The Effectiveness of Bleach in the Prevention of Hepatitis C Transmission

Final Report

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The Effectiveness of Bleach in the Prevention of Hepatitis C Transmission

Final Report

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Table of Contents

1. Introduction

a) Overview

Hepatitis C Virus (HCV) has infected approximately 170 million people worldwide, including an estimated 210,000 to 275,000 people in Canada – 0.8% of the Canadian population[1,2.] HCV continues to infect 5,000 Canadians annually[3-5].

The most significant risk factors for HCV infection have been the receipt of blood products and injection drug use (IDU). The former has been all but resolved with universal blood screening methods introduced in 1990, but the latter is an ongoing problem. HCV is endemic among injection drug users, with over 80% infected in many IDU populations worldwide[2]. HCV can also be transmitted sexually[6-8], during pregnancy and childbirth[9,10], through other percutaneous exposures including occupational needle stick injuries[6,7], acupuncture, electrolysis, tattooing and body piercing[11,12] and by sharing contaminated personal hygiene items such as toothbrushes and razors[1,12]. Overall, these modes of transmission are thought to represent less than 40% of HCV cases[1,6,13,14], whereas IDU accounts for 50% to 70% of current cases[1,2,15,16].

In an effort to interrupt the transmission of HCV – as well as other blood-borne pathogens such as the Human Immunodeficiency Virus (HIV) and hepatitis B virus (HBV) – harm reduction programs in Canada and worldwide have encouraged people who use injection drugs to use bleach to clean needles and syringes, if new needles are not available. However, there is little direct evidence demonstrating the effectiveness of bleach in preventing HCV transmission among these people.

This paper provides background on HCV infection and summarizes the literature regarding the use of bleach as a disinfectant for needles and syringes. It also looks at the comparative effectiveness of bleach as a disinfectant to prevent the transmission of HBV and HIV. Lastly, it draws some important prevention messages from harm reduction programs such as needle exchanges and makes recommendations regarding bleach promotion and general HCV prevention programs.

b) Methodology

This paper summarizes literature identified through Medline literature searches using the MeSH terms hypochlorite, hepatitis, bleach, prevention, substance, abuse, viruses and transmission. Further searches were done on Medline and other information sources for these topics as well as HIV, AIDS, IDU and all related topics. Other sources of information included non-peer reviewed information resources by government agencies, community groups and information displayed on the Internet.

2. Hepatitis C

a) Hepatitis C Virus

HCV is an infectious blood-borne virus first identified in 1989. According to the US Centres for Disease Control and Prevention (CDC), it is the most common chronic bloodborne infection in the United States[17.] While 15% to 25% of persons with HCV resolve their infection, the remaining 75% to 85% of cases go onto chronic infection[1,4]. Most newly infected persons (60% to 70%) have no symptoms and are unaware of their infection, but are infectious and may spread the virus through high-risk behaviours[4].

Long term consequences of HCV infection include cirrhosis, hepatocellular carcinoma and other extra-hepatic manifestations[4,5,18,19]. HCV is responsible for 40% of chronic liver disease, and HCV-associated end-stage liver disease is the most frequent indication for liver transplantation among adults[6,20]. HCV-related chronic liver disease causes 8,000 to 10,000 deaths each year in the United States[6,21] and 800 to 1,000 deaths per year in Canada[19].

While the estimated population prevalence rates are low – approximately 0.8% in Canada[1,3,22] and 1.8% in the United States[6,21] – they increase dramatically among high-risk groups such injection drug users[23,24], incarcerated populations[25,26] and street youth[1,27].

In some cases, HCV can be effectively treated. However, current treatments are only indicated for 20% to 30% of the infected population[20,28]. Treatment is effective in 40% to 80% of these cases[29], with success dependent on genotype, type of treatment, length of treatment and stage of disease[30,31]. There is no vaccine for HCV, and re-infection is possible[4]. This means that prevention relies primarily on the successful interruption of viral transmission and on modification of high-risk behaviours.

b) Modes of Transmission

As many people have multiple risk factors, establishing the exact mode of transmission is often difficult. In the absence of clear risk factors such as IDU, determining which factors – many of which will be forgotten or denied – resulted in transmission is extremely challenging.

Injection Drug Use

In IDU populations, the high HCV prevalence, the high rate of chronic infection, the steady influx of new, susceptible injecting users and the high transmissibility of the virus all contribute to its endemicity[12,15].

There are an estimated 125,000 people who use injection drugs in Canada[32] and approximately 1.5 million in the United States[33]. The estimated average HCV prevalence in these populations is 80%[15], reaching a high of 90% or more in several communities, including in Vancouver, British Columbia[12,23,24]. Worldwide, estimates of HCV prevalence in IDU populations range from 50% to 100%[4,23,24]. IDU accounts for at least 60% of all annual HCV infections in the United States and Canada[2,6,15,16].

When injecting drugs, individuals use – and often share – many different pieces of equipment, including needles[a], cookers, swabs, cotton/filters, tourniquets and water. Sharing any of this equipment is a major risk factor for infection[2,34]. Thorpe et al. reported that sharing cookers is the most significant predictor of HCV infection after controlling for needle sharing, with an adjusted relative hazard[b] (RH) of 4.07. Sharing cotton filters and/or rinse water were also significant predictors of infection in some situations (RH=2.4 & 2.7, respectively)[34].

Health Canada's Enhanced Surveillance System for HBV and HCV revealed that, in the period 1998-1999, 78% of injection drug users interviewed reported having shared needles in the six months before diagnosis[1,15]. The Vancouver Injecting Drug Use Study (VIDUS) found that of participating individuals who had injected drugs in the six months prior to questionnaire completion, 28% reported sharing needles in that time[35]. Likewise, a 1995-1997 New Mexico study found that 90% of participating injection drug users reported sharing injection equipment, primarily with friends (52%) or with their main sex partner (31%). Of those who reported sharing equipment, 85% were anti-HCV positive[36]. Many of these people are unaware of their HCV infection and engage in more at-risk behaviours than those who are aware of their positive status[37].

a In North America, injection drug users most commonly use syringes with non-removable needles, intended for a single use only. This report, therefore, uses the terms "syringe" and "needle" interchangeably.

b 'Relative Hazard' (RH) is the risk of an event, e.g., infection, happening (1.0 is the benchmark or average). In this case, a relative hazard of 4.07 represents a four-fold increase in risk of infection.

Equipment sharing is of particular concern among young adults who are newly indoctrinated into the drug culture. A Chicago study found that almost three quarters (74%) of young adult injection drug users – half of whom had just started injecting during the two years prior to enrolment in the study – had shared injection equipment within the previous six months[34].

Specific drugs increase the risk of HCV infection. Cocaine use, which often involves up to 20 injections per day, increases the likelihood that drug equipment will be shared[4]. Cocaine is also often inhaled and causes nasal erosions and ulcers, creating the potential for HCV to be transmitted through the sharing of cocaine straws[4,6]. Dry and cracked lips, a common side effect of injection drug use, make pipe sharing a potential risk[4,6]. Certain injection practices also increase risk. For example, 'front loading' or 'back loading' where drugs are mixed in one syringe and distributed to other syringes, passes potentially infected materials to several people at one time[4].

Injection drug use and equipment sharing has also made HCV a significant problem in incarcerated populations. Anti-HCV positive rates among inmates in Canada range from 28% to 40%[25,26]. While many infections occur outside of prison, transmission has also been documented while in custody, with infection likely a result of IDU[38].

Other Modes of Transmission

In the past, a significant number of HCV infections were due to infected blood products[2,13], although in the last decade universal blood donor screening has reduced this risk to approximately 1 in 500,000 donations[39].

HCV can also be transmitted during pregnancy and childbirth[9,10] and through needle-stick injury[6,7], sexual contact[6-8], tattooing, body piercing, electrolysis[11,12] and sharing of personal hygiene items such as toothbrushes and razors that may be contaminated with blood[1,12]. These modes of transmission, however, account for a very small number of acute HCV infections compared with IDU[1,6,13,14].

3. Summary of the Data on the Use of Bleach as a Disinfectant

In an effort to slow transmission of bloodborne pathogens among people who use injection drugs, harm reduction programs have tried to educate injection drug users about the dangers of sharing needles and other injecting equipment. These programs encourage the use of new needles for every injection or, when new equipment is not available, to use bleach to clean needles before each use. However, the effectiveness of bleach disinfection has not been adequately examined.

Liquid bleach is sodium hypochlorite (NaOCl) in a water-based solution. Most household bleach contains 5.25% NaOCl (range 3% to 6%)[40], with available chlorine of approximately 50,000 parts per million (ppm)[18].

Studies investigating the use of disinfectants for cleaning needles and syringes used by people who inject drugs have focused primarily on the ability of disinfectants and viricides to inactivate HIV. The goal was to find a method of disinfection that was effective, convenient and inexpensive. Bleach was deemed the best agent, as it met five important criteria: it is relatively non-toxic when injected in small quantities; it is a commonly used disinfectant for environmental surfaces; the disinfectant effect is quick; it is easily available; and it is inexpensive and convenient[41,42]. Bleach is distributed by needle/syringe exchange programs, often in conjunction with sterile needles and condoms[43].

a) HCV Disinfection with Bleach

In vitro studies have shown that bleach is effective for inactivating many pathogens, including HIV and hepatitis B[44-46]. However, relatively little is known about the inactivation of HCV by chemical germicides[18]. The lack of an in-vitro cultivation system for HCV limits the ability to investigate the efficacy of disinfection. Published information comes mainly from experiments in which the integrity of viral particles, antigens, nucleic acid and/or enzymes is used as a measure of the presence or absence of infectious virus. Such tests may show viral presence, but do not necessarily answer questions of infectivity[18]. Even polymerase chain reaction (PCR) detection methods cannot distinguish between infectious and inactivated virus[47].

To address this challenge, some researchers have turned to animal models. Unfortunately, the only truly appropriate animal model is the chimpanzee. Given their endangered status chimpanzee studies are both ethically difficult and very expensive[18]. More recently, other viruses including the bovine diarrhea virus (BVDV) have been used as surrogates for HCV[18,48].

The current challenge of determining true infectivity limits our ability to evaluate appropriate dilution and exposure times. A 1:10 dilution of domestic bleach is commonly recommended for clean up of blood spills, and this concentration should be adequate to deal with HCV (and HBV) in blood[18], although supportive evidence is lacking. However, blood remaining in a syringe poses different challenges than surface blood spills. The risks of transmission from an improperly cleaned and disinfected syringe are much higher than from traces of blood left on an outside surface. Studies have shown that undiluted bleach requires shorter exposure times than diluted bleach to be effective against HIV-1. It may also be more effective in the presence of residual blood in the syringe[49]. Presumably, the same would be true against HCV.

b) Factors Affecting HCV Inactivation

As with any disinfectant, there are factors that reduce bleach's effectiveness against HCV. These include the amount of organic material, e.g., fresh, dried or clotted blood, left in or on the equipment ('soil load'), how long the blood has been sitting in the syringe, the length of time bleach is in contact with the equipment, the "freshness" of the bleach and whether or not the bleach is used properly[42,50].

Studies have shown that contact time and soil load are the two most significant of these. Disinfection with an effective compound for an inadequate time may not succeed in inactivating sufficient amounts of the pathogen to render it non-infective. Likewise, residual organic compounds, such as blood or infected tissue, can significantly impair any disinfectant's ability to inactivate HCV, HBV, HIV or other pathogens. Therefore, even highly effective chemicals can fail to properly inactivate HCV in the absence of proper cleaning (removal of residual blood) of the devices that are being disinfected[18].

The stability of bleach also affects its effectiveness as a disinfectant for injection drug users. For example, dilution and storage in direct sunlight are known to reduce bleach stability and available free chlorine for disinfection[44,51].

Current laboratory methods limit our ability to determine the effectiveness of bleach for inactivating HCV. In the absence of a simple in vitro cultivation system it is difficult for researchers to determine if changes in viruses' physical appearance, reduction of viral load and/or viral inhibition of host cell binding represent loss of infectivity. As well, laboratory test conditions often bear little resemblance to field use. Contact times between the virus and the test product are often too long to be realistic for field use. And the 'soil load' in test virus suspension may not be reflective of difficult-to-deal-with body fluids, such as blood[18].

c) Studies on the Efficacy of Bleach for Disinfecting Injecting Equipment

There have been a limited number of studies that attempted to demonstrate the effectiveness of bleach or related germicides against HCV. Kapadia et al. examined associations between bleach use and HCV seroconversion using a nested case-control[c] design. Compared to participants reporting no bleach use, they found that those who reported using bleach all the time had an odds ratio[d] for HCV seroconversion of 0.35 and those reporting bleach use less than all the time had an odds ratio of 0.76[52]. However, this study did not have sufficient power to determine if these results were statistically significant.

c Kapadia et al. matched 78 cases (IDU HCV seroconverters) with 390 persistently HCV seronegative injection drug users, all between 18 and 30 years of age. Up to five controls were matched to each case on gender, race/ethnicity, recent (within last six months) injection, date of study entry and length of follow-up.

d 'Odds Ratio' (OR) is the chance that an event will happen (e.g., infection/ seroconversion) compared to the chance that it will not happen (e.g., an odds ratio for group A vs. group B. of 4.0 means group A has 400% (four times) the chance of the event happening).

Agolini et al. showed that another chlorine-based compound, sodium dichloroisocyanurate (NaDCC), at a dilution resulting in 2500ppm chlorine inhibited the binding of HCV to host cells, which might imply reduced infectivity. This inhibition reached a maximum of just 91.7% after a contact time of 10 minutes[53]. As this chlorine compound is less sensitive than sodium hypochlorite (bleach) to inactivation by organic substances, household bleach might be even less effective.

In another study, Charrel et al. used molecular tests to evaluate the efficacy of two disinfectants for inactivating HCV: a 2% glutaraldehyde solution and a sodium hypochlorite with potassium permanganate and monosodium phosphate solution. Although the sodium hypochlorite-based disinfectant was able to inactivate HCV-positive serum, it did so only at concentrations greater than 90% (4500 parts/million active chlorine) after a contact time of 10 minutes[54].

Given its disinfectant properties and its success against other pathogens, including hepatitis B, bleach may be effective for disinfecting HCV-infected needles and other IDU equipment. However, the available literature is not conclusive.

4. Bleach Use Among Injection Drug Users

Although bleach, if used properly, may be effective for disinfecting IDU equipment, the effectiveness is irrelevant if people who use injection drugs do not have access to bleach, do not use it, and/or use it incorrectly. Jamner et al. reported that although a majority of injection drug users were aware of the potential benefits of bleaching needles and intended to use bleach, relatively few of them actually did[55]. And while early HIV prevention efforts seemed to show that injection drug users quickly took up the practice of disinfecting shared needles with bleach[56], these encouraging early trends were not sustained.

Today, while most people who use injection drugs may use bleach occasionally or even most of the time, few use it all the time[55] and most do not use it correctly. A 1993 study assessed whether or not injection drug users were aware of recom- mended bleaching guidelines[e] and whether such awareness led to improved bleaching behaviours. They found that only 35% of interviewed drug users knew both that full-strength bleach should be used and that the exposure time must be at least 30 seconds. More importantly, 75% of injection drug users who had shared equipment in the last three to six months reported either not using bleach or using it inconsistently. Only 7% knew the guidelines and reported always using full-strength bleach[58]. Studies have also

e In 1993, the Centers for Disease Control (CDC), the National Institute on Drug Abuse (NIDA) and the Center for Substance Abuse Treatment (CSAT) issued a joint bulletin containing provisional guidelines on the use of bleach to disinfect hypodermic syringes. These guidelines recommended that injection drug users who do not stop injecting and sharing injection equipment use full-strength household bleach to disinfect equipment and keep the bleach in contact with the equipment for at least 30 seconds. They also describe the specific procedure that should be followed for disinfecting syringes[57].

observed that a majority of drug injectors expose their works to bleach for less than the recommended 30 seconds, compromising the effectiveness of the disinfection[46,59].

It should also be noted that although these guidelines were developed in response to HIV research, the data were not then nor are they now considered definitive[46], and no follow-up research has been done to determine whether or not compliance with these guidelines effectively and reliably prevents transmission of HIV, HCV or other bloodborne pathogens.

Interventions to teach and encourage the proper use of bleach have been tested but few have been effective, either because of the time and complexity required for adequate disinfection, or because of decreasing compliance over time. Carlson et al. found that interventions including the provision of the CDC/NIDA/CSAT bleaching guidelines and one-on-one instruction on the use of these guidelines did improve bleach use. However, these improvements were slight and were not sustained[46]. Likewise, McCoy et al. found that among Miami injection drug users who were taught bleach cleansing methods, compliance decreased as stricter criteria (e.g., longer times, pre-cleaning, more rinses, use of water and bleach) were required[59]. In contrast, some targeted interventions have been successful in convincing people who use injection drugs to bleach their injecting equipment. Rietmeijer et al. observed that exposure to their intervention program (peer and role model counselling regarding bleach use, distribution of bleach kits and written materials encouraging bleach use) was significantly associated with an increase in consistent self-reported bleach use (OR 1.8; 95% CI 1.0 – 3.2; $p < 0.05$)[60]. And a San Francisco study found that reported use of bleach to disinfect needles was protective in a multivariate model of anti-HCV[61]. However, these reports rely on IDU self-report, and other studies have found that self-reported bleach use often does not reflect true bleach usage[59].

It is extremely difficult to influence behaviour in a population where individuals are making decisions while high on drugs, have very low self-esteem and little sense of, or desire for, self-care. Even among injection drug users who are positively predisposed to using new needles and/or bleaching used ones, “when forced to choose between postponing drug use and an unsafe injection, the discomfort of withdrawal and the attraction of the drug effect will typically result in injecting[55].” It is unlikely, therefore, that any bleach-based intervention program will achieve good compliance, and will therefore not be able to change behaviour significantly enough to interrupt disease transmission.

5. Comparison of the Efficacy of Bleach in Preventing Hepatitis B and HIV Transmission

a) Hepatitis B

Like HCV, infection with hepatitis B virus (HBV) can become a chronic illness which affects overall health and can cause cirrhosis and carcinoma[62]. Unlike HCV, HBV is vaccine-preventable. Thirty-four percent of HBV infections in Canada are attributable to injection drug use[63].

As with HCV, relatively little is known about the inactivation of HBV by chemical germicides[18]. It does appear that HBV can be inactivated by household bleach[22,64,65]. Sehulster et al. reported that concentrations of 5600ppm or more of available chlorine (approximately 1:9 dilution of household bleach) were able to reduce hepatitis B surface antigen reactivity in plasma after an exposure time of one minute or more[45]. Using a chimpanzee model, Bond et al. found that exposure to bleach for 10 minutes at 20° C resulted in complete HBV inactivation[65]. Payan et al. reported that sodium hypochlorite at 4700ppm free chlorine (approximately 1:11 dilution bleach) reduced viral titres 1000 to 10,000-fold, although more diluted concentrations were not effective, resulting in less than 10-fold viral reduction[66]. And Thraenhart et al. reported that a 1% sodium hypochlorite solution (approx. 1:5 dilution of household bleach) caused Dane particle (the complete, infectious HBV virion) alteration in 60% and disintegration in 50% after an exposure time of five minutes. Disintegration increased to 90% when a 2% solution was used[67].

Caution is still needed in interpreting the results of HBV disinfection studies; as with HCV studies, most of these studies use proxies for infectivity and therefore may not represent true viral inactivation. They also used exposure times that may not be realistic in IDU settings.

Research into the effectiveness of using bleach to eliminate hepatitis B transmission has implications for hepatitis C as HCV is probably at least as easy to inactivate as HBV[18].

b) HIV

HIV infection typically results in immunosuppression, leaving infected individuals vulnerable to opportunistic infections and cancers. As with hepatitis, IDU is an important mode of transmission for HIV. More than one third (35%) of all AIDS cases reported in the United States in 1995 and 30% of annual positive HIV tests in Canada are associated with IDU[68,69].

The CDC, NIDA and CSAT advocate the use of bleach for disinfecting drug injection equipment. In a joint bulletin released in 1993, these organizations stated that, "bleach disinfection of needles and syringes continues to have an important role in reducing the risk for HIV transmission for injecting-drug users who reuse or share a needle or syringe[57].”

Some studies have shown that bleach can inactivate cell-associated HIV in syringes within just 10 seconds of exposure. However, this contact time is insufficient when the contaminated syringes are left standing for three hours at room temperature. Syringe disinfection, then, is dependent on the extent of cleaning in relation to organic contamination[42].

Current data suggest that a minimum bleach exposure time of 30 seconds is required to consistently inactivate HIV, even with full strength bleach[46,49]. This contact time is often not achieved by injection drug users. A 1991 Baltimore study illustrated that bleach use does not eliminate HIV risk among drug users, even among those who report using it all the time[59].

Abdala et al. attempted to replicate a real-world injection drug use situation. They used syringes containing 2µl, 20µl and 40µl of HIV-1 infected blood, rinsed them quickly (taking only the time to draw in and immediately expel rinse liquid) with water, diluted bleach (1:10) and/or undiluted bleach and then tested them for viable HIV-1. More rinses and greater bleach concentrations showed the best results: less than 1% of syringes rinsed three times with water or once with undiluted bleach contained viable HIV-1. Diluted bleach was no better than water after one rinse, and only marginally better after two or three rinses[70]. Importantly, although even undiluted bleach did not inactivate 100% of HIV-1 in 100% of the syringes, it did reduce the viral load significantly. Such a decrease could decrease the risk of HIV transmission among people who use injection drugs[70].

These laboratory-based studies address only the ability of bleach to eliminate HIV in syringes. Epidemiologic studies in real world settings have found that self-reported use of bleach has not been associated with a reduction in HIV prevalence[71]. Titus et al. reported that among a sample of New York injection drug users, increasing levels of bleach use were not consistently associated with decreasing odds ratios for HIV seroconversion[72]. And a prospective study by Vlahov and colleagues (1991) reported no significant difference in seroconversion rates among injection drug users reporting the use of disinfectants all of the time, some of the time, or never[46]. These results suggest that the effectiveness of bleach observed in laboratory studies is not achieved in real-life situations.

6. Harm Reduction Programs

Harm reduction programs for people who inject drugs include strategies to prevent initiation of injection drug use, strategies to enhance safe injection among those who are injecting and may emphasize detoxification and rehabilitation services. Although abstinence can be one goal of harm reduction strategies, it should never be a condition of access to services[2,73].

Needle Exchange Programs

Needle exchange programs (NEP) are probably the most common harm reduction initiative. NEPs provide sterile needles to people who use injection drugs and collect used needles for disposal. In theory, if bleach disinfection works, then a cleaned needle is as good as a new needle. We can, therefore, look at the effectiveness of NEPs to evaluate the potential effectiveness of bleach education and distribution programs for injection drug users.

Needle exchange programs were first established in the 1980s as an effort to slow the spread of HIV. Evaluations of these programs and associated research reported that syringe exchanges reduce HIV risk behaviours, slow the spread of HIV infection among people who use injection drugs and do not produce increases in the injection of illicit drugs[74,75]. Studies have shown a decrease in HIV seroprevalence in cities with syringe exchanges compared to those without[76,77]. They have also reported an increased risk of infection among injection drug users who do not use syringe exchanges compared to those who do[78].

Other studies, however, have found that NEPs are not sufficient to stop HIV transmission. An Amsterdam cohort study found no association between HIV seroconversion and NEP use between 1986 and 1991[79]. In Vancouver, British Columbia, an HIV outbreak continued despite a large-scale, established and well-used NEP which was the main source of syringes even for those who seroconverted during this outbreak[23]. And a 1997 Montreal study found that the risk of HIV infection was significantly higher – 2 to 10 times greater – among injection drug users who reported recent NEP use compared to those who did not[80].

For HCV, there is some research that demonstrates a decreased risk of transmission through the use of NEPs. A series of cross-sectional surveys in Glasgow provided evidence that the prevalence of HCV among people who inject drugs had decreased since the establishment of needle/syringe exchanges in that city[81]. An evaluation of the Tacoma syringe exchange reported strongly significant associations between non-use of the syringe exchange and HBV and HCV infection[75]. The authors estimated that use of NEP would have resulted in a 61% reduction in HBV cases and a 65% reduction in HCV cases[75]. And an ecological review of 190 studies from 101 cities worldwide undertaken by the Australian Commonwealth Department of Health and Ageing found that HCV prevalence was lower in cities with NEP compared to cities without NEP. Among new injectors (injecting for three years or less), this review found an average HCV prevalence of 25% in cities with NEP compared to 66% in those without[77].

However, these limited studies are the only ones that report such success. Many studies report very high HCV prevalence rates in IDU populations (75% to 95%), despite harm reduction interventions[74]. Even with these initiatives, the majority of injection drug users still become infected[12]. For example, in Seattle, a cohort study showed no apparent protective effect of NEP use against HBV or HCV infection, and, in fact, injection drug users who had never used the syringe exchange had a lower incidence of HCV than those who did use the exchange[79]. Similarly, in Sweden, a prospective cohort study followed injection drug users who used a local syringe/needle exchange for between six months and two years. None of those drug users who were HIV-negative at the start of the study seroconverted to HIV positive, but 25% of originally HBV-negative injection drug users seroconverted to HBV positive, and 56% of originally HCV-negative injection drug users seroconverted to HCV positive[82]. This suggests the very high transmissibility of HCV despite NEPs. Likewise, the Australian ecological review, while observing reduced prevalence and incidence rates in cities with NEP, found that these cities still had a median HCV prevalence of 60% and averaged incidence rates of over 18 per 100 person years[77]. In Scotland, studies through the 1990s showed that while there was a decrease in HCV prevalence between 1990 and 1997, the trend did not continue past 1997. Implemented harm reduction measures may have helped to reduce the spread of HCV, but were, "not sufficient to bring this epidemic under control and reduce transmission to sporadic levels[83]."

A potential explanation for the limited effectiveness of NEPs in stopping transmission of HCV infection is that despite access to sterile needles, borrowing and sharing persists[61,81]. Hahn et al. reported that despite well established and extensive syringe exchange programs in San Francisco, one third (32%) of surveyed young injectors (under age 30) had still injected with a needle used by someone else in the preceding 30 days[61]. In Glasgow, a 1996 cross-sectional survey showed that 16% of recruited injectors who use needle/syringe exchanges had injected with a used syringe within the preceding month and 33% admitted to passing their used equipment onto others[81]. And only 19% of injection drug users interviewed as part of the Winnipeg Injection Drug Epidemiology Study reported using a new needle/syringe every time they injected[84], despite the presence and use of NEPs. These studies highlight that NEPs by themselves do not prevent needle sharing.

Equally important, most NEPs do not address the issue of shared injection equipment other than needles/syringes. This paraphernalia includes spoons, filters, cookers, water, water bottles and even the drugs themselves if they are prepared communally. Among Montreal street youth surveyed, 84% reported first injecting with a clean needle, but only 62% used clean drug preparation equipment[85]. Non-injection drug use, too, often involves sharing pipes and/or straws. Shared injecting, snorting and smoking equipment has been correlated with HCV transmission, and likely contributes to NEPs' lack of success in reducing HCV spread[79].

Research has shown that certain factors can influence the success of NEP in preventing HCV infection. For example, Hahn et al. reported that obtaining one's first needle from a needle exchange was protective against HCV infection[61]. Similarly, starting one's injecting career after the establishment of needle exchange program in the community, rather than before, has been shown to be protective against HCV infection, even after adjusting for length of time injecting drugs[81]. These factors must be more closely examined in order to design prevention programs that target high-risk individuals at the appropriate times in their injecting careers.

Overall, the data supporting the efficacy of NEPs are limited, especially against HCV. The reasons for NEP failure are likely diverse and may include difficulty accessing NEPs, inconsistency of use, transmission by equipment not provided by NEPs (e.g., cookers, filters), transmission by non-injection drug use such as snorting cocaine or smoking crack, and/or other individual risk factors. Given the limited NEP efficacy data and the more complicated process that bleach-based sterilization requires, it is unlikely that bleach distribution will be effective in reducing HCV transmission.

Safe Injection Sites

Several European and Australian cities have developed "tolerance zones", "injection rooms", "health rooms" and/or "contact centres". These are supervised injection sites where people who inject drugs can obtain clean injection equipment, condoms, advice and/or medical attention. They often include space where injection drug users can take drugs in a comparatively safe environment, usually under the supervision of medically trained personnel and with access to a full range of sterile injecting equipment[73,86]. These are often called "safe injection sites" although this is a misnomer, as safety cannot be assured until the quality and quantity of drugs is also supervised. Supervised injection sites may have more success than NEPs in reducing the transmission of bloodborne pathogens.

The first 'drug rooms' were established in Switzerland in the late 1980s. The number has since grown, and there are now supervised injection sites in Switzerland, Germany, the Netherlands, Australia and the United Kingdom[73]. The Harm Reduction Action Society has prepared a proposal for a Safe Injection Facility Pilot Project in Vancouver, BC[87], and the establishment of such a site has been supported in public opinion polls (71% support) and by the provincial medical health officer[88]. Elsewhere in Canada, the HIV/AIDS Legal Network advocates for the establishment of, "safe injection facilities as part of an overall strategy of more effectively respond to injection drug use and its harms in Canada[89]."

Although there have been few evaluation studies on European supervised injecting centres published in English, available studies provide evidence that such facilities reduce public nuisance, improve access and uptake of health and other welfare service, reduce opioid-related overdose risk and reduce risk of bloodborne virus transmission[73,90,91]. Injection drug users view safe injection sites favourably and in cities where they are not yet established, most people who use injection drugs self-report that they would use such sites if they were available[86,92]. Whether this would truly be the case is not clear, as other factors may influence use of these sites. However, the acceptability of such sites are supported by the Australian experience, where within six months of opening its doors, the Medically Supervised Injecting Centre (MSIC) registered over 1500 clients and supervised over 11,000 client visits[93]. Use of the MSIC grew monthly, from 401 visits in May to 2988 in October. As well as supervising injections, the MSIC provided 610 referrals for drug treatment, medical consultations and social welfare assistance in this time. MSIC staff also managed 87 drug-overdose related clinical incidence with no adverse sequelae[93]. The transmission of bloodborne pathogens was not assessed.

While most safe injection sites are inside spaces, some cities and countries have experimented with outdoor “open tolerance zones.” Here, people who inject drugs may congregate and use drugs, but the zones are patrolled by police and may be served by NEP, methadone units, crisis centres, medical services and/or other services for injection drug users. The population using these spaces, however, tend to be unstable and volatile and thus these zones have been short-lived[73].

Syringe Vending Machines

Another harm reduction measure that has been tested in various sites is syringe vending machines. These are similar to coin-operated soda machines that accept contaminated syringes and mechanically provide sterile syringes in exchange[94]. Advantages of such vending machines include their 24-hour availability and their provision of anonymous, no-cost needles/syringes[94,95].

In Marseilles, France, a survey conducted after an experimental one-year period with these machines found that they were used regularly and attracted younger injection drug users who were less likely to have had contact with the health care system through participation in drug maintenance treatment programs[94].

7. Summary

While studies on the effectiveness of bleach in inactivating HCV are limited, laboratory studies do demonstrate that bleach can reduce viral titres sufficiently to reduce viral infectivity. However, there are no clear parameters that guarantee viral inactivation. HCV is highly infective; as little as 10^4 copies/mL of the virus has been shown to cause HCV infection and cause chronic disease[96]. Most chronically infected people harbour at least 100 to 1000 times more virus per mL than that, making viral inactivation difficult.

Moreover, although bleach distribution programs are widespread, people who use injection drugs report using bleach inconsistently[55]. As a result, these programs are unlikely to appreciably reduce the risk of HCV transmission.

If used properly, sterile needles obtained through NEPs may reduce the risk of HCV transmission. However, NEPs – like bleach – do not prevent equipment sharing. Evidence suggests that injection drug users continue to share injection equipment, even if sterile equipment is available. Furthermore, neither bleach nor NEPs address other contaminated equipment[f], non-injection drug use or the injecting procedures used while high or desperate for a fix. Therefore, although NEPs could reduce the risk of HCV transmission, they are unlikely to be sufficient for preventing it[61, 81].

HCV is endemic in IDU populations worldwide. This endemicity, coupled with HCV's high infectivity, results in prevalence rates estimated at more than 80%[4,23,24]. Targeting new injection drug users is the best chance for prevention programs to interrupt viral transmission.

f Some NEPs do now provide sterile injection equipment, as well as needles, although the literature does not yet reflect this development.

8. Recommendations

"For both hepatitis B and C, preventing the initiation of drug injection and establishing harm reduction practices among injection drug users hold the key to effective control of transmission[1]."

- **Bleach disinfection should not be recommended outside the context of a broad-based harm reduction strategy**. Although partial effectiveness cannot be excluded, the published data clearly indicate that bleach disinfection has limited benefit in preventing HCV transmission among injection drug users. More research is needed into the ability of bleach to disinfect needles and equipment, into proper bleaching procedures and into IDU behaviour. Bleach distribution and education programs for people who use injection drugs must be careful not to impart a false sense of security regarding bleach's protective efficacy.

- **Support the establishment of safe injection sites as part of a comprehensive harm reduction strategy**. The published data show that neither bleach disinfection nor needle exchange programs are sufficient to stop transmission of HCV and other bloodborne pathogens. European experience suggests that safe injection sites may have greater success. Such sites not only reduce the harm associated with IDU, they also provide access to comprehensive support programs.

- **Support IDU education programs.** Injection drug users must be educated about the risks of their drug use, including the possibility of infection with HIV, HCV or other bloodborne pathogens. Safe injection techniques – using sterile technique and equipment (needles, syringes, cookers, filters, etc.) for every injection – are key. This education should be part of a comprehensive self-care harm reduction framework adapted for ethnicity, educational level and IDU culture.

- **Target high-risk groups**. Persons at high risk of experimenting with or initiating injection drug use should be specifically targeted to prevent IDU-associated infections. Research should investigate the factors that cause people to start injecting drugs, to enable the development and evaluation of prevention programs.

There are many unanswered questions about the best way to prevent transmission of bloodborne pathogens among people who use injection drugs, and no easy answers. What is clear is that a comprehensive approach is essential, and that there is no silver bullet. An expert panel should now be convened in Canada to discuss the issues raised in this report, to develop appropriate policy and to determine next steps, including identifying the necessary components of a comprehensive, integrated approach to effective hepatitis C prevention.

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