HARM PRODUCTION: CORRECTIONAL ENVIRONMENTS, INJECTION DRUG USERS AND RISK OF INFECTION WITH BLOOD-BORNE PATHOGENS

by

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Abstract

Background: Analyses of the individual-, social- and structural-level factors promoting the transmission of HIV and other blood-borne pathogens have consistently identified exposure to correctional environments, especially for individuals who use injection drugs (IDU), as a risk factor for infection. The objectives of this project were: to review the epidemiologic literature on incarceration and HIV infection among IDU, critically examining evidence presented supporting a causal linkage between imprisonment and infection; to investigate incarceration experiences in a cohort of active IDU; and to assess the possible effects of incarceration on the post-release risk environment of active IDU.

Methods: Longitudinal datasets for quantitative analyses were derived from the Vancouver Injection Drug User Study (VIDUS) and the Scientific Evaluation of Supervised Injection (SEOSI), both prospective cohorts of IDU in Vancouver's Downtown Eastside neighbourhood. In the first analysis, the prevalence and correlates of reporting incarceration in the the previous six months were identified in SEOSI using generalized estimating equations (GEE). In the second analysis, the possible effect of imprisonment on the prevalence of risk factors for HIV infection was estimated in VIDUS using linear growth curve analysis.

Results: In the first analysis, 902 individuals interviewed at least once between 1 July 2004 and 30 June 2006 were included. Overall, 423 (46.9%) reported an incarceration event at some point during the study period. In a multivariate GEE model, recent incarceration was independently associated with a number of high-risk factors, including syringe sharing. In the second analysis, 1603 individuals were interviewed at least once between 1 May 1996 and 31 December 2005 and in cluded. Of these, 147 (9.2%) matched the study criteria and were included as cases; 742 (46.3%) were included as matched controls. In linear growth curve analyses adjusted for age, gender and ethnicity, syringe sharing was significantly more common in the incarcerated group ($p = 0.03$) after incarceration than in the control group.

Conclusions: Our findings support the existence of a role for incarceration in continued viral transmission. In response, appropriate harm reduction measures should be expanded within correctional environments and social, political and legal reforms enacted to reduce the incidence of imprisonment for individuals who use illicit drugs.

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Dedication

Peter Collins; Bud Osborn; David Simon; Dean Wilson

Co-authorship Statement

This is to certify that the work presented in this thesis was conceived, instrumented, written, and disseminated by the Master's student. The co-authors of the manuscripts that make up part of this thesis made contributions only as is commensurate with committee or collegial duties. The co-authors reviewed each manuscript prior to submission for publication and offered critical evaluations, however, the student was responsible for conducting the analyses and preparing the intital drafts of all manuscripts. In addition, the candidate was responsible for revising the manuscripts based on the suggestions of the co-authors, submitting manuscripts for publication, and preparing final revisions based on the journal editor's and the comments of the external peer reviewers.

CHAPTER 1

BACKGROUND, STUDY JUSTIFICATION, AND OBJECTIVES

1.1 Epidemiology of HIV/AIDS pandemic

Since it first emerged in a series of explosive outbreaks beginning in the early 1980s, the human immunodeficiency virus (HIV) has infected over 50 million people worldwide [1]. First isolated in 1984 [2], the retrovirus was soon recognised as the aetiologic agent of Acquired Immune Deficiency Syndrome (AIDS) [3], a disease characterised by a growing deficit of immune system CD4+ cells, leading to a loss of immune system function, colonisation by typically benign microorganisms such as *Candida albicans*, and death [4]. By the end of 2006, UNAIDS, the international agency charged with coordinating the global response to the HIV/AIDS pandemic, estimated that 25 million people worldwide have died of AIDS-related illness since 1980 [5]. In both absolute and relative terms, the burden of mortality is highest in the countries of sub-Saharan Africa [1]; in Canada, the Public Health Agency of Canada estimated in 2005 that slightly more than 56,000 Canadians had tested positive for HIV infection since 1985 and approximately 21,000 had died [6].

The prevalence and distribution of HIV infection is not random; the transmission dynamics and pathogenic traits of the virus, combined with individual-, social- and structural-level characteristics of human communities have determined patterns of infection, morbidity and mortality [7]. Unable to survive outside the human host, the virus cannot be transmitted through casual contact, including touching, aerosolised transfer, or by an arthropod vector. Instead, viral spread relies on the transfer of microscopic amounts of blood or other bodily tissues, including breastmilk, semen and vaginal secretion, through sexual contact, vertical transmission from a mother to her

child, blood transfusions and other medical procedures, or the use of contaminated injection equipment. In Western settings, initial outbreaks were predominantly among individuals reporting frequent exposures, such as men who have sex with men (MSM) and individuals using injection drugs (IDU) [8]. Although the transmission patterns in many regional or country-level outbreaks have since broadened, especially in areas of sub-Saharan Africa where population prevalence is often as high as 25% [1], in many settings individuals in these populations remain particularly vulnerable to HIV infection [5]. New cases among IDU and their sexual partners are an important component of the outbreaks in China, South Asia, Central Asia, southeast Asia, and the countries of the former Soviet Union [1]. Outside of sub-Saharan Africa, infections among IDU accounted for one-third of new infections in 2006 [9]. In Canada, initial HIV cases were reported among MSM, especially in urban centres such as Vancouver, Montreal and Toronto, in the mid-1980s [10]. According to Public Health Agency of Canada, in 2005, new infections were concentrated among MSM (1,100 to 2,000; 45%) and IDU (350 to 650, 19%) [11].

1.2 Injection drug use

Coincident with the emergence and spread of HIV is the growing use of illicit drugs by injection, most commonly opioids such as heroin or stimulants such as cocaine and methamphetamine [12]. In 1989, injection drug use was reported in 80 countries worldwide; of those, 59 (74%) also reported HIV infection among IDU [13]. By the end of the next decade, 128 countries reported the presence of IDU, of which 100 (78%) also reported HIV infection among IDU [14]. The most recent review of global prevalence [12] estimated the number of IDU worldwide to be 13.2 million, or 0.3% of the world population, in 130 countries. HIV prevalence figures were found for 78 of those

countries, with 25 reporting HIV prevalence of 20% or more among IDU either nationwide, in the capital, or in another site [12]. While some of this increase might be attributable to improved surveillance efforts, the data reflects the widespread global prevalence of injection drug use.

Typically, HIV outbreaks among IDU are explosive, characterized by a rapid increase in prevalence concentrated in time and space [15-18]. In addition to the efficient transmission of HIV through contaminated syringes [19], these outbreaks are enabled by the tightly interrelated social networks of IDU [20, 21], often marginalized within urban environments marked by poverty, addiction, violence and disempowerment [22]. These dynamics have been observed in settings as diverse as Baltimore, Maryland [23]; Edinburgh, Scotland [24]; Milan, Italy [25] and Bangkok, Thailand [26]. In addition to infection with HIV, injection drug use is also the ultimate cause of a wide range of harms; IDU suffer from an elevated burden of morbidity and mortality from overdose and other accidents [27], cutaneous and bacterial infections [28], and physical violence, including murder [29].

1.3 Addiction, criminalization and HIV/AIDS

In all Western and many developing countries, the use of drugs such as heroin is governed by political, medical and legal frameworks aimed at controlling all aspects of the production and consumption of psychoactive chemicals deemed to have no substantial therapeutic benefit and/or pose a risk of dependence [30]. These frameworks prohibit the production and consumption of some drugs, such as heroin, cocaine, and cannabis, while variably regulating others, such as tobacco and alcohol [30, 31].

This regulatory approach has spawned a broad variety of political, legal, cultural and economic interventions operating on individual, social and structural levels to prohibit the use of some psychoactive drugs [31-33]. While several critiques of illicit drug prohibitionism have focused on its apparent inability to reduce the population prevalence of illicit drug use [34, 35], a growing number of analyses in the biomedical literature have described how many of these interventions cause negative health impacts among individuals dependent on the use of illegal drugs [36-38]. In particular, analyses of official efforts to control drug use by arresting, prosecuting and imprisoning street-based or otherwise marginalized drug users have identified conflicts between the demands of public order and the aims of public health [39-41]. Studies from diverse political, economic and cultural settings have identified how various tactics in the broad continuum of criminal justice interventions against illicit drug use — from the "law on the books" to enforcement strategies to the practice of street-level police officers [33] — produce drug-related harms. Especially for street-based IDU, among the most addicted and vulnerable illicit drug users, particular attention has been focused on the specific actions, tactics and methods used to police urban drug markets and their effects on public health: police surveillance and crackdowns have commonly displaced IDU into areas of greater risk, further from health-care services, including syringe exchange outlets [42]; worsened the severity of overdose events [43]; and changed local drug consumption patterns, promoting the use of higher-risk drugs, practices or routes of administration [44]. The public health impacts of the criminalization of addiction are no less apparent in analyses of HIV transmission patterns among IDU. Studies of injection-driven outbreaks in many urban settings have identified a causal contribution by local criminal justice actions to viral transmission. Typically, these criminal justice

interventions have the effect of promoting the use of contaminated injection equipment [45] or moving individuals into environments carrying a higher risk for infection [46].

Perhaps no setting better represents the conflict between public order and public health as the correctional institution, whether in the form of a city holding cell, regional prison or federal penitentiary. Although extrajudicial executions of drug users have been reported [47], the most severe official penalty for illicit drug users is arrest, conviction and imprisonment. In the last four decades, the increasing prevalence of injection drug use and growing emphasis on criminal justice interventions to address illicit drug use [48], especially in the United States [31], has resulted in substantial levels of incarceration among IDU [49-51]. Also, a large proportion of prisoners in many correctional systems report either previous or current use of injection drugs [52-54]; the prevalence of HIV infection is often many times higher in prison populations than in comparable non-imprisoned populations [50, 55, 56]. While many analyses have concluded the elevated prevalence is the result of selection bias for higher-risk individuals [57], a number of epidemiological investigations have presented evidence for a role for correctional environments in sustaining viral transmission among IDU [58-60].

1.4 The risk environment and incarceration

Initial public health attempts to reduce HIV transmission focused on changing the actions of individuals to reduce their risk of infection [61, 62]. These projects identified risk behaviours, for example unprotected sex, and implemented individual-level attempts to reduce their prevalence. As an example, so-called "safe sex" campaigns — education- and media-led awareness efforts that highlighted the risk of infection and encouraged sexual abstinence and condom use — were a central

component of early anti-HIV efforts [63]. However, it was this emphasis on the rational decision making potential of individuals that defined the limits of these initial actions [64]. Instead of stressing the reform of individual behaviour, public health interventions should consider how physical, social, economic and policy conditions enable or restrict the possibilities for HIV prevention interventions. Rhodes' 'risk environment' is the space, both social and physical, in which these factors interact to produce drug-related harm [64]. At its crudest, the risk environment includes factors in four domains — physical, social, economic and policy — at two levels — micro and macro — that determine drug-related harms for IDU [64].

The framework was soon augmented by considerations of how risk was structured for IDU by legal factors, specifically: legal statutes; management of law enforcement agencies; knowledge, attitudes, beliefs and practices of front-line workers; and attitudes and experiences of IDU [33]. However, less attention has been devoted to examining the role that incarceration plays in shaping the risk environment of IDU.

1.5 Study setting, samples and objectives

The analyses in this thesis will seek to describe, quantify and assess the effect of incarceration and the correctional risk environment on risks for HIV transmission among individuals who inject illicit drugs. They will draw on previous biomedical investigations into the experience and impacts of incarceration as well as longitudinal epidemiologic data from two prospective cohorts of active IDU based in the Downtown Eastside (DTES) neighbourhood of Vancouver, Canada.

Since the mid-1990s, the DTES has been the focus of an explosive and ongoing outbreak of HIV among the estimated 5,000 individuals there who use illicit drugs [65]. Often called Canada's poorest postal code and "Skid Row" in popular accounts, the

DTES is characterized by extreme poverty, endemic homelessness and an open drug market concentrated in 10 city blocks east of the city's downtown core [66]. The individual- and ecological-level determinants of HIV infection and other drug-related harms among DTES IDU were first explored using the Vancouver Injection Drug User Study (VIDUS), a prospective cohort of IDU recruited using community outreach beginning in 1996 [65]. Cross-sectional and longitudinal analyses of the VIDUS cohort identified several factors structuring HIV transmission patterns, including frequent cocaine injection [16], poor housing [65] and insufficient access to syringe exchange facilities [67]. Findings from VIDUS helped inform several community-based social and political movements, including the Vancouver Network of Drug Users (VANDU), established in 1998 to promote the human rights of individuals who use heroin, cocaine and other illicit drugs [68]. In 2001, a coalition of political leaders, corporate interests and community organizations agreed under the "Four Pillars" initiative to support novel measures to address drug-related harms in the city, including infectious disease transmission, death from overdose and crime [69].

As a part of the commitment to harm reduction principles, North America's first supervised injection facility (SIF), modelled on existing sites in Europe and Australia, opened in the spring of 2003 [70]. Operating as a scientific pilot study, the SIF is being evaluated for its effect on the prevalence of infectious disease risk factors such as syringe sharing, the incidence and severity of overdose events and access to health care by IDU, including recruitment into treatment for drug and alcohol addiction [70]. The scientific assessment is being supported with the Scientific Evaluation of Supervised Injection (SEOSI) prospective cohort, a representative sample of SIF clients recruited at random [71]. Analyses of SEOSI and other data have found that use of the SIF has been associated with a number of benefits [72], including reduction in risk behaviours for

HIV infection, such as syringe sharing [73], and has not led to any negative impacts, such as initiation into injection drug use [72]. Both VIDUS and SEOSI have been reviewed and approved by the Providence Health Care/University of British Columbia's Research Ethics Board.

This thesis will address three objectives:

1. **To review the epidemiologic literature on incarceration and HIV infection among IDU, critically examining the evidence presented in qualitative and quantitative analyses supporting a causal contribution by the correctional risk environment on the transmission of blood-borne pathogens**. Chapter 2 will present the results of a search of the biomedical literature for analyses of: the burden of incarceration among IDU; the prevalence of HIV in incarcerated populations; the frequency of risk behaviours for HIV infection in correctional environments; and interventions to reduce drug-related harms for imprisoned IDU. Although all studies dating from the beginning of the HIV/AIDS pandemic will be considered, emphasis will be placed on research from the last 10 years. Where possible, the review will identify and analyse evidence for intraprison HIV transmission among IDU.
2. **To investigate incarceration experiences, including injecting while incarcerated and links to HIV infection, in a cohort of active IDU recruited from Vancouver's Downtown Eastside**. Chapter 3 will present the results of a longitudinal analysis of the SEOSI cohort, assessing the prevalence of incarceration in the last six month in baseline and follow-up surveys and identifying the factors associated with reporting recent incarceration in a multivariate statistical regression model. A subanalysis will examine if a

history of incarceration is independently associated with HIV infection while controlling for a number of drug-related and other risk factors.

3. **To assess the possible effects of incarceration on the post-release risk environment using a community-recruited prospective cohort of active IDU in Vancouver's Downtown Eastside.** Chapter 4 will present the results of a linear growth curve analysis of the changes in the prevalence of individual-, social- and structural-level risk factors for HIV infection, including unstable housing, high-risk drug-using practices, sex-trade participation and syringe sharing, before and after a period of incarceration among VIDUS participants reporting incarceration and a matched control group of VIDUS participants not reporting incarceration.

This thesis is presented in five chapters: Chapter 1 provides an introductory context for the analyses that follow, including the broad outlines of the social epidemiology of the HIV/AIDS pandemic, injection drug use and incarceration, as well as the setting, samples and objectives of the studies; Chapter 2 is a literature review of the relationship between incarceration and HIV infection for individuals addicted to injection drugs; Chapter 3 is a longitudinal analysis of the prevalence and correlates of recent incarceration in a community-recruited cohort of active IDU in Vancouver, Canada; Chapter 4 is a linear growth curve analysis of the prevalence of independent risk factors for HIV infection before and after a period of incarceration among active IDU in Vancouver, Canada, compared to a matched control group of IDU not reporting incarceration; Chapter 5 synthesises the introductory context and research findings to suggest possible contributions of this thesis to evidence-based public policies regarding

addiction, incarceration and HIV in prison settings as well as recommend avenues for future research.

1.6 Summary

Continued transmission of HIV through IDU and their sexual partners is an important component of the ongoing HIV/AIDS pandemic, especially in North America, Europe and the countries of the former Soviet Union, and South, Central and East Asia [74]. For many IDU, arrest, prosecution and incarceration is an inevitable result of the political and legal emphasis placed on public order responses to illicit drug use [31]. Thus, imprisonment is a common experience for IDU [50] and a substantial proportion of prisoners in many correctional environments report previous illicit drug use [53]. The prevalence of HIV infection is typically many times higher in imprisoned populations than among analagous non-imprisoned populations [55, 75]. Although previous studies have concluded the higher prevalence of HIV in imprisoned populations is the result of selection bias for higher-risk individuals [57], some have described how the experience and environment of imprisonment contributes to continued viral transmission [58, 76]. Thus, the analyses in this thesis will seek to describe, quantify and assess the effect of the correctional risk environment on HIV transmission among individuals who inject illicit drugs.

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CHAPTER 2[1]
CORRECTIONAL ENVIRONMENTS AND TRANSMISSION OF HIV

2.1 Introduction

In all areas where it is prevalent, including countries in North and South America, Europe, Australia and New Zealand, and south, southeast and central Asia [1, 2], the use of illicit drugs by injection is not only the cause of substantial morbidity and mortality [1, 3-5] but also a crime and the focus of a diverse variety of official responses. Although executions, both official [6, 7] and extrajudicial [8, 9] have been reported, the typical punitive state response is incarceration. Over the last four decades, especially in the United States, the dominance of prohibitionist policies against illicit drugs has resulted in a drastic increase in both the absolute number of and proportion of the population imprisoned for drug-related crimes [10-12]. In the United States, for example, at the end of 2006, over two million people were incarcerated in local, state or federal prisons, an increase of 1100% since 1980 [11]; of these, six in ten were serving sentences for drug offences [13].

Concurrent with the increasing emphasis on law enforcement was the emergence of the HIV/AIDS pandemic. From its beginning, the spread of the blood-borne pathogen has caused substantial morbidity and mortality amongst active and former injection drug users (IDU) and their sexual partners [1, 14]. Efficient viral transmission via contaminated syringes [15], tightly interrelated social networks [16] and poor coverage of prevention resources and related medical care [17-19] have fuelled many HIV outbreaks among IDU. To date, explosive outbreaks amongst IDU have been

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reported in a large number of locales, most often urban settings marked by addiction, endemic poverty, and social and political disenfranchisement, notably: Baltimore, Maryland [20]; New York City, New York [21]; Vancouver, Canada [22]; Edinburgh, Scotland [23]; Kabul, Afghanistan [24]; Barcelona, Spain [25]; Togliatti City, Russia [26]; Kaliningrad, Russia [27]; Milan, Italy [28]; Rio de Janeiro, Brazil [29]; Bangkok, Thailand [30]; and Tehran, Iran [31]. In many cases, uncontrolled outbreaks among IDU have preceded wider epidemics, for example in Thailand [30]; in others, especially the areas of the former Soviet Union, China and south and southeast Asia, the continued expansion of the HIV/AIDS pandemic is being sustained by new infections among IDU and their sexual partners [3, 32].

As a result of substantial HIV transmission in IDU populations and the intensification of the criminal justice response to addiction, correctional environments are focal points in the pandemic. Although HIV prevalence among prisoners varies from institution to institution, the proportion infected can be as high as 25% [33-35] and is often closely related to the infection rate among IDU in local non-incarcerated populations [36, 37]. In many settings, prisoners bear a disproportionate burden of morbidity and mortality from HIV/AIDS [38, 39]. In many countries — for example Canada [40], the United States [39] and Russia [38] — the prevalence among prisoners is many times higher than among non-incarcerated individuals.

The cause of the elevated prevalence of HIV infection amongst prisoners has commonly been ascribed to the higher-risk characteristics of correctional populations [41]. However, in addition to this effect of selection bias, several lines of evidence support a role for incarceration, its environment and the experience, in continued viral transmission, including contact-tracing investigations [42], ethnographic analyses [43], and both cross-sectional [44] and longitudinal [45] surveys of former prisoners. In light

of this and the increasing burden of both HIV/AIDS and imprisonment for individuals addicted to illegal drugs, [46], the following study reviews the links between infection and incarceration in settings worldwide. Particular attention is paid to direct and indirect epidemiologic evidence of viral transmission within populations of prisoners and interventions to reduce prison-based drug-related harm.

2.2 Burden of incarceration for IDU

Because both injection drug use and the means commonly used to support the behaviour — including involvement in the sex trade [47], drug dealing [48] and small-scale theft and fraud [49] — are illegal, incarceration is a common experience for IDU. In many settings, this is demonstrated not only by the proportion of prisoners who report a history of injection drug use but also by the prevalence of incarceration among IDU.

In surveys of active and former IDU, a history of incarceration is reported by the vast majority of participants. Typical are the results from a large multicentre study of five European cities in which 60 to 90 percent of IDU reported incarceration at some point since commencing injection [50]. A prevalence of incarceration in that range was also reported in surveys of active IDU from Helsinki, Finland [51]; Vancouver, Canada [52]; Bangkok, Thailand [53]; and Rhode Island, US [54]. In Tehran, Iran, a cross-sectional study of 207 community-based IDU found that the median length of injecting careers was five years; in that time, over three-quarters had experienced two or more incarceration episodes, with almost one-quarter reporting five or more [55]. Similarly, in a representative sample of 365 men drawn from a methadone maintenance therapy (MMT) clinic in New York City, exposure to the criminal justice system was nearly

universal: 94% reported at least one arrest in their lifetime; and 74% indicated a history of incarceration [56].

Conversely, surveys of prison populations have revealed a substantial proportion report a history of injection drug use [53, 57-59]. In Thailand, of 689 male inmates included in a survey of a Bangkok prison, most (67.2%) were labourers; almost half (45.9%) were in prison for narcotics-related offenses; and a majority (50.9%) reported heroin injection prior to incarceration, with a substantial fraction of those (41.0%) declaring an injection career of seven years or longer [53]. In Canada, approximately 30% of prisoners reported a history of injection drug use in three cross-sectional studies of provincial prison systems [57-59]. In a random sample of 1,607 men and women remanded to seven short-term jails in the Canadian province of Quebec, 377 (27.8%) reported a history of injection drug use prior to incarceration and 353 (26.0%) reported sexual contact with an IDU [59].

While the burden of incarceration among IDU in many settings is well described, less well understood are the characteristics of imprisonment episodes, for example, their length, frequency and security level or the likelihood of post-release recidivism. Fragmentary evidence suggests IDU are more likely than non-IDU to be repeatedly incarcerated [60]; similarly, injection drug use was more common among prisoners in maximum- and medium-security prisons in Canada than for those in minimum-security [61]. Whatever the measure, individuals addicted to illicit drugs represent a substantial fraction of prison populations in many areas. In most countries, these populations are primarily male [62, 63], disproportionately drawn from racial or ethnic minorities [10, 64, 65], especially indigenous groups [66, 67], and suffer from an interrelated variety of political, social and economic inequities, including poverty, lack of social support and

preexisting medical conditions [68-70], which can exacerbate vulnerability to HIV infection [71].

2.3 Burden of HIV infection within prisons

Epidemiologic investigations of the prevalence of HIV among prisoners — from the first decade of the pandemic [72-76], to the turn of the century [35, 41, 60, 77-98], and from the year 2000 on [33, 34, 37, 57, 99-106] — have consistently reported a higher level of infection in prisons than in surrounding communities.

In the earliest days of the pandemic in the United States, a case review of infections in the state correctional system in New York found infections to be largely among IDU and estimated the incidence to be 20 per 100,000 per year [72]; within five years of the first report of prison-based HIV-related disease [107], a study from the U.S. Centers for Disease Control and Prevention found that the virus had been found in individuals in the federal prison system, 24 state prison systems, and 33 of the 37 largest city and county jail systems [73]. Since then, reviews of disease prevalence in prisons in the United States [39] have documented an elevated level of infection as compared to non-incarcerated populations. In 2001, a U.S. federal government report summarised available data to estimate that 1.9% of prisoners were known to be infected with HIV, three times the level of the general population [108]. Consistent with regional disease trends and national demographics, infections were concentrated in prisons in the northeast and south, with New York State, Florida and Texas reporting the highest prevalences; levels of HIV infection were higher among female prisoners [108]. In a review of data from the US national HIV surveillance system, 4% of all positive test results from 1994 to 1996 were from correctional settings; of those diagnosed while

incarcerated, 61% indicated a history of injection drug use, versus only 27% in non-prison settings [109].

This pattern of a disproportionate burden of HIV infection among prisoners with a history of injection drug use persists in jurisdictions outside the United States. In the United Kingdom, a representative serosurvey performed by the Department of Health of prisons in England and Wales observed a prevalence of HIV infection of 0.3% among adult male prisoners and 1.2% among adult female prisoners [110]; in Scotland, levels were, respectively, 0.3% and 0.6% [111], approximately one order of magnitude greater than the prevalence of HIV in the non-incarcerated population in all three countries [112]. A similar ratio was observed in the first national survey of HIV infection in the federal prison system in Canada [40]. At the end of 2001, Correctional Service Canada calculated that 1.8% of prisoners were known to be HIV seropositive, or 4.7% of women and 1.7% of men, a level 10 times higher than a decade previous [40]. However, the testing regime was voluntary and only 30% of prisoners had a known test result, leading the government agency responsible for federal penitentiaries to conclude that "reported infection rates may severely underestimate the true burden of disease within federal correctional facilities." [40] Finally, a review of data on prisons in low- and middle-income countries [38] observed that HIV prevalence exceeded 10% in 10 countries of 55 outside Africa (Estonia, Romania, Slovakia, Ukraine, Indonesia, Malaysia, Vietnam, Cuba and Brazil.)

Although the range of HIV prevalence in prisons both within and between countries is large, the jurisdictions with the highest levels of infection are areas where the virus is pervasive among IDU [36]. This correlation between prison and IDU prevalence was demonstrated in a retrospective analysis using both prison and hospital surveillance data from Edinburgh, Scotland which found that HIV prevalence in local

prisons closely mirrored levels among IDU during the first decade of the Scottish epidemic [37]. Research that has estimated the prevalence of HIV infection and assessed related risk factors indicates that a history of injection drug use prior to imprisonment is typically the most common risk factor for HIV infection. For example, in a prevalence study of 4269 new prisoners surveyed at intake into the prison in Rhode Island, US from 1998 to 2000, a history of injection drug use was the strongest correlate of infection with HIV (Odds Ratio [OR] 8.1, 95% Confidence Interval [95% CI]: 4.99 – 13.11), HCV (OR 27.9, 95% CI: 21.45 – 36.17) or HBV (OR 8.4, 95% CI: 6.78 – 10.30) [105].

Despite the clear evidence of the disproportionate burden of HIV among prisoners, it must be noted that surveillance within most prison systems is incomplete [38]. Despite occasional calls for mandatory testing of prisoners for reasons of public health [113] or occupational safety [114], only a small proportion of existing surveillance data is the result of mandatory testing schemes. Although testing is offered in many prison systems, uptake is generally low [82, 115, 116] and likely grossly underestimates the prevalence of infection [40]. Even in many areas where the prevalence is known, the relative contribution of different risk factors is often undetermined [38]. Further, ethical and political considerations often limit scientific access to prison populations [117, 118] and the vast majority of HIV prevalence estimates for prison populations are the result of blinded and voluntary cross-sectional analyses [57, 59, 82, 96, 97, 119]. We are unaware of any long-term longitudinal analyses of prison populations which would provide more reliable estimates of the prevalence and incidence of disease as well as associated risk factors.

2.4 Risk behaviours and HIV transmission

Evidence generated from a variety of analyses — including contact tracing and case reviews of infected prisoners, viral sequence analyses, cross-sectional and longitudinal surveys and ethnographic interviews — has demonstrated the link between incarceration and HIV infection for IDU.

Contact tracing investigations of incident HIV infections among prisoners have revealed the transmission dynamics within correctional environments. Perhaps the most infamous episode of this nature was the outbreak of hepatitis B (HBV) and HIV at Glenochil prison in Scotland. In the first half of 1993, eight symptomatic cases of HBV and two undiagnosed HIV infections were discovered [42]. In the resulting public health intervention, which included counselling, voluntary HIV testing and the provision of methadone maintenance therapy, a further 14 cases of HIV infection were identified [120]. All of the men were IDU; in interviews, all reported injecting with used syringes in the prison [42]. This was borne out in a later molecular analysis of the viral genetic sequences of the prisoners which found 13 of the 14 were infected with closely-related isolates [121]. Similarly, in an investigation using contact tracing, chart review and interviews of a group of 13 ex-prisoners in Australia in 1993 and 1994 [122], four were determined to have most likely been infected in prison through shared injection equipment. Six individuals linked to the 13 were not included in the analysis as they had already died of AIDS-related illnesses. Similar outbreaks in prison populations fuelled by shared injection equipment have also been documented in Lithuania [123] and Tartarstan in the Russian Federation [124]. Finally, in a number of U.S. state prison systems, likely cases of in-prison infection were identified by examining HIV test results alongside individual incarceration histories [116, 125, 126]. In Georgia, a review of voluntary HIV test results from 1988-2005 found 88 prisoners with a negative result upon entry to prison and a later confirmed positive result [116]. In Florida, a case

review in 1994 of all 556 prisoners continuously incarcerated since 1977 found that 18 (21%) of those tested were infected with HIV. This was, the authors concluded "strong evidence" for transmission within the state's prison system [126].

In addition to direct evidence of transmission, risk behaviours for infection have been reported in both qualitative and quantitative surveys of current and former prisoners. For IDU, these risk behaviours persist due in part to the ongoing failure of prison authorities to stem the flow of illegal drugs into correctional environments [43, 58, 127, 128]. Despite the efforts of authorities, drug use continues in prisons [43, 129, 130], as many individuals are imprisoned with established addictions [58] and many others begin using drugs in response to an environment that is inherently violent, boring and disorienting [101, 131-133]. Although few system-wide estimates of the prevalence of drug use by prisoners are available, semi-random urine tests in Canada's federal prisons from 1994 to 1998 were positive in at least 10% of cases during the study period for a variety of psychoactive substances including opiates, cocaine, cannabis and alcohol [127]. Similar results were reported from surveillance systems in the United Kingdom [134] and federal prisons in the United States [135].

The prevalence of injecting and HIV infection within prisons are further perpetuated by the initiation of injection drug use while imprisoned, as well as the high risk behaviour that characterizes injecting within prisons. In a wide variety of settings, a substantial number of IDU report that their first injection occurred while incarcerated [53, 60, 90, 99, 101, 122, 131, 136-138]. In a survey of 9 of 15 prisons in Ireland, 509 (42.7%) of prisoners had a history of injection drug use; of those 104 (20.8%) reported they began injecting while imprisoned and a strong majority (69.3%) of imprisoned drug users reported sharing syringes while incarcerated [101]. A slightly higher level of initiation (25%) was reported by Scottish prisoners during the 1995 investigation into

the HIV outbreak in Glenochil; 70% of IDU imprisoned during the outbreak reported sharing syringes [60]. In Finland, 21.7% of prisoners in four institutions reported initiation into drug use and 19.2% reported injection drug use while incarcerated [137]. In Thailand, 22.8% prisoners with a history of injection drug use reported initiation within prison [53]. While these studies do not elucidate possible causal factors for initiation, social determinants of initiation into injection or change of route of administration previously identified in non-correctional environments, including the relative prevalence of injecting in the local network of drug users [139, 140] or the perceived efficiency of injection in a period of drug shortage [141, 142], could be considered for imprisoned populations.

In general, the proportion of prisoners reporting injecting while incarcerated is lower than the proportion reporting a history of injection drug use [143]. For example, in a random sample of prisoners in six correctional institutions in the Canadian province of Ontario, nearly one-third (32%) had ever injected drugs in the community; of those, one-quarter reported injecting while incarcerated [58]. These findings are in line with previous reports: in England, of those with a history of injection drug use, 30% reported injecting while incarcerated [100], while in another study, 16% of all prisoners reported injecting heroin while imprisoned [128]; in Australia, 44% of imprisoned IDU reported injecting [144]; in Greece, 60% of imprisoned IDU reported injecting in prison [145]. Similar levels have been reported in studies from Bangkok, Thailand [53]; in the US state of Rhode Island [54]; and a prison for women in the Canadian province of British Columbia [146]. Injecting while incarcerated has also been reported by former prisoners, for example in cohort studies of IDU in Bangkok, Thailand [147]; Glasgow, Scotland [148]; London, England [149] and Vancouver, Canada [45, 52, 150].

Although the proportion of individuals reporting injection while incarcerated is lower, the practice of injection drug use is commonly high risk in the typical penal setting, owing to the lack of reliable sources of unused and sterile syringes; the absence of safety, security and privacy for prisoners; the punitive consequences of drug use if discovered [94, 151]; and the high rates of syringe reuse and sharing [45, 101, 145]. Thus, the harms associated with addiction to injection drugs in the community are exacerbated when individuals inject within prisons [43]. This dynamic was found in ethnographic analyses involving prisoners from Canada [43], Russia [152] and the United States [153]. In a study involving 80 men in prisons in four US states [153], participants reported drugs were readily available to prisoners, often through the active or passive involvement of guards. Only one-third (36%) said they had direct knowledge of injection drug use in prisons; of those, most said syringe sharing was common and prisoners rarely used bleach or alcohol to clean their needles. "You don't have time to sterilize needles in the joint… A majority of people that do that [inject drugs] may have life without parole. They ain't got nothin' to lose… Shoot up. I am going to die in here anyway," said one participant [153]. In Canada, 26 former male prisoners from a prospective cohort of community-recruited IDU said that while the prevalence of drug use among prisoners was very high, prison policies prohibiting the possession of syringes meant that the few available were recycled clandestinely and continuously [43]. "Equipment like syringes are in very, very short supply," said one respondent. "You see syringes that have literally been around for months and months, if not years… patched and repaired, used over and over and over again. I am sure that many, many cases of HIV were transmitted because of those practices… Everybody shares." [43]

The pervasiveness of drug use and syringe sharing identified in qualitative studies has been supported by quantitative analyses of prison populations. In cross-

sectional studies, syringe sharing while incarcerated has been reported by a substantial number of drug-using prisoners: 71% in Ireland [101]; 50% in Greece [145]; 61% in Vancouver, Canada [45]; 56% in Liverpool, England [91]; and between 50-76% in a multi-centre survey of six prisons in Europe [154]. Similar levels of in-prison syringe sharing have been reported in other studies, often from institutions in Europe or Canada [41, 44, 58-60, 87, 91, 94, 131, 146, 155, 156]. A study of drug users in Scottish prisons found that while 32% reported injecting prior to their current sentence, only 11% reported injecting while incarcerated [143]. However, while 24% reported sharing injection equipment before their current sentence, 76% of those injecting in prison reported sharing equipment [143].

Incarceration has been associated with a greater risk of HIV infection in numerous cross-sectional studies of prisoners or IDU. For example, in Epperson *et al*.'s survey of men enrolled in a methadone maintenance programme in New York City [56], while sexual risk behaviours were not uncommon in the sample, in a multivariate regression model a lifetime history of incarceration was strongly associated with being HIV positive (Adjusted Odds Ratio [AOR]: 5.08, $p < 0.01$). Similarly, an association between HIV infection and incarceration or injection while incarcerated has been observed in a number of other settings, including: Bangkok, Thailand [157, 158] and northern Thailand [159]; Rhode Island, United States [98]; Italy [34]; England and Wales [100]; northwestern Spain [160, 161]; Berlin, Germany [44]; Edinburgh, Scotland [162]; Puerto Rico [163-165]; and Tehran, Iran [31, 55].

Although quantitative analyses of imprisoned IDU are typically cross-sectional, multivariate analyses of data from prospective cohorts of active IDU have also identified links between incarceration and HIV infection. In Vancouver, Canada, in a representative sample of IDU recruited from the city's supervised injection facility, a

longitudinal analysis determined that recent incarceration was independently associated with syringe sharing (AOR = 1.40, 95%CI = 0.03), after adjustment for a number of socio-demographic and drug-using covariates; further, a history of incarceration was independently associated with HIV infection [150]. Similar results were reported from a different prospective cohort of IDU in Vancouver [45] and echo earlier findings about the links between incarceration, syringe sharing and HIV infection [52, 166]. In a study of Vancouver's explosive outbreak of HIV, an attributable risk analysis determined that 21% of infections were the result of incarceration [167]. In Thailand, investigators constructed a hierarchy of risk for HIV infection in a cohort of over 1,200 seronegative IDU [147, 168]. Over the follow-up period, the scale was strongly related to HIV incidence, with each step corresponding to a doubling of incidence; the top, or riskiest, behaviour in the scale was injection while incarcerated [147].

Finally, prison systems have been identified as crucial sites in the genesis or persistence of several explosive outbreaks of HIV among IDU. In the United States, among the earliest identified victims of the AIDS pandemic were IDU imprisoned in the New York State prison system [72]; early explanations identified those IDU as members of a "bridge population" that introduced the virus into non-IDU populations [169]. More vividly, retrospective analysis of treatment and testing data from Bangkok, Thailand, supported the hypothesis that mixing of incarcerated IDU in the fall of 1997, followed by a general amnesty in December, 1997, sparked the emergence of a broader Thai epidemic [30]. While Thailand has rightly been praised for its use of evidence-based interventions to reduce transmission of the virus through heterosexual contact, its reliance on law enforcement to address drug use has failed to reduce HIV prevalence among IDU [170-172]. In fact, parenteral transmission within correctional environments,

specifically syringe sharing among IDU suffering withdrawal in police holding cells, has been identified as a central component of the continued epidemic [158]. In Iran in 2004, following many years of low seropositivity, the number of incident cases of HIV infection began to double each year [173, 174]. The majority of these infections (80%) resulted from injection drug use; thus, prevalence among IDU has risen rapidly, with more than 15% of individuals attending a drug treatment centre in Tehran testing positive for HIV infection [55]. In a logistic regression analysis, the strongest correlate of infection among participants was ever sharing a syringe within prison (AOR 12.37, $p < 0.001$) [55]. Zamani *et al.* [55] also reported a dose-dependent response between likelihood of HIV infection and number of days ever incarcerated. This follows an earlier study of one Iranian prison which, echoing studies from other correctional institutions around the world, found that although only 10% of imprisoned IDU reported injecting drugs, 95% of those individuals reported syringe sharing [32].

2.5 Interventions to reduce drug-related harms

In the absence of an effective vaccine or curative therapy, efforts to reduce the morbidity and mortality from HIV infection focus on the prevention of transmission and the reduction of pathogenesis. While interventions to lower the risk of transmissions through sexual contact and expand coverage of antiretroviral treatment have both shown success in many settings [170, 175], these benefits have not been fully shared by members of all groups at heightened risk for infection, including individuals addicted to injection drugs [17].

For IDU, HIV prevention programmes are a primary component of efforts to reduce the incidence and severity of harms resulting from drug use [176]. These programmes can be grouped into two major categories: Interventions to reduce the

likelihood of parenteral transmission by promoting safer injection practices; and interventions to reduce risk by lowering the frequency of drug use, possibly to abstinence. The former category includes a variety of schemes, including safer injection education [177], drug consumption rooms where IDU can use pre-obtained drugs in safe, sterile and monitored settings [178-180], and the distribution of sterile syringes [176, 181]. As such, they are pragmatic interventions to prevent the harms attendant to addiction regardless of the legal status of drug use, a strategy often referred to as "harm reduction" [182]. In particular, needle exchange programmes (NEP) have been introduced in a wide variety of settings in over 60 countries [32]. Their effectiveness at reducing risk behaviours and lowering the prevalence of infection with blood-borne pathogens has been demonstrated in a variety of studies, including cohort [181, 183, 184], case-control [185], and ecological studies [176]. Despite evidence of their effectiveness, NEPs remain controversial in some areas, and have even been outlawed in some jurisdictions, largely over fears they promote and perpetuate drug use [186]. While NEPs are recognised by both public health scientists [176] and the World Health Organization [187] as the primary means of preventing or reducing HIV transmission among IDU, need for them far exceeds their reach. Only 8% of IDU around the world have access to appropriate HIV prevention services, the lowest coverage of any group highly vulnerable to infection [188].

Strategies proven effective to reduce the frequency of drug use include detoxification, treatment for drug addiction and methadone maintenance therapy [189-192]. In particular, methadone maintenance therapy (MMT), has been shown to reduce the likelihood of suffering a number of the harms of injection drug use, including heroin use [192], criminal activity [193], and death from overdose [194]. MMT, typically consisting of doctor-prescribed and -supervised provision of daily dosages of

methadone, a synthetic opioid agonist usually delivered in oral solution, has also been shown to reduce the likelihood of risk behaviours for HIV infection among IDU [195-197]. In a randomised control trial of MMT (as compared to detoxification and counselling) for IDU, participants in the methadone arm benefited from significantly higher levels of treatment retention and lower levels of drug-related HIV risk behaviours [192]. Unfortunately, like needle-exchange programmes, MMT remains controversial in many settings [186]; even where it is an accepted medical treatment, demand typically far outstrips availability [198]. Similarly, the partial opioid agonist buprenorphine is being used for both short-term detoxification and longer-term maintenance of individuals dependent on opioids. Most studies comparing buprenorphine and methadone report similar outcomes [199, 200]; one long-running clinical trial of methadone and buprenorphine maintenance for IDU in Australia found similar treatment and mortality profiles in the two treatment arms [201].

Incarceration obviates one of the chief challenges to both needle exchange and methadone maintenance programmes: discovery and contact with injection drug users, typically a "hidden" urban population difficult to reach with conventional strategies [202]. Unfortunately, coverage of these HIV prevention tools is low for imprisoned IDU. If harm reduction is an opportunity denied to many individuals addicted to illegal drugs, it is doubly so for those incarcerated for their addictions [203]. Although needle exchange operations exist in over 60 countries worldwide [32], a 2004 review found that only 11 countries had implemented or were planning prison-based needle-exchange programmes (PNEPs), mostly in western Europe and central Asia [203]. Typically, these exchanges take the form of hand-to-hand distribution by nurses or peer outreacher workers or automated vending machines in common areas [204]. Likewise, despite a longstanding recommendation by the World Health Organization, prison-based

methadone treatment is available in far fewer settings than community-based methadone [205, 206].

In most cases, evaluations of PNEPs have identified reductions in syringe sharing among imprisoned IDU [207-214]. For example, in two prisons in Berlin, Germany, self-reported rates of syringe sharing by drug-using prisoners at baseline was 71%; it dropped to 0% at the third four-month follow-up period [212]. While the authors recognised that their analysis was weakened by the lack of a comparison group, they concluded that sterile syringe distribution was safe and feasible within the prison environment [212]. In a prison in Bilbao, Spain, correctional officials invited a local NGO, which was already involved in some harm reduction activities in the prison, to implement a needle exchange. After two years, an internal evaluation reported no increase in drug use; syringes had not been used as weapons against other prisoners or guards; and involvement in needle exchange encouraged drug users to take up other further harm reduction measures, such as methadone [209]. In addition to lowering the risk of HIV transmission, PNEPs have thus far not resulted in the negative effects often predicted by prison guards and staff, including an increase in drug use, initiation into injection drug use, or the use of syringes as weapons [32, 203, 211, 214, 215].

Because it is intended as a strategy to replace illicit drug use, methadone maintenance therapy is more widely accepted in correctional environments and is being implemented in an increasing number of countries. However, the number remains small as most prison systems, in the words of one author, "favour 'cold turkey' as 'treatment'" for dependence on opioids [206]. Consistent with the World Health Organization's 1993 statement that prisoners on methadone maintenance treatment in the community should be able to continue it when incarcerated [216], methadone is now available in all federal and some provincial and municipal prisons in Canada [217,

218]; New South Wales, Australia [219]; New Zealand [220]; all 25 member states of the EU [120, 205]; and some American states [205, 206, 221-223]. Like prison-based needle exchange, the limited availability of methadone to prisoners is not because its effectiveness has yet to be demonstrated. Methadone's role in long-term in-prison treatment for drug addiction has not been well assessed [205, 224] and reasons for its in-prison use include not just therapeutic but also penal goals [205]. However, it has been determined to be effective in reducing HIV risk behaviours among prisoners in a number of studies [130, 195, 225-227]. In a randomised control trial of methadone versus psycho-social counselling in an Australian prison, participants in the MMT arm reported significantly lower levels of all measures of risk at five-month follow-up, including heroin injection and syringe sharing [195]. This is consistent with findings that have observed reduced levels of injecting while incarcerated [130, 225, 227, 228]. However, both Dolan *et al*. and Boguna *et al*. observed that the full benefits of treatment were only experienced by individuals prescribed daily dosages greater than 50 mg [195, 225]. In the United States, effective maintenance treatment with methadone was associated with significantly lower prevalence of drug use and higher prevalence of treatment retention one month post-release in a randomised control trial in Baltimore, Maryland [229].

By comparison, information on the use of buprenorphine for detoxification or maintenance of dependent prisoners is fragmentary and incomplete. Clinical trials of buprenorphine are underway in prisons in the United States [230] and England [231]; in France, the use of buprenorphine for detoxification and harm reduction appears widespread [232-234], however, the only published evaluation [234] was flawed and inconclusive.

Faced with the increasing evidence of HIV infection within prisons, administrators in many settings have favoured interventions that might have the potential to reduce viral transmission but are short of an endorsement of more controversial harm reduction measures. Several global surveys care report that the provision of disinfectants, typically bleach, to clean used syringes is the most common harm reduction measure, and often the only one, available to imprisoned drug users [203, 235]. Unfortunately, the World Health Organization has concluded that the evidence supporting the use of disinfectants to prevent transmission of HIV is, in non-correctional settings, "weak" [187] and little evaluation of their effectiveness in prison environments has been completed [236]. In Canada, bleach has long been distributed in the country's federal prisons for the explicit purpose of "reducing the transmission of bloodborne pathogens among IDU" [40]. However, formerly-imprisoned IDU in Canada reported in an ethnographic survey [43] that bleach was inconsistently available, often used for other purposes, watched by guards, and considered ineffective.

2.6 Conclusion

In conclusion, the evidence assembled here tells of a remarkeably consistent dynamic. Individuals who are regular users of drugs via injection can reasonably expect, regardless of setting, to be apprehended at some point during their injection career and imprisoned as a result of their drug use. Once within a correctional institution, for the minority who continue to use drugs, it will be at greater risk of infection with HIV and other blood-borne pathogens due to the greater likelihood of sharing injection equipment and that preceeding users of that syringe are themselves infected. Finally, measures which individuals might access in the community, not only

clean needles but also as methadone or buprenorphine to assist in treatment for addiction, are often unavailable.

Although the findings presented here are often fragmentary, limited by the requirements of the penal environment or demands of prison authorities, it includes clear evidence of the heavy burden of infection and addiction amongst prisoners; the prevalence of risk factors responsible for the transmission of HIV within prison populations; and the low and incomplete coverage of effective interventions to reduce the likelihood of infection. As such, it appears clear that the effect of correctional institutions in the global HIV/AIDS pandemic is one of amplification; both the environment and experience of imprisonment promote the continued expansion of the pandemic. While many IDU appear to cease injecting while incarcerated, perhaps evidence of the transient success of punishment, those that persist do so in an environment of magnified risk. The scarcity of sterile injection equipment alongside the addiction of dependent prisoners have been common factors identified in each public health investigation into incident HIV infections, whether in Scotland [42], Australia [237] or Russia [124].

Unfortunately, concerns arising from this evidence of disease transmission via injection drug use while incarcerated has typically been met by, at best, promises by officials to bolster educational initiatives warning of the dangers of drug use [238, 239] or, at worst, interventions to reemphasize punitive sanctions against drug use [133]. Nowhere have evidence-based interventions against the harms related to injection drug use been implemented so infrequently as within correctional systems. Some of the concerns underlying the hesitation to augment needed harm reduction measures for prisoners, such as occupational safety for prison guards, are understandable even if, thus far, they have not found support in the evidence. However, it is increasingly clear

that the result of continued intransigence on the part of prison authorities will only be an increase in the burden of blood-borne pathogens and other drug-related harms for individuals addicted to illicit drugs.

In the face of this apparent stalemate between the public health needs of prisoners addicted to illicit drugs and the public order demands of prison administrators and affiliated political authorities, a number of authors have called for new regimes that recognise the health needs of prisoners within the legal context of international human rights [32, 203, 240]. Specifically, prison health care should be organized in light of the "principle of equivalence," affirmed by both the United Nations and the Council of Europe, that states that services provided to prisoners should be equal to those provided to the general community [241]. But beyond — or in addition to — an enhancement of prison-based health services should be a reduction in the incidence of imprisonment for those suffering from addiction. Regardless of the condition or experience of the prison environment, imprisonment has thus far not been shown to be an effective treatment for either addiction or its sequelae nor a succesful method of lowering the population prevalence of illicit drug use. Thus, thought should be given to plausible alternatives to the current legal framework with the aim of reducing the role of penal interventions.

In addition to the moral and legal responsibilities of states to avoid acting against the health interests and human rights of its citizens, especially those in its custody and control, is the pragmatic consideration that, given the demonstrated influence of prison systems on HIV transmission patterns among IDU, prison-based interventions hold the promise of making substantial contributions to efforts to control the HIV/AIDS pandemic. For example, recent estimates suggest that one-quarter of all HIV-infected individuals in the United States pass through a correctional facility each year [242].

Thus, prisons could serve as sites for effective public health interventions for individuals suffering from many interrelated vulnerabilities, including poverty, addiction and infection with HIV and associated comorbidities [243]. As the vast majority of individuals now incarcerated will be returned to their home communities, the introduction of effective and appropriate measures to reduce the likelihood of HIV infection for prisoners is in the interests of all; in the words of the Dublin Declaration on HIV/AIDS in prisons in Europe and Central Asia: "Good prison health is good public health." [244]

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CHAPTER 3[1]

INCARCERATION EXPERIENCES IN A COHORT OF ACTIVE INJECTION DRUG USERS

3.1 Introduction

Individuals who inject drugs typically contend with an array of medical, social and legal harms [1-4]. Because the dominant societal response to injection drug use in most jurisdictions continues to be arrest and punishment, one nearly unavoidable experience for injection drug users (IDU) is incarceration. For example, in samples of IDU in Thailand [5], the United States [6, 7] and Spain [8] between 55 to 96 per cent of study participants reported a history of detention.

For many IDU, prisons are characterised by increased risks to health and safety. Although incarcerated IDU typically inject less often than in community settings [9-11], the scarcity of sterile syringes and the punitive consequences of drug use promote higher-risk injection practices [7, 12, 13]. A substantial proportion of inmates in a variety of settings have reported injection while incarcerated [14-17] and sharing of needles with one or more partners [13, 14, 18, 19]. Opportunities for harm reduction among inmates, where available, are typically limited in comparison to services in the general community [16, 20, 21]. As a result, among inmates, rates of infection with blood-borne pathogens like

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hepatitis B (HBV), hepatitis C (HCV) and human immunodeficiency virus type 1 (HIV) are often much higher than in the non-incarcerated population [9, 10, 22-24]. In some areas, such as Asia, Eastern Europe and the countries of the former Soviet Union, the continued expansion of the HIV/AIDS pandemic is being driven largely by new infections in IDU, which are often acquired while behind bars [25].

In Canada, surveillance by the Correctional Service of Canada, the government agency responsible for the country's federal prisons, has found high levels of HIV, HCV and HBV [26]. However, the screening program is voluntary and CSC officials admit the results could "severely underestimate" the true burden of infectious disease [26]. Risk behaviours that promote transmission of blood-borne pathogens, like syringe sharing, have been reported in cross-sectional surveys [14, 22, 27] and qualitative studies [13, 28] of incarcerated populations in various settings. Presently, few harm reduction measures are available to Canadian prisoners [13, 21] and CSC has rejected repeated calls to initiate a pilot prison-based needle-exchange program [29, 30], stating it will instead focus on interdiction of drug supply and inmate education [30, 31]. Concurrently, Canadian Prime Minister Stephen Harper announced a new anti-drugs strategy that ended the federal government's commitment to harm reduction and promised increased legal and financial emphases on enforcement and incarceration [32].

The federal government's commitment to enforcement over harm reduction is of concern given recent evidence from Vancouver's HIV outbreak that IDU incarcerated in the previous six months are 2.7 times more likely to seroconvert to HIV [33] and given that an external evaluation concluded that

21% of infections in the city's Downtown Eastside were attributable to incarceration [34]. However, we know of no Canadian studies which have investigated the level or factors associated with incarceration among a community-recruited cohort of active IDU or the level of injecting within prisons. Therefore, the present study was conducted to investigate incarceration among a community-recruited cohort of active IDU in Vancouver, Canada.

3.2 Methods

Vancouver's Downtown Eastside (DTES) neighbourhood is the focus of well-documented outbreaks of HIV and HCV among the estimated 5,000 residents who inject drugs [35]. In September 2003, North America's first government-sanctioned Supervised Injection Facility (SIF) opened in the DTES. The SIF, known as Insite, is being evaluated using the Scientific Evaluation of Supervised Injecting (SEOSI) cohort which has been described in detail [36]. In brief, the SEOSI cohort is a representative sample of Insite users [37]. The sample was derived through random recruitment of SIF users who provided informed consent to enroll into the study. Recruitment involves using random number generation to select blocks of time during Insite's hours of operation (between 10:00 am and 4:00 am, seven days a week.) During these times, users of the SIF are invited to enroll in the SEOSI study. A nominal financial stipend ($20 CDN) is offered to those who attend the research site, located near Insite. A venous blood sample is drawn for HIV and HCV testing and an interviewer-administered questionnaire is conducted with those who provide informed consent. The SEOSI cohort has been approved by the University of British

Columbia/Providence Healthcare Research Ethics Board.

This analysis includes all participants who completed semi-annual follow-up visits between July 1, 2004 and June 30, 2006 (i.e., four separate six month follow-up periods were considered). The primary endpoint of interest in this study was recent incarceration, or reporting being in jail, prison or detention overnight or longer at any period in the previous six months. This definition is relevant as all participants were over the age of 18, and therefore would have been placed in an adult jail as opposed to youth detention. We considered variables potentially associated with incarceration, including those variables associated with incarceration in previous analyses [38-40] including: age; gender; Aboriginal ancestry (yes vs no); frequent cocaine use (yes vs no); frequent heroin use (yes vs no); frequent crack cocaine use (yes vs no); frequent crystal methamphetamine use (yes vs no); residence in the DTES (yes vs no); unstable housing (yes vs no); involvement in the sex trade (yes vs no); sharing syringes (yes vs no); binge drug use (yes vs no); public drug use (yes vs no); condom use with regular partners (yes vs no); condom use with casual partners (yes vs no); non-fatal overdose (yes vs no); drug dealing (yes vs no); treatment for drug use (yes vs no); methadone maintenance therapy (MMT) use (yes vs no); and years injecting. All dichotomous behavioural variables were in regard to the six months prior to the interview except for residence in the DTES and MMT use, which referred to current status. As in previous work [41], persons who reporting using cocaine, crack cocaine, heroin or crystal methamphetamine one or more times per day were defined as frequent cocaine, crack cocaine, heroin or crystal methamphetamine users. Unstable housing was defined as living in a single-room occupancy hotel, shelter or being homeless [41].

We began by examining univariate associations between the explanatory variables and recent incarceration. Since analyses of factors potentially associated with recent incarceration during follow-up included serial measures for each subject, we used generalized estimating equations (GEE) for binary outcomes with logit-link for the analysis of correlated data. This approach allows for the identification of factors independently associated with the outcome during the entire study period [42]. Standard errors are calculated using an exchangeable correlation structure and adjusted by multiple observations per person. As each individual can report incarceration or no incarceration during the previous six months at each study visit, a GEE model examines behaviours and characteristics correlated with times when incarceration did or did not occur within and between individuals. This approach has been used to analyse datasets containing repeated measures of a binary variable, such as longitudinal cohorts, for example in a study identifying correlates of access to drug treatment in a prospective cohort of IDU [43].

Next we fit a multivariate GEE model using a model-building protocol defined *a priori* to include all explanatory variables with a *p*-value smaller than 0.05 in univariate analyses. In subanalyses, we also determined the proportion of participants who reported injecting in jail at some point during follow-up. All statistical procedures were performed using SAS software version 8.0 (SAS, Cary, North Carolina). All *p*-values are two-sided.

3.3 Results

Between 1 July 2004 and 30 June 2006, 902 individuals completed the interviewer-administered questionnaire and were included in this analysis. Of these,

255 (28.27%) were female and the median age at the most recent study visit was 40.9 years (IQR: 35.6 – 47.3).

In total, the 902 individuals contributed 2237 observations to the analysis. The median number of visits by each participant was 3 (IQR: 2-3). In total, 536 (59.42%) participants reported being incarcerated at some point since initiating injection drug use. Overall, 423 (46.90%) participants reported an incarceration event at some point during follow-up, with 674 (30.13%) observations involving an incarceration event. 29 (3.22%) of participants reported ever injecting in jail during follow-up, with 33 (5.05%) of 674 observations reporting injecting while incarcerated.

As shown in Table 1, incarceration was positively associated with unstable housing, residence in the DTES, frequent heroin use, frequent crack cocaine use, public injecting, non-fatal overdose, sharing syringes, drug dealing and condom use with casual partners. Age was inversely associated with recent incarceration as was female gender and current MMT use.

Factors independently associated with recent incarceration in the multivariate GEE analysis are also shown in Table 1. They include unstable housing (Adjusted Odds Ratio [AOR] = 1.92, 95% Confidence Interval [CI]: 1.43 – 2.56); residence in the DTES (AOR = 1.42, 95% CI: 1.09 – 1.85); frequent heroin use (AOR = 1.32, 95% CI: 1.07 – 1.63); public injecting (AOR = 1.63, 95% CI: 1.30 – 2.03); sharing syringes (AOR = 1.40, 95% CI: 1.03 – 1.89); and drug dealing (AOR = 1.61, 95% CI: 1.30 – 1.99). Older age (AOR = 0.97, 95% CI: 0.95 – 0.98), female gender (AOR = 0.51, 95% CI: 0.40 – 0.65) and current MMT use (AOR = 0.75, 95% CI: 0.60 – 0.93) were each protective for incarceration in the last six months.

We recognized that the window for HIV and HCV seroconversion was too brief in the study period to allow for an investigation of the impact of recent incarceration on

risk of infection. Given the association with syringe sharing observed above, we examined potential associations between ever being incarcerated and prevalence of both HIV and HCV infection. We conducted two separate sub-analyses using incarceration overnight or longer since initiating injection drug use as the dependent variable. In multivariate GEE models that adjusted for all factors associated with incarceration in univariate analyses, we found that a history of incarceration was associated with both HIV (AOR 1.64, 95% CI: 1.21 – 2.23; $p < 0.01$) and HCV (AOR 1.94, 95% CI: 1.46 – 2.58; $p < 0.0001$) infection.

3.4 Discussion

In this study we observed that incarceration was a common experience among IDU using a local supervised injection site, with over half of the study population reporting a history of incarceration and almost one-third reporting recent incarceration at each study visit. Further, 29 (3.22%) of participants who reported an incarceration event during follow-up also reported injecting while in jail. Consistent with what is known about the adult prison population in Canada [44], males in our study were more likely than females to have been incarcerated. However, although it is well known that the Aboriginal population is overrepresented in Canadian prisons [45], Aboriginal ancestry was not associated with incarceration in our study. In separate sub-analyses, infection with HIV or HCV was positively associated with having been incarcerated overnight or longer since initiating injection drug use. In the multivariate GEE model, recent incarceration was positively associated with a number of high-risk drug-using practices, including public injecting, frequent heroin use and syringe sharing.

Our findings support previous work suggesting that the sharing of used syringes within prisons may be responsible for the transmission of blood borne pathogens in incarcerated populations [22, 26, 46, 47] and may potentially be a significant source of infectious disease transmission among IDU populations and their sexual partners in Canada [33, 34]. Our findings are not consistent with an earlier cross-sectional study from the province of Ontario that found a similar level of syringe sharing in prison and non-prison environments [14]. Although not verified by our data, it may be that the differences in syringe sharing across injection settings (i.e., prison vs. non-prison environments) may be explained by the availability of harm reduction programs such as needle exchange and supervised injection sites in the community in our setting, especially given the growing body evidence indicating their positive impact on rates of syringe sharing [48]. In this instance, the lack of a medical service for incarcerated individuals that is available in the community appears to contravene both a United Nations General Assembly resolution [49] and the Canadian federal law governing the operation of the prison system [50].

Our findings have clear policy implications. Numerous Canadian governmental and non-governmental organizations have called on the CSC to establish a pilot prison-based needle exchange programme [51-57]. It has consistently refused [26, 29, 30], despite evidence from Switzerland that its prison-based NEP was not associated with a single violent incident nor any case of seroconversion to HIV or HCV [58]. In 2006, the Public Health Agency of Canada reviewed the evidence from prison-based needle exchange programmes and concluded they do not lead to increased injection drug use, the use of needles as weapons but do decrease injection-related harms [59]. The CSC

responded to the report by again refusing to initiate a pilot programme, stating instead they "prefer to educate inmates about the dangers of drug use in prison" [31]. The CSC has also stated its "primary focus" is to reduce the supply of illicit drugs within its institutions [30]. Given the quantitative and qualitative findings regarding syringe sharing and injection while incarcerated [13, 60]; the high prevalence of blood-borne pathogens in Canadian jails [22, 26, 46, 47]; the consistent association between incarceration and infection with HIV and HCV [61]; and the CSC's continued failure to stem the flow of drugs into its institutions [13, 51, 55], it is clear that additional harm reduction measures are urgently needed in prisons. In particular, although the introduction of prison-based NEPs has been challenging in some cases due to the concerns of prison guards, in most settings these challenges have been overcome by utilizing various methods of syringe distribution, including peer-based syringe delivery [57]. Given what is known about the impact of community-based NEPs on HIV risk behaviour and HIV incidence, it is clear that such programs are likely to similarly reduce the transmission of blood-borne diseases in prisons.

This study has several limitations. First, GEE analyses cannot resolve the temporality between exposure and outcome; as well, in this cohort in any six month period the correlate could precede, follow or coincide with an incarceration event. Thus, this model cannot determine whether incarceration is a result of some factors, for example higher-intensity drug use, or if the effect of incarceration predisposes individuals to these behaviours. It is conceivable that the elevated likelihood of some of the identified correlates is a result of selection bias for higher-risk individuals [60], although it should be noted that we did adjust for a variety of high-risk behaviours.. It is also plausible that incarceration

disrupts customary networks and patterns of drug use, forcing newly-released individuals to rely on higher-risk means to support their addictions. Further work is needed to identify potential causal relationships between incarceration and risk behaviours and environments. Second, previous studies have observed that socially-undesirable behaviours may be underreported by IDU [62]. We know of no reason why risk factors would be differentially reported by IDU reporting or not reporting recent incarceration in this cohort. Finally, in this study incarceration events are not distinguished by type, length or location of incarceration. Future studies should aim to address the effect these modifiers might have on active IDU and risk behaviours.

In summary, the level of recent incarceration in this community-recruited sample is high and an alarmingly high proportion of active IDU reported injecting while incarcerated. Recent incarceration was independently associated with syringe sharing and a history of incarceration was independently associated with both HIV and HCV infection. These findings indicate the urgent need for alternative justice interventions for addicted individuals, including those that prioritize addiction treatment over incarceration, harm reduction programming in prisons, as well as the need for the federal government to respect the conclusions of the Public Health Agency of Canada [59].

Table 3.1 Univariate and multivariate GEE* of factors associated with recent incarceration (n = 902)

Characteristic	Unadjusted Odds Ratio (95% CI‡)	*p*-value	Adjusted Odds Ratio (95% CI‡)	*p*-value
Age				
(per year older)	0.96 (0.95 – 0.97)	< 0.001	0.97 (0.95 – 0.98)	< 0.001
Gender				
(female vs male)	0.66 (0.53 – 0.82)	< 0.001	0.51 (0.40 – 0.65)	< 0.001
Aboriginal ethnicity				
(yes vs. no)	0.99 (0.78 – 1.25)	0.914	-	-
Unstable housing †				
(yes vs. no)	2.93 (2.29 – 3.75)	< 0.001	1.92 (1.43 – 2.56)	< 0.001
Sex trade involvement †				
(yes vs. no)	0.93 (0.72 – 1.20)	0.567	-	-
DTES residence †				
(yes vs. no)	1.88 (1.51 – 2.33)	< 0.001	1.42 (1.09 – 1.85)	0.009
Current methadone use				
(yes vs. no)	0.62 (0.50 – 0.75)	< 0.001	0.75 (0.60 – 0.93)	0.009
Frequent heroin use †				
(yes vs. no)	1.91 (1.59 – 2.31)	< 0.001	1.32 (1.07 – 1.63)	0.010
Frequent cocaine use †				
(yes vs. no)	1.23 (0.99 – 1.52)	0.057	-	-
Frequent crack use †				
(yes vs. no)	1.88 (1.30 – 2.71)	< 0.001	1.30 (0.88 – 1.91)	0.190
Frequent crystal meth use †				
(yes vs. no)	1.07 (0.64 – 1.78)	0.806	-	-
Public injecting †				
(yes vs. no)	2.49 (2.05 – 3.01)	< 0.001	1.63 (1.30 – 2.03)	< 0.001
Non-fatal overdose †				
(yes vs. no)	1.51 (1.12 – 2.02)	0.006	1.14 (0.82 – 1.58)	0.428
Syringe sharing †				
(yes vs. no)	2.01 (1.52 – 2.66)	< 0.001	1.40 (1.03 – 1.89)	0.029
Drug dealing †				
(yes vs. no)	2.22 (1.84 – 2.69)	< 0.001	1.61 (1.30 – 1.99)	< 0.001
Condoms with regular partners †				
(yes vs. no)	0.96 (0.71 – 1.29)	0.776	-	-
Condoms with casual partners †				
(yes vs. no)	1.55 (1.21 – 1.98)	< 0.001	1.24 (0.95 – 1.62)	0.111

Note: * GEE = Generalized Estimating Equation; ‡ CI = Confidence Interval;
† Denotes activities/events in the previous 6 months.

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CHAPTER 4[1]

SYRINGE SHARING AFTER INCARCERATION AMONG INJECTION DRUG USERS

4.1 Introduction

Incarceration is common among injection drug users (IDU) and has consistently been associated with drug-related harms, especially infection with blood-borne pathogens like hepatitis C and HIV [1-3]. While many IDU cease drug use upon imprisonment [4, 5], those that persist do so in environments of elevated risk. In many penal facilities, including those in the United States, Canada, Australia and the United Kingdom, harm reduction measures, such as the distribution of sterile syringes, are unavailable and the possession of injection equipment is outlawed [6, 7]. Epidemiological surveys of prisoners in a variety of settings, including the United Kingdom [8-11], Greece [12] and Thailand [13, 14] identified endemic use of contaminated contraband syringes. Contact tracing investigations found this dynamic fuelled prison-based HIV outbreaks in Australia [15], Russia [16], Lithuania [17] and Scotland [1].

Although the link between imprisonment and HIV infection is robust and well described, the possible effects of incarceration on post-release behaviours of IDU and their HIV risk environment remain largely undetermined [18]. Findings from related inquiries into sexual risk factors for ex-prisoners suggest the experience of incarceration, transition to non-correctional settings and reintegration into communities all influence post-release behaviours [19-21]. While these studies are primarily concerned with individual-level sexual risks, newly-released prisoners often face

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difficulties finding employment [22, 23], securing housing [22, 24], reestablishing social supports [25, 26], accessing healthcare [22, 27], and enduring discrimination [28], and these factors are known to structure HIV risk for IDU [29, 30]. However, very little attention has been paid to the post-release trajectory of IDU or the specific determinants of their risk environment.

We are unaware of any analyses that identify the effect of incarceration on the risk factors for HIV infection following release from prison or analyses that describe the specific individual, social and structural determinants of the post-release risk environment for IDU. Thus, in the current analysis, we sought to determine the possible effect of imprisonment on the post-release risk environment by identifying the prevalence of independent risk factors for HIV infection before and after a period of incarceration as compared to a non-incarcerated matched control group.

4.2 Methods

In May 1996, the Vancouver Injection Drug User Study (VIDUS) began recruiting IDU through self-referral and street outreach. This prospective cohort study has been previously been described in detail [31]. In brief, individuals were eligible for recruitment if they had injected drugs at least once in the previous month, resided in greater Vancouver and provided written informed consent. At baseline and every six months, participants provide venous blood samples and complete an interviewer-administered questionnaire. This structured questionnaire elicits demographic data, information about recent drug use patterns, HIV risk behaviours, encounters with the criminal justice system and experiences in addiction treatment and other health-care settings. All participants are given a $20 stipend at each visit. This study has received

approval from the Providence Health Care/University of British Columbia Research Ethics Board.

To inform our analysis of HIV risk factors, we first identified all participants who reported being incarcerated in a municipal jail, provincial prison or federal penitentiary overnight or longer since initiating injection drug use, a definition consistent with previous analyses [32, 33]. Among these individuals, only those who had completed a study visit both before and after this incarceration episode were included in the incarcerated group. Using frequency matching, participants who had completed identical follow-up visits and did not report recent incarceration at these times were included in the control group. We examined if there were significant differences between the two groups with regards to age, gender and ethnicity (Aboriginal vs. non-Aboriginal) using χ^2 tests and Wilcoxon rank-sum tests.

Next, we selected explanatory variables that had previously been identified as implicated in the transmission of HIV in this setting: frequent cocaine injection (yes vs. no) [34]; frequent injection of a mixture of heroin and cocaine ("speedball") (yes vs. no) [35]; needing help injecting (yes vs. no) [36, 37]; binge drug use (yes vs. no) [38]; living in unstable housing (yes vs. no) [34]; having been denied addiction treatment (yes vs. no) [39]; residence in the DTES (yes vs. no) [31]; public drug use (yes vs. no) [40]; participation in the sex trade (yes vs. no) [36]; and syringe sharing (yes vs. no). We also included consistent condom use with regular sexual partners (yes vs. no) and consistent condom use with casual sexual partners (yes vs. no). As in previous work, frequent drug use was defined as once or more per day [41]. Unstable housing was defined as living in a single-room occupancy hotel room, a shelter, or being homeless [41]. All variables referred to the previous six months except unstable housing, which referred to current conditions.

To test for differences between the before and after periods within each group, we used McNemar's test to examine the proportion of individuals reporting each risk factor in the incarceration and control groups. To test for differences over time and between groups, we constructed linear growth curve models for each risk factor in which a statistically significant trend was observed in one or both groups. Commonly used in drug use research, the linear growth curve technique enables the identification of changes over time by using an interaction term in the model to determine if those changes are significant [42, 43]. In each linear growth curve model, the slope represents the differences in outcomes by group (incarcerated vs. control) over time (before vs. after); the *p*-value represents the significance of the interaction term. In addition, each model was adjusted for age, gender and ethnicity (Aboriginal vs. non-Aboriginal). All *p*-values were two-sided.

4.3 Results

Between May, 1 1996 and November 30, 2005, 1,603 participants were recruited, including 584 (36.4%) women and 435 (27.1%) people who reported Aboriginal ancestry. At baseline, the median age of the participants was 33 (IQR = 26-40). Among the study participants, 147 (9.2%) individuals reported an incarceration event and completed a follow-up survey both before and after the event. Of the remainder, 742 (46.3%) had identical follow-up periods but did not report an incarceration event; they were included in the matched control group. Participants in the matched control group had a median age of 35.5 (IQR: 28.8 – 41.3), significantly older than the incarceration group (median age: 33.4, IQR: 26.3 – 39.0, p-value < 0.01). The groups did not differ significantly with respect to gender or ethnicity.

The proportion of each group reporting HIV risk factors in each period, as well as the result of McNemar's test assessing whether the proportions within groups are equal, is reported in Table 1. No significant differences between the before and after period were observed for either the incarcerated or control group in the prevelance of frequent speedball injection, living in unstable housing, being denied addiction treatment, public drug use or consistent condom use with regular or casual sexual partners (all $p > 0.05$). Thus, these factors were not included in the linear growth curve analyses. For frequent cocaine injection, a significant decrease was observed in the control group ($p < 0.001$); the decrease among the incarcerated group was not statistically significant. A statistically significant decrease in needing help injecting was observed in both the incarcerated and control group (both $p < 0.001$). For binge drug use, a statistically significant decrease was observed in both the incarcerated ($p < 0.005$) and control ($p < 0.001$) groups. Fewer individuals in both the incarcerated ($p = 0.016$) and control ($p = 0.011$) groups reported living in the DTES. A significantly lower proportion of individuals reported participating in the sex trade in the incarcerated ($p = 0.012$) and matched ($p < 0.001$) groups. A statistically significant decrease in the prevalence of syringe sharing was observed in the non-incarcerated group ($p < 0.001$); the decrease in the incarcerated group was not statistically significant ($p = 0.398$).

The results of the linear growth curve analyses are presented in Table 2. In models adjusted for age, gender and Aboriginal ethnicity, no significant differences were found in the prevalence of frequent cocaine injection ($p = 0.737$); needing help injecting ($p = 0.201$); binge drug use ($p = 0.273$); living in the DTES ($p = 0.105$) or participation in the sex trade ($p = 0.623$) before and after a period of incarceration compared to a matched control group. However, in the linear growth curve analysis of syringe sharing, a significant difference ($p = 0.033$) was observed between the slopes for

the incarcerated and control groups, indicating a significant decrease in prevalence in the control group but no significant decrease in the incarcerated group.

4.4 Discussion

In this analysis, we found individual, social and structural risk factors for HIV infection were common among active IDU both before and after periods of incarceration. In a linear growth curve analysis, individuals reporting incarceration were significantly more likely to report sharing contaminated sharing syringes in the after period, unlike individuals who did not report incarceration.

This finding sheds further light on the relationship between incarceration and the ongoing HIV epidemic among IDU in this setting. Both qualitative [44] and quantitative [32-34] findings from two prospective cohorts of IDU in Vancouver have confirmed the link between incarceration and an elevated risk of infection [31, 34]. In a longitudinal analysis of incident cases, individuals reporting incarceration were more than twice as likely to become infected with HIV [34]; incarceration was also independently associated with syringe sharing [32, 33]. As a result of these risks and the high prevalence of incarceration among local IDU [32], 21% of HIV cases in the Vancouver outbreak are estimated to be the result of imprisonment [45]. The current findings suggest the environment or experience of incarceration supports the persistence of syringe sharing among individuals after they are released from custody. While these findings are exploratory, they should spur further research to evaluate hypotheses examining the cause of post-release syringe sharing, for example, whether IDU are normalized to the practice while incarcerated [44].

To our knowledge, this is the first analysis to evaluate the effect of incarceration on post-release rates of syringe sharing. Two previous studies measured the prevalence

of syringe sharing following release from prison in Bangkok, Thailand [2] and New South Wales, Australia [46]. In Thailand, HIV-positive cases were significantly more likely (AOR = 2.9, 95% Confidence Interval: 1.7 – 5.0) to report borrowing syringes in the month following incarceration compared to HIV-negative controls. In Australia, a larger proportion of HIV-positive cases (20%) than HIV-negative controls (15%) reported syringe sharing after discharge from prison. However, in neither study could the effect of incarceration be determined as a non-incarcerated control group was not included; the comparison group was constructed by serostatus. In our study, the use of a non-incarcerated control group allowed the identification of the independent effect of imprisonment.

We did not observe an effect of imprisonment on any of the risk factors for HIV also classified as crimes in our setting, including participation in the sex trade and illicit drug use. This is in line with previous analyses that found many IDU resume drug use following release [47] and that there is no empirical evidence to support the use of enforcement to reduce the population prevalence of drug use [48]. While this study was not conducted as an evaluation of local prison rehabilitation programmes, nor was exposure to prison-based treatment a covariate in these analyses, it should be noted that no beneficial effect of incarceration could be detected among the individuals participating in this study, despite addiction treatment programmes in some local prison settings [49, 50].

These findings suggest a need for a number of policy reforms. The recent decision by Canada's federal government to remove harm reduction from the official "Anti-Drug Strategy" while increasing its emphasis on law enforcement [51] should be considered in light of these findings and previous analyses linking imprisonment and syringe sharing [4, 32, 33, 44]. On a practical level, federal and provincial prison

authorities should expand the in-prison availability of methadone maintenance therapy, recently shown in a randomised control trial to improve treatment and drug-use outcomes for recently-released prisoners [52], and promote post-release support and referral to harm reduction opportunities, including needle exchange, addictions treatment and the city's supervised injection facility.

This study has methodological limitations to consider when evaluating the findings. First, VIDUS is not a random sample, although it is believed to be representative of the local population of IDU. Second, although several of the surveyed behaviours may be under- or over-reported due to social desirability, we do not believe they were differentially reported by incarceration history. Finally, we were not able to include the length or location (i.e., municipal, provincial or federal) of incarceration events in these analyses.

To conclude, we evaluated the prevalence of independent risk factors for HIV infection before and after incarceration among active IDU, and, after comparison with a matched control group, observed a statistically significant relationship between syringe sharing and the post-release period. We did not find any association between incarceration and the frequency of other individual, social and structural factors, including those also defined as crimes. These findings point to the need for the ongoing development of programs both within and following prison that aim to reduce risk behaviour among IDU exposed to correctional environments.

TABLE 4.1 Risk factors for HIV infection among incarcerated cases ($n = 147$) before and after a period of incarceration compared to matched controls ($n = 742$)

Risk factor	Before		After		*p*-value*
	n	%	*n*	%	
Frequent cocaine injection					
Incarcerated	46	31.3	37	25.2	0.170
Matched control	205	27.6	150	20.2	**< 0.001**
Frequent speedball injection					
Incarcerated group	12	8.2	17	11.6	0.297
Matched control	70	9.4	67	9.0	0.748
Need help injecting					
Incarcerated group	46	31.3	27	18.4	**0.001**
Matched control	202	27.2	142	19.1	**< 0.001**
Binge drug use					
Incarcerated group	66	44.9	45	30.6	**0.005**
Matched control	271	36.5	210	28.3	**< 0.001**
Unstable housing					
Incarcerated group	100	68.0	101	68.7	0.889
Matched control	418	56.3	414	55.8	0.806
Denied addiction treatment					
Incarcerated group	24	16.3	19	12.9	0.411
Matched control	95	12.8	81	10.9	0.230
Resident in the DTES					
Incarcerated group	96	65.3	78	53.1	**0.016**
Matched control	377	50.8	343	46.2	**0.011**
Public drug use					
Incarcerated group	32	21.8	22	15.0	0.114
Matched control	116	15.6	110	14.8	0.602
Sex trade participation					
Incarcerated group	36	24.5	25	17.0	**0.012**
Matched control	154	20.8	116	15.6	**< 0.001**
Syringe sharing					
Incarcerated	38	25.9	33	22.5	0.398
Matched control	231	31.3	133	17.9	**< 0.001**
Condoms w/casual partners					
Incarcerated	27	18.4	23	15.7	0.505
Matched control	116	15.6	103	13.9	0.312
Condoms w/regular partners					
Incarcerated	30	20.4	28	19.1	0.739
Matched control	133	17.9	113	15.2	0.121

* *p*-value associated with McNemar's test of equality

TABLE 4.2 Linear growth curve analyses of HIV risk factors modelled as outcome, adjusted for age, gender and ethnicity (Aboriginal vs. non-Aboriginal)		
Risk factor	Slope	*p*-value
Frequent cocaine injection		
Incarcerated	-0.342	0.737
Matched control	-0.403	
Need help injecting		
Incarcerated	-0.777	0.201
Matched control	-0.467	
Binge drug use		
Incarcerated	-0.630	0.273
Matched control	-0.373	
Resident in the DTES		
Incarcerated	-0.574	0.105
Matched control	-0.185	
Sex trade participation		
Incarcerated	-0.575	0.623
Matched control	-0.398	
Syringe sharing		
Incarcerated	-0.217	**0.033**
Matched control	-0.722	

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CHAPTER 5

RESEARCH FINDINGS, UNIQUE CONTRIBUTIONS, POLICY IMPLICATIONS, FUTURE RESEARCH AND CONCLUSIONS

5.1 Research findings

The three analyses in this thesis each investigated the effect of incarceration on the health of individuals who inject illicit drugs, especially infection with blood-borne pathogens like HIV. As well as confirming a number of findings from other settings, these studies add new evidence to the growing literature on the negative public health impacts of public order interventions to control illicit drug use.

Chapter 2 surveyed the available peer-reviewed and grey literature on the relationship between incarceration and HIV for injection drug users, focusing on the correctional risk environment and its role in sustaining viral transmission patterns. The dynamic which emerged from the review of cross-sectional, longitudinal, qualitative and contact tracing investigations among prisoners and formerly-incarcerated IDU was remarkably consistent regardless of setting. Individuals who inject drugs bear a heavy burden of incarceration; once incarcerated, many cease drug use while others continue, facing an environment of elevated risk of infection with blood-borne pathogens. Although drug use is pervasive, institutional factors typically restrict the supply of sterile injection equipment. As a result, the prevalence of infection with blood-borne pathogens such as HIV is typically higher among imprisoned populations than in analagous non-imprisoned populations.

Chapter 3 observed the level of incarceration in a prospective cohort of active injection drug users and, in a longitudinal multivariate regression analysis, identified factors associated with reporting recent incarceration. Consistent with previous

analyses [1-4], the study found that incarceration was a very common experience for local IDU; alarmingly, a high proportion of participants reported injecting while incarcerated. In the multivariate regression model, syringe sharing was independently associated with reporting incarceration after adjustment for a variety of sociodemographic characteristics and drug-using behaviours. Recent incarceration was also associated with poorer housing status, male gender, living in the DTES, frequent heroin use, injecting in public and drug dealing. Individuals reporting engagement in methadone maintenance therapy were statistically less likely to report recent incarceration. Also, in separate sub-analyses, infection with HIV and HCV were both associated with a history of incarceration since initiating injection drug use. Taken together, these findings support earlier work [5-8] that determined that the sharing of used syringes while incarcerated may be responsible for the transmission of blood-borne pathogens among IDU.

Chapter 4 used a linear growth curve analysis to estimate the effect of incarceration on the post-release risk environment for active IDU. Specifically, the study observed the prevalence of individual-, social- and structural-level factors associated with HIV infection before and after a period of incarceration among active IDU reporting incarceration compared to an age-, sex- and ethnicity-matched non-incarcerated control group. Chapter 4 found that sharing syringes was significantly associated with the after period for active IDU reporting incarceration; no effect of imprisonment on several risk factors classified as crimes in this setting, including illicit drug use and participation in the sex trade, was observed. These findings support the hypothesis that the harms produced by the correctional risk environment persist past the period of imprisonment.

5.2 Unique contributions

These analyses and their findings make a number of unique contributions to the epidemiologic literature on the transmission of blood-borne pathogens among IDU.

Although a number of recent studies have surveyed aspects of incarceration and HIV transmission for IDU — including substitution treatment in prisons [9], substance abuse among prisoners [10], the burden of blood-borne pathogens among US prisoners [11], HIV prevalence in prisons in low- and middle-income countries [12] and prison-based syringe exchange programmes [13] — only one [14] reviewed the prevalence of both risk factors for and infection with HIV among incarcerated populations. The literature review in this thesis included information about the experience and risk environment of prisons gathered from both incarcerated and non-incarcerated populations. Further, it is the first to explicitly consider imprisonment within the risk environment framework and, as such, the role of correctional institutions sustaining viral transmission.

Chapter 3, a version of which has been published in *Drug and Alcohol Review* [15], is among the first analyses to investigate the level of and factors associated with incarceration in a community-recruited prospective cohort of active IDU. Also, it is among the first to assess the relationship between a history of incarceration and seropositivity for HIV or HCV among active IDU. Further, few studies [16-18] have evaluated the level of injecting within prison reported by formerly incarcerated study participants. In addition, this study is among the few to take advantage of a dataset using repeated measures of cohort participants. This permitted the use of longitudinal regression analysis which typically provide a more precise estimate of population- and individual-level effects [19]. Finally, the finding of an association between recent incarceration and syringe sharing in the multivariate regression model provides

evidence of an independent effect for incarceration after adjustment for possible confounders. This supports the hypothesis that the elevated HIV prevalence observed in many penal settings is not only the result of selection bias for riskier individuals but also a result of the correctional risk environment itself.

The final study used a linear growth curve analysis which, although common in studies of illicit drug use, has not often been applied to investigations of HIV transmission patterns. This analysis was among the first to not only describe features of the post-release risk environment for active IDU but also to evaluate the possible effect of imprisonment on HIV risk factors using an imprisoned and control group. While only an exploratory study, the finding of an association between syringe sharing and the post-release period for IDU with a history of incarceration supports further investigation into the effect of incarceration on individual-, social- and structural-level factors for HIV infection.

5.3 Policy implications

These analyses assessed the effect of on injection drug users of incarceration, the dominant societal response to injection drug use. As such, their findings suggest a number of implications for the improvement of public policy.

Taken together, a number of findings — specifically the multiple links between incarceration and syringe sharing and the association between a history of incarceration and infection with HIV and HCV — provide evidence of the direct harm produced by the correctional environment on the health of addicted individuals and, as such, support urgent measures to reform Canada's jails and penitentiaries. As discussed in Chapter 3, these reforms should be informed by the principle of equivalence of care, endorsed by the United Nations as: "Prisoners shall have access to the health services

available in the country without discrimination on the grounds of their legal situation [20]", as well as section 86 of Canada's *Corrections and Conditional Release Act 1992* [21] which mandates all inmates must receive "essential health care" that conforms "to professionally accepted standards." Given these obligations and the findings of this thesis, it is clear that Canada's federal, provincial and municipal correctional authorities should follow recommendations from numerous expert observers [22-26] and immediately design, implement and evaluate a pilot prison-based needle exchange programme. Correctional authorities, in consultation with public health authorities and local drug users, should also consider appropriate evidence-based measures which have been shown to reduce the likelihood of drug-related harm, such as therapies for drug and alcohol addiction, including substitution treatments [27-31]. A number of exhaustive reviews of successful prison-based needle exchange programmes have already been published [26, 32] which could guide the implementation of a pilot project in a Canadian context. As discussed in Chapter 2, numerous harm reduction interventions described in the review have been successfully implemented in correctional environments in many settings internationally with few adverse events. Further, the results of the linear growth curve model presented in Chapter 4 point to the need for prison- and community-based programmes to support individuals moving from the prison to non-prison environment. These programmes could ensure continuity of care, especially for treatment for drug and alcohol addiction, including substitution therapy, as well as access to appropriate harm reduction strategies, including needle exchange and supervised injection facilities, especially given the high risk of fatal overdose in this period [33].

In addition, a number of findings — including the high level of imprisonment among active IDU; the greater risk for incarceration faced by individuals with the most

intense drug-use profile; the apparent lack of effect of prison on criminal activity; and the extensive links between imprisonment and infection — provide further support for the statement that "the single most important strategy in controlling HIV in prison is to stem the rate of incarceration itself." [34] Alternative criminal justice interventions for individuals suffering from addictions, such as programmes that prioritize treatment over imprisonment, should be developed. Also, reform of all aspects of drug market enforcement should be considered, from changes in police tactics and procedure to repeal of anti-drug statutes. Finally, innovations to complement public order interventions with public health principles should be considered. For example, Drug Action Teams (DATs) in the United Kingdom are meant to facilitate cooperation between police, social service and public health agencies to encourage diversion of addicted offenders towards medical services [35]. Unfortunately, results of evaluations have been mixed [36]; it remains an open question if the principles of harm reduction are compatible with the culture and tactics of urban police forces [37]. Other political and legal initiatives may need to be developed to restrict the criminal justice system's jurisdiction over addicted individuals.

5.4 Future research

The findings and limitations of this thesis suggest a number of future research opportunities. In general, this thesis supports the observation that data available from the penal setting is limited [12] and limits opportunities for necessary evaluations. As discussed in Chapter 2, analyses involving prisoners are typically cross-sectional, often voluntary, and occasionally omit discussion of behaviours or conditions deemed inappropriate. There is no ongoing study of prisoners followed prospectively from intake, through their sentence, and to discharge, which could estimate some effects of

incarceration. For IDU, these thesis findings support the contention that imprisonment should be evaluated as an intervention; given its profile in the health of addicted individuals, future analyses could explore if imprisonment has any positive rehabilitative effect on addiction.

Given that the findings presented here support the use of a correctional risk environment framework to analyse the health of IDU, future inquiries should endeavour to further describe its social and structural characteristics. For example, there is a need to differentiate the correctional risk environment by institution, security level, length of sentence, presence or absence of specific health care opportunities, and other factors.

Finally, considering the prevalence of incarceration in many studies of IDU, it is perhaps surprising that more attention has yet to be paid to its effect on post-release behaviours, conditions and outcomes. While only syringe sharing was significantly associated with the post-release period among active IDU reporting incarceration in Chapter 4, future work might benefit from more precise measures of incarceration to describe the post-release risk environment. For example, a number of retrospective mortality analyses have identified the high risk of death from overdose faced by newly-released prisoners [33, 38]; the post-release period should be evaluated for its effect on the risk environment for HIV infection.

5.5 Conclusions

The analyses in this thesis support the contention that correctional facilities in Canada are, for individuals suffering from addiction to outlawed drugs, unsafe environments. For individuals who use injection drugs, incarceration is associated with harms both during and after release from custody. Within the context described in

Chapter 2's literature review, the longitudinal analysis in Chapter 3 identified a high burden of incarceration among local IDU and found it to be associated with a number of higher-risk practices, including sharing of used syringes. Using a linear growth curve technique, the analysis in Chapter 4 assessed the effect of imprisonment on the post-release risk environment and found that syringe sharing was associated with the after period among active IDU reporting incarceration. Taken together, these findings support numerous previous complaints that Canada's prison systems are responsible for the spread of infectious disease among people who use injection drugs. While the proximate cause of these potentially prison-acquired infections is, as identified in Chapter 3, the use of contaminated syringes, the ultimate causes include the social and structural factors embedded in the prison risk environment.

These findings support not only various urgent measures to reform the prison environment, including the provision of appropriate harm reduction measures such as needle exchange, but also interventions to lower the incidence of incarceration among IDU. A reduced emphasis on criminal justice approaches to issues of illicit drug use and addiction will lower the number of individuals exposed to the prison risk environment. In the interim, Canada's correctional administrators, public health authorities and political representatives must endeavour to guarantee the right to equivalent healthcare enshrined in international covenants and federal law.

By describing a small aspect of the harm to public health caused by criminal justice interventions, it is hoped this thesis supports efforts to improve the health and protect the human rights of individuals who use illicit drugs.

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ETHICS CERTIFICATE OF EXPEDITED APPROVAL

PRINCIPAL INVESTIGATOR:	DEPARTMENT:	UBC-PHC REB NUMBER:
Thomas Kerr	UBC/Medicine, Faculty of Medicine	H08-01730

INSTITUTION(S) WHERE RESEARCH WILL BE CARRIED OUT:

Institution	Site
Providence Health Care	St. Paul's Hospital

Other locations where the research will be conducted:
Downtown Eastside study office

COINVESTIGATOR(S):
Michael-John Milloy

SPONSORING AGENCIES:
N/A

PROJECT TITLE:
Incarceration and risk of HIV infection among injection drug users in Vancouver

THE CURRENT UBC-PHC REB APPROVAL FOR THIS STUDY EXPIRES: July 23, 2009

The UBC-PHC Research Ethics Board Chair or Associate Chair, has reviewed the above described research project, including associated documentation noted below, and finds the research project aceeptable on ethical grounds for research involving human subjects and hereby grants approval.

DOCUMENTS INCLUDED IN THIS APPROVAL:	APPROVAL DATE: July 23, 2008	
Document Name	**Version**	**Date**
Protocol:		
Michael-John Milloy Research Proposal	N/A	August 10, 2008

CERTIFICATION:

1. The membership of the UBC-PHC REB complies with the membership requirements for research ethics boards defined in Part C Division 5 of the Food and Drug Regulations of Canada.
2. The UBC-PHC REB carries out its functions in a manner fully consistent with Good Clinical Practices.
3. The UBC-PHC REB has reviewed and approved the research project named on this Certificate of Approval including any associated consent form and taken the action noted above. This research project is to be conducted by the principal investigator named above at the specified research site(s). This review of the UBC-PHC REB have been documented in writing.

Approval of the UBC-PHC Research Ethics Board or Associate Chair, verified by the signature of one of the following: