Injected heroin	144	33	1.25	(0.50, 3.10)
Speed injection/30 d				
No speed	115	31	1.00	
Injected speed	54	32	1.10	(0.55, 2.18)
Cocaine injection/30 d				
No cocaine	141	30	1.00	
Injected Cocaine	27	37	1.34	(0.58, 3.12)
Speedball injection/30 d				
No speedballs	120	33	1.00	
Injected Speedballs	49	31	0.92	(0.45, 1.87)

Alcohol consumption				
<35 drinks/wk	152	32	1.00	
35+ drinks/wk	17	35	1.18	(0.43, 3.28)
Drug treatment/30 d				
Not in treatment	151	34	1.00	
In drug treatment	18	17	0.39	(0.12, 1.33)
Frequency of Injection/30 d.				
<30	51	26	1.00	
30-89	59	32	1.39	(0.61, 3.16)
90+	59	37	1.73	(0.77, 3.91)
Route of injection/30 d (4)				
Intravenous only	131	24	1.00	
Skin pop/ muscle 1 or more times	34	62	5.21	(2.36, 11.5)
Primary route of injection (>50% of injections)/30 d				
Intravenous most	154	27	1.00	
Skin pop/ muscle most	15	80	10.7	(3.05, 36.8)
Pattern of injection/6 mo. (3)				
Same spot	49	35	1.00	
Inching along vein	43	28	0.73	(0.30, 1.75)
Rotating Limbs	74	32	0.90	(0.43, 1.93)

Table 10: Prevalence of abscess and/or cellulitis on physical examination with odds ratios and 95% confidence intervals, by hygiene-related injection practices, Tenderloin, May 1997 (N=169).

Variable (# missing data)	**No. of IDUs**	**% with abscess/ cellulitis**	**OR**	**(95% CI)**
Oral contamination/30 d (2)				
Did not lick needle	121	30	1.00	
Licked needle before injecting	46	37	1.38	(0.68, 2.81)
Skin cleaning/6 mos.				
Not always	116	35	1.00	
Always cleans before injecting	53	24	0.59	(0.29,1.23)
Washed hands before injecting/30 d (4)				
Never	59	32	1.00	
Sometimes	78	33	1.05	(0.51, 2.15)
Always	28	29	0.84	(0.32, 2.22)
Used a used syringe/30 d (4)				
All brand new syringes	63	27	1.00	
Used syringe use	102	36	1.54	(0.78, 3.04)
Sharing syringes/30 d				
Did not share	123	30	1.00	
Shared syringes	46	37	1.36	(0.67, 2.76)
SEP use/30 d				
Did not use SEP	34	32	1.00	
Used SEP	135	32	0.98	(0.44, 2.16)

Table 11: Prevalence of abscess and/or cellulitis on physical examination with odds ratios and 95% confidence intervals, by locations used as one of three most common sites of injection, in the last 30 days, Tenderloin, May 1997 (N=169).

Injection site (# missing data)	**No. of IDUs**	**% with abscess/ cellulitis**	**OR**	**(95% CI)**
Groin/Buttocks (1)				
No	152	30	1.00	
Yes	16	44	1.79	(0.65, 4.94)
Neck (1)				
No	152	31	1.00	
Yes	16	38	1.34	(0.48, 3.78)
Arm/shoulder (1)				
No	29	31	1.00	
Yes	139	32	1.03	(0.44, 2.40)
Thigh/Leg (1)				
No	132	28	1.00	
Yes	36	44	2.05	(0.97, 4.36)
Foot/Ankle (1)				
Yes	53	9	1.00	
No	115	6	1.61	(0.51, 5.06)

Table 12: Prevalence of self-reported current abscess or with odds ratios and 95% confidence intervals, by participant characteristics and drug-related practices, Tenderloin, May 1997 (N=169).

Variable (# missing data)	**No. of IDUs** *	**% with self-reported abscess**	**OR**	**(95% CI)**
Frequency of Injection/30 d				
1-59	70	11	1.00	
60-89	36	8	1.53	(0.57, 4.14)
90+	57	23	3.63	(1.59, 8.25)
Route of injection/30 d (4)				
Intravenous only	127	19	1.00	
Skin pop/muscle ≥1 time	32	50	4.29	(1.90, 9.69)
Primary route of injection/30 d				
Intravenous	150	23	1.00	
Skin pop/muscle	13	62	5.46	(1.75, 16.9)
Used a used syringe/30d (4)				
All brand new syringes	61	18	1.00	
Used syringe use	98	31	2.01	(0.93, 4.33)
Health benefits				
Has benefits	69	17	1.00	
Does not have benefits	94	32	2.23	(1.05, 4.70)
Wants drug treatment if available (13)				
Does not want treatment	71	18	1.00	
Wants treatment	69	35	2.38	(1.25, 5.75)

* 6 people did not know whether they had an abscess and are therefore not included in this analysis.

Chapter V

Discussion

Summary and implications of the results

Abscesses and cellulitis are extremely common among IDUs in the Tenderloin. These data indicate that nearly a third (32%) of active IDUs have abscesses, cellulitis or both using standard medical criteria for identification of skin and soft tissue infections: the clinical history and physical exam. This is the first study to use the clinical process to identify cases in the community. Using a methodology which allowed self-reporting of only one abscess per six month period per participant, a previous study from Amsterdam estimated an incidence of 33 per 100 IDU person-years.[62] The incidence found by Amsterdam is likely to be artificially low because of their reporting method. Our study from San Francisco showed a point prevalence of abscesses of 29%, and a median duration at the time of data collection of 14 days, which suggests that the incidence in San Francisco may be higher than the incidence calculated in Amsterdam.

The high prevalence of multiple abscesses and abscesses with cellulitis suggests that practitioners who treat IDUs should search for more than a single locus of infection when treating skin and soft tissue infections among IDUs. A high percentage of participants were judged to require a health center visit (20%) and/or antibiotic treatment (21%) for their infections, suggesting that delayed and inadequate care is not uncommon in this population. Three participants required emergency treatment, indicating that potentially grave and untreated systemic infections are not unusual among non-hospitalized IDUs.

A large proportion of IDUs have attempted medical and surgical self-treatment of their abscesses. Sixteen percent of IDUs have bought antibiotics on the street in an effort to treat their abscesses. This finding raises concerns regarding the potential for the evolution of antibiotic resistant strains of organisms among IDUs. The development of antibiotic resistant *Staphylococcus aureus* is a worldwide concern, and this organism is

frequently isolated from abscesses. Self-treatment with inadequate or inappropriate antibiotics could encourage the development of resistant strains among IDUs.

Twenty-seven percent of IDUs had lanced their own abscesses in an effort at self-treatment. Abscesses should be lanced using sterile equipment in a clean environment. Using dirty equipment to perform a surgical procedure raises concern not only about introducing secondary pathogens into the wound but also about the spread of infectious agents such as Hepatitis B and C viruses via non-sterile equipment used for lancing abscesses. These results suggest that some IDUs do not access the health care system for skin and soft tissue infections even when they suspect that they need antibiotic treatment or an incision and drainage procedure and raise questions about why IDUs are not seeking treatment in medical facilities for such infections. IDUs may resist seeking treatment because they know they will be a low priority at the emergency room, may not be given adequate (or any) pain relief for surgical procedures, and may be treated with disdain by the medical staff. Examining the reasons why IDUs delay seeking care may help guide the development of early treatment interventions.

A major risk factor for skin and soft tissue infection was identified: the practice of injecting subcutaneously or intramuscularly as opposed to injecting intravenously. IDUs who skin popped or muscled at least once in the preceding 30 days were five times more likely to have an abscess or cellulitis than IDUs who injected only into veins. IDUs who skin popped or muscled more than they injected intravenously were over ten times more likely to have a skin and soft tissue infection. This result is consistent with a recent case-control study examining the risk factors for wound botulism in injection drug users in California. Passaro and colleagues identified injecting subcutaneously or intramuscularly as the major risk factor for the development of paralysis associated with *Clostridium botulinum* toxin.[49] In addition, a review of case reports of IDUs with tetanus in California indicated that a large proportion of patients with tetanus reported skin popping.[63]

The reasons why IDUs use subcutaneous and intramuscular routes of injecting are not clear. IDUs may turn to skin popping when the veins they know how to use become scarred or damaged, if they lack knowledge about where to find veins, or if environmental or lifestyle circumstances make it difficult to take the time to inject intravenously. Other hypotheses that might explain why IDUs use subcutaneous and intramuscular routes include obesity and emotional factors.

The preceding conclusions rest on the assumption that skin popping and muscling are the behaviors that lead to skin and soft tissue infections, based on a biological hypothesis that drugs and their contaminants cause local reactions that hinder an adequate tissue immune response and produce a milieu that is hospitable to multiplying pathogenic organisms. It is important to note, however, that this study was cross-sectional and cannot conclusively determine the direction of causation. It is possible that IDUs skin pop or muscle when they develop skin and soft tissue infections because they can no longer inject into their regularly used veins. It is more plausible, however, that injecting directly into the subcutaneous and muscular tissues has a mechanical mass effect that destroys the integrity of the tissue and that drugs and their contaminants have vasoconstrictive effects that slow the immune response. In addition, the time it takes for an appropriate immune response in the tissues may be longer than in the bloodstream.

The role of hygiene in the development of skin and soft tissue infections

Associations between hygienic factors and skin and soft tissue infection were expected but not observed in this study. Skin cleaning, hand washing, and use of brand new, never used syringes were expected to protect from abscesses and cellulitis. These methods are employed in health care settings in an effort to prevent infection. The Centers for Disease Control and Prevention recommends the use of alcohol wipes among IDUs prior to injection, at the site of injection to prevent transmission of blood-borne viruses such as HIV and hepatitis B and C. [69] SEPs in the San Francisco Bay Area provide

alcohol prep pad saturated with 70% isopropyl alcohol to IDUs in an effort to prevent a variety of infections. Using such hygienic measures would be expected to reduce skin and soft tissue infection among IDUs as well. A previous study examining a sample of predominantly African-American IDUs in Baltimore found that the rate of abscesses by self-report was significantly lower in IDUs who reported skin cleaning all the time than in IDUs who cleaned their skin sometimes or never.[60]

Despite the fact that in this study hygienic factors were not significantly associated with skin and soft tissue infections, the data do not rule out the possibility that skin cleaning, using brand new never used syringes, and avoiding shared syringes are mildly protective for skin and soft tissue infections. A larger sample size may have shown that cleaning the skin prior to injection resulted in a significant decrease in infection, but the effect may be small compared to the effect of skin popping and muscling. It is not clear that such a small effect, even if detected in a larger sample, would have a significant effect from a prevention standpoint.

Nearly 70% of the IDUs did not always clean their skin prior to injecting despite the availability of alcohol wipes at syringe exchange sites in the Tenderloin. This finding may in part be because the numbers of alcohol wipes distributed are inadequate for the number of injections by each IDU per week. The lack of a significant association between skin cleaning and skin and soft tissue infections suggests that the skin cleaning product most used, alcohol prep pads, may not be particularly effective at preventing skin and soft tissue infection.

Alcohol wipes in the setting of inadequate housing and poor access to showers and baths may not be sufficient to clean injection sites effectively. IDUs may not be using the wipes in the most effective manner. Swiping the injection site once may not be as effective as rubbing the site in a circular outward motion to dislodge dirt and bacteria. Providing education about how and when it is most important to clean skin (i.e. before rather than

after injecting), distributing more wipes, and piloting new products may have added impact.

Alcohol can be an effective skin disinfectant when 70% ethyl alcohol or alcohol and green soap are used with appropriate technique, but alcohol does not have sustained residual activity like other antiseptics. Alcohol is best used in conjunction with other antiseptic agents, such prior to a 10-second skin preparation with a povidone-iodine (Betadine) swab.[70] Cleaning the injection site with water and soap, particularly soap with antibacterial properties, may prove more effective than using alcohol wipes alone. Other antiseptic products and techniques should be tested to determine if they can more effectively prevent infections in this population. Future studies on the role of skin cleaning in IDUs must describe the formulation of alcohol wipes that are used for antisepsis.

Chlorhexidine (Hibiclens), used with water as a scrub, kills a broad range of resident and transient organisms, is commonly used in hospitals, and is currently the preferred agent for antisepsis.[70] If this product could be formulated at a low cost, it could be an option for skin cleaning among IDUs. IDUs may not have access to water at all times of the day. However, the sustained residual activity of chlorhexidine[70] might allow it to be an effective antiseptic if is used in conjunction with alcohol wipes immediately prior to each injection, even if the chlorhexidine not used before every injection. SEPs could consider distributing antibacterial soap, chlorhexidine, and povidone-iodine swabs as adjuncts to alcohol wipes.

Spijkerman and colleagues found that participating in a syringe exchange program (SEP) was a risk factor for abscesses.[62] In the Tenderloin, participating in a SEP was neither protective nor a risk factor for skin and soft tissue infection. SEP use is important to avoid infections that are transmissible from one IDU to another (e.g. HIV, and Hepatitis B and C viruses) but may be less important for infections that are caused by normal commensals of the skin and mouth. On the other hand, participating in an SEP should not increase the likelihood of skin and soft tissue infection unless the alternative is a more

effective way to access sterile injecting equipment, such as buying syringes in larger quantities and of better quality from pharmacies.

Licking needles and using spit to dissolve or prepare drugs have been identified as potential sources of oral bacteria commonly isolated from skin and soft tissue infections in IDUs. We found that licking needles before injecting is a common practice among IDUs in this population. While not significantly associated with skin and soft tissue infections in this study, the practice may be one of the major sources of organisms isolated from those abscesses containing bacteria that normally inhabit the oropharynx. A study which includes microbiological data could potentially find an association between the practice and the subset of IDUs with abscesses that contain normal commensals of the oropharynx. Using spit in the preparation of drugs, on the other hand, was uncommon and is not a likely source of oral bacteria isolated from abscesses. Another unexplored practice that could explain the presence of oral bacteria in abscesses is the use of saliva to clean the skin.

The role of demographic and drug-related characteristics on abscesses and cellulitis

Long term injection drug use was associated with a slight but insignificant reduction in skin and soft tissue infections in bivariate analysis. This finding may be the result of survival bias or of the experience that comes with long term injection drug use. IDUs who have had many skin and soft tissue infections may have gotten severely ill and died from bacteremia or endocarditis secondary to a severe infection or they may have stopped injecting. Long term injectors may have developed their own ways of preventing abscesses. Both possibilities could have contributed to the difference observed in the percentages of skin and soft tissue infections in each category. Skin popping and muscling was expected to be correlated with long term injection drug use because IDUs with scarred veins would be expected to turn to alternate routes of administration, but this correlation was not found. The practice of skin popping and muscling was also expected to be

correlated with short term injection because of lack of knowledge, but few IDUs in this study were short-term injectors and the correlation was not detected.

HIV-positive antibody status was expected to increase the odds of having a skin and soft tissue infection because of weakened immunity against bacterial pathogens associated with HIV, as found in Amsterdam.[62] Survival bias may have precluded this finding. HIV positive individuals with skin and soft tissue infections may have sought care earlier or had more destructive infections or been too sick to come to the study site, excluding them from the study sample. The low numbers of HIV-positive IDUs in our sample may also have precluded the possibility of finding a true association.

Homelessness was expected to increase the risk of skin and soft tissue infections because of environmental factors. Living on the streets would be expected to increase exposure to dirt and make hygiene, hand-washing and showering difficult. However, even IDUs with a permanent living situation may live in substandard conditions that expose them to many of the same hazards as homeless IDUs. A slightly higher percentage of IDUs who were homeless and lived on the streets had skin and soft tissue infections, but the results were not significant in this study sample.

High alcohol consumption could have an influence on skin and soft tissue infections for three reasons: the negative impact of alcohol on health protective behaviors, a controversial but possible independent impact of alcohol on the immune system, and the possibility that IDUs who drink more than 35 drinks per week are members of a subset of IDUs who are less discriminating about what substances they are willing to inject.[71] However, high alcohol consumption had virtually no effect on skin and soft tissue infections. Alcohol consumption may not have an additional effect on the immune system or on health protective behaviors when IDUs are already injecting potent substances that could also have a negative impact of the immune system and on health protective behaviors. Furthermore, none of the hypotheses regarding why alcohol would have an impact on skin and soft tissue infections involves direct and independent biological causation.

Cocaine and methamphetamine use were expected to increase the odds of a skin or soft tissue infection because of their biochemical activity at the site of injection. As described in the literature review, the vasoconstrictive properties of cocaine would be expected to increase its potential for facilitating the development of skin and soft tissue infections, particularly in IDUs who skin pop and muscle. Without controlling for contaminants, however, no difference would be expected because street heroin can contain multiple contaminants with biological properties that mimic the local action of cocaine (e.g. lidocaine). Cocaine and methamphetamine users did not have an increased odds of skin and soft tissue infection compared with heroin users.

This study could not conclusively assess the effect of treatment for drug addiction on abscesses because it was a study of active IDUs. Ten participants who had not injected in the prior 30 days were excluded from analysis. The IDUs who were excluded from analysis were significantly more likely to be in drug treatment than those who were included. IDUs who were excluded presumably stopped injecting because of drug treatment. Among IDUs who had injected in the prior thirty days, being in drug treatment did not decrease the prevalence of abscesses and cellulitis. Improved access to drug treatment should lower the frequency of injection if not reduce it to zero. The data from this study did not conclusively show that a lower frequency of injection decreased the prevalence of skin and soft tissue infection. Thus, drug treatment may be an indirect way of decreasing the incidence of skin and soft tissue infections for those IDUs who stop injecting altogether, but it should be considered within a comprehensive plan which also includes IDUs who are not interested in drug treatment (approximately half of this sample) and those who will not stop injecting completely while in drug treatment.

The practice of rotating limbs was expected to be associated with a lower prevalence of skin and soft tissue infections in comparison with injecting repeatedly into the same spot, but this practice did not alter the odds of having an infection. Likewise, the location of injection did not alter the odds of a skin and soft tissue infection. However, due to the

complications associated with an abscess near the femoral artery and nerve[33] or in the neck.[72 73] IDUs would be well-advised to avoid injecting into the groin, neck and head. The commonness of these practices is alarming.

The risks associated with using cigarette filters to filter drugs is unknown. Whether injecting particles found in cigarette filters damages veins, tissues and heart valves is unclear. Despite anecdotal reports that this practice is no longer common because of educational efforts and SEP distribution of 100% cotton balls, this practice continues in a quarter of the IDUs in this sample.

Methodological issues

This study examined skin and soft tissue infections in a community sample. The sample in this study had a slightly higher proportion of IDUs who inject methamphetamine and had a moderately lower prevalence of HIV than samples from other neighborhoods in the San Francisco Bay Area, based on UHS open cohort results (unpublished results). Whether these differences represent the leading edge of a trend of increasing methamphetamine use and decreasing HIV rates in San Francisco is unknown. However, the male to female, black to white and homeless to not homeless ratios suggest that the results of this study can be generalized to a wide population of IDUs.

Targeted sampling involves the risk of certain biases. This study may not represent the full range of IDUs because those of high socioeconomic status and those who have jobs during the standard workday may not have participated because of fear of recognition and time constraints, respectively. The sampling technique may have been biased towards long-term IDUs who are indigent and willing to identify themselves to study staff as IDUs. The population targeted by this sampling technique may be at high risk for adverse health outcomes related to their long term drug injection habits and poor living conditions. However, the population of active IDUs who could not be accessed by this sampling technique is unknown and difficult to identify given the clandestine nature of drug use.

Targeted sampling may represent the best method currently available to examine practices and health outcomes among IDUs. The advantages of using a community sample rather than a sample derived from a drug treatment clinic or public service agency outweighed the disadvantages of the targeted sampling technique for the purpose of estimating the prevalence of skin and soft tissue infections and the prevalence of injection-related behaviors in the community of active IDUs.

This study was a cross-sectional study which measured prevalent rather than incident skin and soft tissue infections. The use of incident cases might have increased the validity of this study because it could have avoided the risk of survival bias. Tracking incidence, however, would involve following a group of IDUs with a clinical history and physical exam every few days, as cellulitis and some abscesses can be short-lived. This process would be extremely unwieldy. Alternatively, the use of incident cases based on self-report involves assuming self-diagnosis is a valid proxy for physical diagnosis by an experienced health professional, an assumption that has not been validated by this study. The sensitivity of self-report in this sample was 79% and the specificity was 87%. Thus, 21% of prevalent cases could not be correctly identified using self-report of infection alone.

Vlahov and co-workers examined a subset of their sample from Baltimore and found that the percent agreement between self-report of a history of abscess in the last six months and physical exam for signs of "recent" abscess was 89%.[60] They did not report the sensitivity or specificity of their self-report measure. The measures involved in this study were different than those of Vlahov and co-workers because outcome measures examined were self-reported and diagnosed current skin and soft tissue infections, not past infections.

Using self-report of abscess or other local infection as the outcome variable altered the results of bivariate analysis. While skin popping was also significantly related to self-report of an abscess, other relationships appeared statistically significant that were not significant in analysis using physical diagnosis. Increasing frequency of injection and re-

using used syringes significantly increased the odds of self-report of abscess. IDUs who self-reported current abscesses were more likely to be without health benefits and to say they wanted treatment for drug addiction if it were available. These variables do not correspond to the significant variables from Spijkerman *et al.*[62] and Vlahov *et al.* [60] and did not correspond to associations using diagnosed abscesses and cellulitis as the dependent variable. Thus, using self-report as the outcome variable did not support the findings of other studies and would have led to different conclusions regarding prevention.

A few atypical cases who would have had a skin and soft tissue infection on physical exam may have been misclassified as "no infection" based on their negative history (see figure 1 in Methods). Doing a physical exam on symptom-free participants who looked healthy and reported no infection was considered inefficient and would have made the study considerably more expensive. The risk of misclassification bias was reduced with a sensitive clinical history that required a physical exam for participants with one or more symptoms of infection.

A diagnosis of an abscess or cellulitis was based on physician and nurse practitioner clinical judgment. Healed infections, phlebitis, and scarring were excluded from the diagnosis. Using clinical judgment involved the risk of a lack of precision in the diagnosis because abscesses and cellulitis do not have strictly standardized diagnostic definitions. Clinical judgment, however, better represents actual clinical practice than a standard definition would have. Prior to conducting this study, informal interviews with infectious disease experts, a pathologist, a surgeon and other physicians revealed that there is no consensus regarding standardized diagnostic definitions of abscesses and cellulitis. Standardizing the definitions of abscesses and cellulitis with size constraints or by requiring the presence of specific characteristics would have been arbitrary and inconsistent with general clinical practice and the literature. However, the lack of precise measurement of the outcome variable could lead to an erosion of true associations[74] and may have biased the

results towards the null. For this reason, results that were not statistically significant but were nevertheless consistent with an expected association were reported in the results.

The risk of imprecision in diagnosis was addressed in several ways. The clinicians used in this study serve IDUs on a regular basis and frequently encounter and treat skin and soft tissue infections. They were considered experts based on their experience and training. The clinicians did not have access to the questionnaire responses regarding injection behaviors in order to prevent them from diagnosing cases based on exposures they felt were relevant.

Recall bias in classifying exposures was not a concern in this methodology because this was not a case-control study. The diagnosis was made following the interview, in which were largely integrated into an extensive questionnaire with many questions about behaviors and drug use unrelated to the exposures of interest for this study.

Small effects or associations involving rare exposures may not have been detected in a statistically significant manner because of the small sample size (N=169). Prior to this study, the prevalence of abscesses among IDUs and the frequencies of relevant injection behaviors were largely unknown. With the results of this study, the prevalence of a variety of injection-related behaviors and of skin and soft tissue infections among IDUs can be estimated with greater precision. Adequate power to examine small effects could be obtained with larger sample sizes.

Presumably, the induction period between inoculation of bacteria and the development of an abscess or cellulitis is short. Participants were mostly asked to recall behaviors in the preceding 30 days to examine risk factors for skin and soft tissue infection. Thirty-day recall was considered more accurate than six-month recall, particularly regarding frequency of injection-related behaviors (i.e. skin cleaning, number of injections, sites of injection). However, six IDUs reported that an abscess or cellulitis had been present for 30 or more days. In those cases, events in the preceding six months would be more likely to have influenced the development of their infections.

An experimental study, such as a randomized control trial, would perhaps be the ideal way to determine the relationship between exposures and skin and soft tissue infections. However, experimental studies mandating certain behaviors are difficult to carry out and experimental studies with this population have challenging ethical and logistical implications. For instance, assigning IDUs to a group that does not clean their skin prior to injection while another group cleans their skin is unethical and impractical if we or the enrollees are convinced that skin cleaning is important to preserving health. Providing education to one group of IDUs about standard hygienic practices, such as those employed by health care professionals when giving injections to patients, while denying that information to another group may be unethical because the exposure alternatives are not "equally acceptable under present knowledge."[75] Moreover, information learned in educational interventions is likely to be transmitted between the two groups through social networks. Thus, an experimental study would require careful consideration of the practical and ethical issues involved in randomizing IDUs to behaviors or education.

Further research

Further research is needed to answer the question of why IDUs skin pop and whether it is safe and feasible to encourage IDUs to choose injecting intravenously over skin popping. Vein care education has been proposed by some activists to help IDUs from damaging their veins to the point where they start to inject in risky places such as their neck and groin or start skin popping and muscling. Would teaching IDUs how to inject intravenously and to find safer veins into which to inject prevent IDUs from skin popping and muscling? Furthermore, is it safe for IDUs who normally skin pop to inject the same doses intravenously without risking overdose? Is intravenous injection associated with risks, such as bacteremia, sepsis and endocarditis, that are not associated with skin popping and muscling? These considerations that should be addressed prior to making policy decisions regarding the prevention of skin and soft tissue infections.

The most widespread prevention effort now employed is the distribution of alcohol wipes at syringe exchange sites. Distribution of brochures recommending skin cleaning has also be attempted. Finally, methadone maintenance is a prevention tactic recommended in the literature.[59] All three of these approaches ought to be evaluated systematically before they are assumed beneficial.

Future studies may add support to the associations found in this study and clarify the role of risk factors and protective factors identified in Baltimore[60] and Amsterdam.[62] Is the prevalence of skin and soft tissue infections higher in San Francisco and in other cities and counties?

Work is needed to explore ways of making health services more accessible to IDUs so that they are inclined to access health services instead of buying antibiotics on the street and lancing their own abscesses. Early, targeted and respectful health services for skin and soft tissue infections may be the first step toward decreasing morbidity and lengthy hospital stays among IDUs.

Abscesses: An opportunity for health screening and disease prevention?

Abscesses are a common impetus for IDU contact with the health care system. Thus, these infections may represent a critical opportunity for health intervention and the initiation of an ongoing primary care relationship. Providers treating abscesses in a primary care setting rather than in an emergency room can initiate a continuing provider-patient relationship with the IDU in order to address the many health issues IDUs may face. A clinical contact for an abscess is an opportunity to educate IDUs about syringe exchange, HIV, hepatitis B and hepatitis C. The contact also offers the opportunity to vaccinate a high-risk group[69] against hepatitis B and to provide primary tetanus-diphtheria toxoid, tetanus booster dose, or tetanus immunoglobulin to IDUs.[63] Vaccination against Influenza A and B viruses should to be considered for HIV positive IDUs. It may also be considered

for IDUs in general, as many are likely to reside institutional settings[76] during the Influenza season, such as homeless shelters, drug treatment facilities, and jails or prisons. The visit could afford an opportunity to recommend HIV-antibody testing, risk reduction and antiretroviral therapy for HIV-positive individuals. Bergstein *et al.*,[27] recommended screening IDUs who present with abscesses for hepatitis B and HIV. Non-drug related conditions may also be screened for, including hypertension and diabetes. Abscess care also provides an occasion to give a referral to drug treatment and information about detox programs if desired by the IDU. A clinic visit for even a minor abscess can be a critical point of intervention to prevent excess morbidity and early death in IDUs.

Recommendations

Expanded and unencumbered access to syringe exchange, skin and syringe cleaning supplies, and methadone maintenance and treatment continues to be well-advised. Recommended prevention efforts include education in the form of targeted and appropriate brochures, 'zines and videos about safer injection methods, vein care, self-care of abscesses and where and when to seek treatment. Nurses and physicians should open dialogue with IDUs in their patient populations about risky injection practices such as licking needles, using cigarette filters and injecting into the groin or neck. Such a dialogue may be a means for providers to initiate a discussion regarding the prevention of infections such as HIV with their IDU patients, to encourage HIV antibody testing, and to encourage hepatitis B serologic testing and vaccination.

There are a number of ways to encourage early treatment of skin and soft tissue infections. Physicians and nurse practitioners work at some syringe exchange sites on a regular basis to administer antibiotic treatment, provide on site services and to give referrals to local health care centers. Expanding these services to a greater number of syringe exchange sites is one way to provide early abscess treatment. A similar approach would be

stationing abscess treatment vans at regular times in places where users are concentrated in the city, including in the Tenderloin. Abscess clinic times at health centers, which could incorporate rapid triage and treatment, would encourage IDUs to seek early treatment. The medical professionals at abscess clinic times would be prepared to address the needs of IDUs with some promise of a respectful and humane attitude towards IDUs. Finding creative ways to encourage IDUs to seek treatment for abscesses before they require hospitalization would be an appropriate goal for city health departments concerned about the high prevalence of skin and soft tissue infections.

Hospitals should continue microbiological surveillance efforts to guide appropriate treatment of skin and soft tissue infections and detect emerging antibiotic resistance patterns. These data should be shared with health centers that commonly treat IDUs to guide antibiotic choices.

IDUs suffer from a number of infections and health conditions that do not pose a direct threat to non-drug using populations, but are debilitating, life-threatening, costly and cause suffering. These illnesses, which strike a particularly vulnerable population, warrant high quality research and thoughtful planning from epidemiological, policy and medical perspectives.

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