FACTORS ASSOCIATED WITH VOLUNTARY HIV TESTING AND SEROSTATUS
AMONG NORTH CAROLINA STATE PRISONERS, 2004-2006

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ABSTRACT

DAVID L. ROSEN: Factors associated with voluntary HIV testing and serostatus among

North Carolina state prisoners, 2004-2006

(Under the direction of Victor J. Schoenbach)

Background. Despite the heavy burden of HIV among prisoners, HIV testing strategies vary widely across US state prison systems. A voluntary HIV testing program in a large southern state prison system was evaluated by estimating HIV testing rates among prisoners, identifying inmate characteristics associated with testing status and infection status, and estimating the number of infected prisoners who remained untested during their incarceration.

Methods. Electronic imprisonment and lab records were obtained for all prisoners entering the NC DOC between January 2004 and May 2006. Associations between inmate characteristics and both HIV testing and HIV serostatus were estimated separately using log-linear and logistic regression. The number of undetected cases was estimated using age-sex-race specific HIV prevalences from tested prisoners and from statewide HIV reporting.

Results. Eight-five percent of female and 31% of male prisoners were tested for HIV during their incarceration. In four of the six intake prisons for men, <15% of prisoners were tested. Among men, the proportion tested was 10% higher among those reporting heroin use, crack/cocaine use, tuberculosis disease, and any conventional HIV risk behavior (e.g. sharing needles, MSM), but >60% of men reporting a conventional risk behavior remained untested.

In bivariate and covariate-adjusted analyses, black men were 30% and 13%, respectively, less likely than whites to be tested.

Nearly 3.4% (718/21,419) of tested prisoners were HIV+. Of those HIV+ prisoners, <50% reported a history of any conventional HIV risk behaviors. Infection was most strongly associated with being a MSM (OR=8.0), non-white race (OR=6.2-7.4), and ages 35-44 years (OR=4.1). The strongest risk factor among women was black race (OR=3.8); ORs < 3.0 were observed for several other risk factors. Sixty-five percent of HIV+ prisoners were HCV-coinfected. Between 23% and 63% of HIV cases remained undetected.

Conclusion. HIV testing varied greatly by intake prison, and many male inmates were never tested. The majority of cases denied conventional HIV risk behaviors suggesting limitations of risk-factor based testing. Expanded HIV testing could improve case finding. However, testing expansion must be joined with adequate treatment and follow-up services, and monitoring is needed to ensure testing is not coercive.

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This dissertation would not have been possible without the advice, expertise, and hard work of many people. Foremost, I am grateful for the guidance provided by my dissertation committee and, in particular, the committee chair, Victor Schoenbach. Dr. Schoenbach's balance of thoughtful critique and support helped ensure that this project was a productive learning experience. After interacting with Dr. Schoenbach for many years—as a student in his class, teaching assistant, and masters and doctoral advisee—I can think of no other professor who matches Dr. Schoenbach's selfless commitment to students' academic and professional development.

I have had the pleasure of knowing and, in many cases, working with other committee members for several years. Before I began to consider graduate school, David Wohl hired me in 1998 to enter data for a clinical study with the promise that I could assist him with prison-related research as those projects were launched. Looking back, it is with some amazement that those early research experiences in the prison system eventually led me to a dissertation nearly a decade later. I credit the rich environment created by Drs. David Wohl, Becky White, Carol Golin, and the late Andrew Kaplan during that early period of research with not only seeding my interest in this dissertation project, but more broadly in fostering my interest in a career as a physician-researcher.

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LIST OF ABBREVIATIONS

AIDS   Acquired Immune Deficiency Syndrome

AMA   American Medical Association

APHA   American Public Health Association

BJS   Bureau of Justice Statistics

CDC   Centers for Disease Control and Prevention

DSM   Diagnostic and Statistical Manual of Mental Disorders

HAART   Highly Active Antiretroviral Therapy

HITS   HIV Testing Survey

HIV   Human Immunodeficiency Virus

HBV   Hepatitis B

HCV   Hepatitis C

IDU   Injection Drug Use

MSM   Men who have Sex with Men

NC DOC   North Carolina Department of Correction

NC DHHS   North Carolina Department of Health and Human Services

RPR   Rapid Plasmid Reagin

TB   Tuberculosis

WHO   World Health Organization

CHAPTER 1

INTRODUCTION

In June, 1981, the Centers for Disease Control and Prevention (CDC) published a report of "5 young men, all active homosexuals" who had laboratory confirmed *Pneumocystis carinii* pneumonia.[1,2] The editorial accompanying the report concluded that the cases "suggested the possibility of a cellular-immune dysfunction related to a common exposure that predisposes individuals to opportunistic infections." [1,2] During the next two years, the wide range of sequelae resulting from the cellular-immune dysfunction referred to in the editorial would be named Acquired Immune Deficiency Syndrome (AIDS), and its causative pathogen identified as the Human Immunodeficiency Virus (HIV).

By the mid 1980's, the annual number of new HIV infections in the US reached 150,000 and the number of deaths was ever-increasing.[3] But a combination of public awareness, public health prevention programs, and the eventual development of treatment reduced both the spread and the toll of AIDS domestically. By the mid 1990's, the number of new AIDS cases and AIDS deaths began to dramatically decline.[3] Despite these declines, the number of new HIV infections has remained essentially stable at an estimated 40,000 annual cases for the last 15 years.[4]

At the same time, the face of HIV/AIDS has changed. Initially seen as a gay white man's disease, by the 1990s HIV/AIDS was disproportionately prevalent among poor

minority communities including women. Despite comprising just 13% of the US population, by 1996 blacks accounted for more new cases of HIV than any other racial/ethnic group.[3]

As HIV was becoming increasingly prevalent among minority communities, these same communities were being disproportionately affected by incarceration. Starting in the late 1970s and continuing through the 1980s and 1990s, the prison population increased nearly 3-fold, a result of harsher sentences with less flexibility for early release and an increase in the imprisonment rate among arrestees.[5] Although both blacks and whites experienced large relative increases in imprisonment, the absolute increase among blacks greatly outpaced that of whites. From 1974 to 2001, the proportion of US residents ever imprisoned rose from 1.4% to 2.6% among whites and from 6.7% to 16.6% among blacks,[6] so that today the US has the highest imprisonment rate in the world.[7]

With overlap between behaviors that increase risk for both HIV infection and arrest, and overrepresentation of minority communities with relatively high rates of HIV infection, prisons have become an important venue to identify new HIV cases. But in the absence of federal regulations, HIV testing policies differ across US state prison systems.

As of 2005, 22 state prison systems mandated HIV testing for all inmates.[8] In the other 27 state prison systems with available data, voluntary (i.e. consent-based) testing is performed. Little is known, however, about the extent of use or effectiveness of voluntary HIV testing in prison. In light of the 2006 CDC recommendations to expand HIV testing in the US across venues, including correctional settings, this dissertation assesses the use of voluntary HIV testing services in a large southern prison system, the North Carolina Department of Correction (NC DOC). Specific aims of this project are the following:

Specific Aim 1. Determine system-wide and facility-specific HIV testing rates among inmates without a pre-existing HIV diagnosis, in a state prison system with voluntary HIV testing

Specific Aim 2. Identify inmate characteristics associated with receipt of an HIV test among inmates without a pre-existing HIV diagnosis

Specific Aim 3. Identify inmate characteristics associated with HIV serostatus

Specific Aim 4. Estimate the number of HIV-infected prisoners who remain untested in the North Carolina prison system

Chapters 2 and 3 provide a review of issues relevant to HIV testing services in prison. Chapters 5 and 6, which were written as stand-alone manuscripts, present the results of analyses addressing specific aims one through four. Chapter seven provides a synthesis of results and discussion from chapters 5 and 6, presents policy recommendations, and outlines future areas of inquiry.

CHAPTER 2

BACKGROUND AND SIGNIFICANCE

.   At mid-year 2003 US state prisons incarcerated approximately 1.2 million individuals,[9] a population that has grown by 270% since 1985.[10]   The majority of those incarcerated are impoverished young men of color[9] with low levels of educational achievement[11] and little contact with health care services.[12, 13] In the community, these men have high rates of communicable diseases.[13] Since there is some commonality between illicit behaviors and behaviors that put one at risk for communicable disease, the burden of communicable diseases tends to be disproportionately high in prison populations as compared to community populations.

HIV has taken a particularly high toll on the health of incarcerated populations. The prevalence of HIV among state prison inmates is estimated to be 2.3-2.98%, a range approximately 8-10 times that of non-incarcerated populations (0.3%).[14] With 13-19% of all those infected with HIV thought to be released from a prison or jail each year, [14] these facilities provide an important opportunity to test high risk populations.[15] HIV screening in prison has been endorsed by the Centers for Disease Control and Prevention as a key strategy in the control of the US HIV epidemics.[16]

There are several individual and societal benefits of HIV testing.

<u>Inmates tested for HIV in prison are more likely to receive their results than if tested in the community</u>.

In community settings, HIV testing services are limited by clients' willingness to return for results. A multi-city study of high-risk individuals conducted as part of the CDC's HIV Testing Survey (HITS) found that 10- 27% of respondents failed to return for test results, and those with the highest self-perception of risk for infection were least likely to return.[17] Greater than half (55%) of clients attending public testing sites in one southern state did not return for their results and 7 HIV-infected individuals were never located.[18] Given these high rates of failure to return, it is not surprising that receipt of results is higher among incarcerated testers than testers in other settings (CDC unpublished data, cited in [19]).

<u>HIV-positive inmates can matriculate into medical care and access ancillary services</u>.

Once detected, infected inmates can initiate medical treatment at no monetary cost to themselves; access to antiretroviral care is a constitutionally protected right (8th Amendment), confirmed by the courts.[14] HIV treatment can suppress viral burden resulting in reconstitution of the immune system, reduction in opportunistic infections, and reduction of transmission risk. HIV care in prisons has generally been successful as demonstrated by a 75% decline in AIDS-related deaths among state prisoners from 1995 to 2001,[20] a reduction comparable to national trends among non-incarcerated populations.[21] Two studies supporting the benefits of HIV care in prison report that recidivists have greater levels of viral suppression while incarcerated than in the community.[22, 23] In addition to medical services, the widespread availability of substance abuse treatment programs and mental

health services available in prison may provide psychosocial support to inmates as they deal with the emotional, social and psychological consequences (e.g. depression and adjustment disorder) commonly associated with newly detected infection.

Diagnosed inmates may reduce their risk behaviors as they return to their communities.

With counseling and testing shown to reduce sexual risk behaviors among individuals testing seropositive,[24-26] inmates testing positive for HIV while in prison may reduce the frequency of their high risk behaviors upon release, as compared to pre-incarceration levels. As a result, HIV testing in prison may help reduce community rates of HIV transmission. Studies conducted among Rhode Island and Massachusetts inmates have shown that services which support continuity of care as HIV-infected inmates return to their communities have the additional benefit of reducing recidivism among this population.[27, 28] These reductions may be indicative of reduced risk behaviors in the community.

Most prison inmates are incarcerated in facilities with voluntary HIV testing; large variations in testing rates exist between state systems.

As of 2005, 22 state prison systems had a policy of mandatory HIV testing upon prison admission. Of the other 27 prison systems without a policy of mandatory testing upon inmate admission (data was unavailable for Alaska), all systems reported testing upon inmate request, 7 reported targeted testing of high risk groups, and 26 reported testing upon clinical indication.[29] All of these testing scenarios require inmate consent, and as such, are collectively referred to as voluntary testing.[30] Our calculations indicate that greater than 50% of all prison inmates are incarcerated in prison systems with a policy of voluntary testing, and data from existing studies suggest that HIV testing in these prison systems ranges widely

(39%-71%).[31, 32] These observed testing rates, however, may not be representative of nationwide testing.

Despite the large number of inmates incarcerated in facilities with voluntary testing and the wide range of testing rates from existing studies, few studies have examined individual and systemic factors related to inmates' receipt of HIV testing. Information from such an evaluation could be useful in improving voluntary testing programs.

HIV testing is likely to remain consent-based within the majority of prison systems. The proportion of prison systems with voluntary HIV testing has remained relatively stable since at least 1993[33, 34], suggesting that a policy of voluntary testing is firmly entrenched in many prison systems. The continued implementation of voluntary testing is firmly supported by the American Public Health Association, and the World Health Organization Programme on AIDS considers mandatory testing unethical and a violation of basic human rights[35, 36]. Despite some experts' argument that mandatory testing, conducted in a non-prejudicial manner, is an effective and appropriate policy to detect HIV infection,[15] there is little evidence to suggest future policy changes. As such, the evaluation of voluntary HIV testing among inmates is, and will likely remain, a relevant public health issue.

Seroprevalence studies indicate a substantial proportion of infected inmates remain undetected in prison systems with voluntary testing.

Seroprevalence studies that include information about inmate testing decisions provide a powerful tool to evaluate the effectiveness of voluntary testing services. Rates of HIV infection observed in seroprevalence studies exceeded rates of infection observed from voluntary testing alone in the Maryland, California, Illinois, New Jersey,[30] Wisconsin[37] and

Oregon[38] state prison systems. Studies in the Maryland (1994)[39] and Wisconsin (1998)[37] state prison systems, for example, reported that rates of HIV-infection among those tested blindly were twice that of volunteer testers. In Wisconsin, 31% (8/26) of all HIV-infected inmates declined to be tested, and in Maryland 66% (134/204) of all HIV-infected inmates declined testing, suggesting that an important proportion of HIV-infected inmates remain undetected in prison systems with volunteer testing policies. While some HIV-infected inmates in these studies may have opted out of testing because they were already aware of their serostatus, no documentation exists to substantiate this possibility.

Overlap exists between inmate characteristics associated with both HIV infection and decreased acceptance of testing.

Four US seroprevalence studies reporting inmate characteristics and HIV infection status have been published in the last 15 years. Inmate characteristics associated with HIV-infection in these studies include female gender[39, 40], African American[37, 39, 41] and Hispanic[32] race-ethnicities, increasing age,[37, 39, 41] increasing number of prior incarcerations,[32] shorter sentence length,[39] history of sexually transmitted disease,[39, 41] history of injection drug use,[39, 41] Hepatitis B seropositivity,[37] and history of a psychiatric condition.[41]

Three US studies and one Canadian study have examined the relationship between inmate characteristics and acceptability of testing. The Maryland study (1994) found inmates 40 years of age or older, drug offenders, and African Americans were reported to be more likely to refuse voluntary HIV testing than other inmates.[39] Inmates with hepatitis B seromarkers[37] and female inmates with a history of drug-related convictions or exchanging sex for money or drugs[42] have also been shown to have lower acceptance rates of HIV tests

compared with other inmates. A more recent study of Ontario inmates by Burchell et al found that testing was positively associated with injection drug use but negatively associated with report of "casual" community partners.[43]

In total, the overlap of characteristics associated with both HIV infection and decreased acceptance of testing is cause for great concern and supports the need for research investigating reasons why high risk inmates opt out of voluntary HIV testing.

Although few studies have been conducted examining HIV testing among prisoners, reasons informing testing decisions have been examined among other high risk populations. The CDC's HITS is a serial, multi-city study of HIV testing decisions among individuals at high risk for HIV; respondents were recruited through STD clinics, street outreach, and gay bars.[44] The first two waves, HITS-I and HITS-II, were conducted during 1995-1996 and 1998-1999, respectively. Statements most frequently endorsed by respondents tested for HIV were "to know where you stood" (HITS-I 41%, HITS-II 45%) and "thought exposed during sex" (HITS-I 12%, HITS-II 14%), suggesting that testing behavior was encouraged as a means to assess health status and by perception of risk. Among respondents not tested for HIV, "fear of a positive result" was most commonly cited in both surveys, but decreased from 27% to 18%, perhaps indicating a change of attitudes with the availability of highly active antiretroviral therapies (HAART).

Considering that the only US study of inmate attitudes was conducted in 1991, studies are needed to assess if similar attitude changes have occurred among the incarcerated population.   Finally, while the HITS studies report broad reasons for testing decisions (e.g. there may exist many reasons to fear a positive HIV test), further investigations are necessary to elucidate the psychosocial factors shaping these reasons and ultimately, testing behaviors.

HIV testing in North Carolina

In North Carolina, the state department of health collects data on HIV testing performed by county health departments as well as testing conducted by "a number of community-based organizations."[45] In 2004, the last year with available data, approximately 120,000 HIV tests were reported to the state health department. Of these tests, 36% were among people who had never previously been tested for HIV. The proportion of tests positive for HIV was 0.2%. The majority of tests, 92%, are conducted in traditional testing sites, such as public health departments. At traditional sites, the majority of clients receiving tests are women (68%), while the majority of tests at non-traditional sites are conducted among men (58%). Overall, two-thirds of all tests are conducted among women.[45]

HIV cases in the United States

In the US, case data are available from the 33 states with confidential name-based HIV test reporting. In these states, 76% of cases were among men, and 70% of cases were aged 25-49 years at the time of diagnosis. About 50% of cases were among non-Hispanic blacks and 31% of cases were among non-Hispanic whites. Among males, 67% of cases were attributed to male-to-male sexual contact, 13% were attributed to injection drug use, and another 5% were attributed to both MSM and injection drug use. About 16% of cases were attributed to high risk heterosexual sexual contact. Among women, 80% of cases were attributed to high risk sexual contact, and 19% attributed to injection drug use.[46]

HIV cases in North Carolina

At the end of 2006, there were an estimated 31,000 people in North Carolina living with HIV. Seventy percent of living HIV cases were among blacks, and 25% of cases were among whites. Sixty-nine percent of living cases were male. The HIV rate among black males (103/100,000) was greater than 7 times that of white males (14/100,000), and the HIV rate among black females (42/100,000) was nearly 17 times that of white females. Among males, at least 46% of HIV transmission was thought to be from sex with other men while as much as 90% of transmission among women was from heterosexual contact. Between 2-4% of men and 5-11% of women were infected via injection drug use.[45]

In 2006 CDC updated its HIV testing recommendations, calling for routine opt-out testing across several health care venues, including correctional facilities.

The CDC first developed its HIV testing recommendations in the mid-1980s, when treatment options were limited to prevention of a few opportunistic infections, and the fear of AIDS created an atmosphere of great stigma and severe discrimination for those infected. The early recommendations called for informed consent to help ensure that patients understood the testing process. Pre- and post-test counseling was also regarded as essential so that patients would receive adequate guidance and emotional support. Eventually, however, the use of written consent and pre-test counseling was thought to discourage healthcare providers from offering and patients from accepting HIV testing.

With stunted progress in reducing new infections and the development of life-extending treatment options, the CDC began exploring ways to improve testing uptake. In 2003, CDC updated its recommendations, calling for routine testing in settings in which the

prevalence of HIV was 1% or greater.[4] That same year, CDC recommended that HIV

testing be offered to prisoners upon intake, without prescribing a prevalence threshold.[47]

In 2006 CDC released HIV testing recommendations in healthcare settings, including

correctional facilities, calling for routine "opt-out testing" of persons aged 13-65 years

regardless of setting prevalence. CDC defined routine opt-out testing as the provision of

testing as a regular part of medical care; patients are informed that they will be tested for

HIV unless they actively decline.   Pre-test counseling and written consent are no longer

required, but patients testing positive are still provided post-test counseling and referral to

treatment.

It is unclear whether these recommendations, which are specific to healthcare

settings, are applicable to the testing of prisoners upon intake.   With concerns about the

financial burden of increased testing as well as existing state laws which mandate that pre-

test counseling be provided before HIV testing is conducted, states have been slow to

implement the 2006 recommendations in community settings. Nevertheless, as routine opt-

out testing becomes increasingly common in community settings, state prison systems will

likely face greater pressure to adopt similar testing policies.

Health screening and processing of new inmates in the North Carolina prison system

includes opportunity for HIV testing.

Eight NC state prisons function as diagnostic processing centers, serving as entry

points into the state prison system. At these processing centers, inmate demographic,

familial, and criminal histories are collected and entered into a computer database.

Diagnostic tests are administered to inmates in groups to assess inmate education, reading

level, and skills. Inmates are also assessed for medical, dental, and mental health problems. As part of the medical assessment, inmates are queried about HIV-risk factors and are suppose to have an opportunity to be tested for HIV. The mental health assessment begins with a 10 question screening form. Affirmative responses, history of psychological problems, or any indication of psychological morbidity leads to a referral for further psychological evaluation for the purposes of diagnosis and treatment.

Potential benefits of the proposed research to subjects and society.

Results from this project will serve to improve our understanding of HIV testing at both the systemic- and individual-level. This information will serve to improve testing uptake for the purpose of detecting more HIV infected inmates in the context of consent-dependent testing. The detection of infected inmates upon admission to prison is an important mechanism to matriculate inmates into medical care and to initiate antiretroviral therapies, when appropriate. As individuals continue antiretroviral therapy, viral burden, and consequently infectiousness, is dramatically reduced, reducing the probability of secondary transmission. Further, studies have shown that individuals who test positive for HIV subsequently reduce their HIV-related risk behaviors. Given the substantial flow of people between prison and the community, the detection of HIV among prisoners could diminish secondary transmission upon inmates' release.

The methods proposed in this dissertation to (1) assess system-wide HIV testing (2) identify individual characteristics associated with HIV testing and serostatus, and (3) estimate the number of undetected HIV-positive inmates may provide health service

researchers and prison officials with tools to evaluate and improve the delivery of HIV testing services in other state prison systems.

The studies comprising this dissertation, which were based on analyses of existing administrative and laboratory records, did not provide any immediate benefits to the subjects. However, national studies have shown that 25% of released inmates are re-imprisoned within three years of release.[48] Anecdotal reports suggest that these rates may be higher in NC. Consequently, subjects' participation in this study may improve the HIV counseling and testing opportunities some participants encounter during future incarcerations.

CHAPTER 3

HIV TESTING IN STATE PRISONS: BALANCING HUMAN RIGHTS AND PUBLIC

HEALTH[1]

With approximately a quarter of the one million HIV-infected individuals in the

United States unaware of their infection,[49] increased testing among high-risk populations has

been promoted nationally.[50] The importance of providing HIV testing to prison inmates—a

population that generally suffers from a lack of routine community health care[12, 13] and for

whom the prevalence of HIV infection is several-fold higher than among the general

population[14]—has been well documented for nearly 20 years.[51-54] Although the potential

individual and societal benefits of testing this high-risk population are substantial,

considerable debate remains about the best practices for screening prison inmates for HIV

infection. State legislators, public health officials, and prison administrators, among others,

must consider whether HIV testing should be mandated for all inmates, and if not, the degree

to which consent-based voluntary testing should be available, encouraged, and targeted. The

HIV screening policies that states choose have implications for the protection of inmate

rights and for the public health. In this review, I briefly describe current prison-based testing

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[1] With minor revisions, first published as Rosen DL, Schoenbach VJ, Kaplan AH. HIV
testing in state prisons: balancing human rights and public health. *Infectious Diseases in
Corrections Report*. April 2006; 9(4): 1-5.

practices, summarize issues raised in the existing debate and outline possible research and evaluation efforts to help guide future HIV testing practices in prison.

Why Test?

The potential benefits of HIV testing for both the inmates being tested and society at large are compelling. In contrast to non-incarcerated settings where HIV testing is typically prompted by illness and provided late in the course of infection,[55, 56] screening asymptomatic inmates may allow for earlier diagnosis and consequently, more timely initiation of care, fewer opportunistic infections, and extended survival.[57] Further, the confines of prison can help facilitate the receipt of HIV test results compared to community settings where failure to return for test results is common.[17-19] In addition, testing coupled with counseling provides opportunities to engage inmates in discussions about risk reduction.

For those inmates testing positive for HIV infection, access to healthcare has been affirmed by the Supreme Court[58] and highly active antiretroviral therapy (HAART) is widely available in correctional settings.[59] The effectiveness of HIV care in prisons has brought about a 75% reduction in AIDS-related mortality,[20] a decline mirroring that of non-incarcerated populations.[60] Further, the structured environment and the provision of basic necessities in prison (e.g. food and shelter) may provide therapeutic support lacking in some community settings. As discussed in the March 2006 issue of *Infectious Diseases in Corrections Report*, ancillary services such as substance abuse and mental health treatment may also be more readily accessed in some prisons than in community settings, further supporting care.

In addition to entering HIV-infected inmates into treatment, HIV testing programs in prison have an important role in prevention. Identification of HIV-infected inmates can initiate contact tracing, thereby prompting others to be HIV tested and potentially hindering the spread of the virus within the community. With studies indicating that non-incarcerated individuals reduce their frequency of risk behaviors following HIV diagnoses[24-26], inmates who are diagnosed in prison may also reduce HIV transmission behaviors both in prison and upon returning to the community. Among those inmates who test positive and initiate care, successful maintenance of HAART minimizes infectiousness by reducing viral load in genital secretions, further reducing the risk of transmission.[61, 62]

Negative Consequences of HIV Diagnosis in Prison

Despite the benefits of HIV testing, there are also disincentives for inmates to be tested. Inmates may be reluctant to be screened for HIV infection because of the fear that, if positive, information about their HIV status will disseminate throughout the prison to correctional staff and other inmates. The serostatus of HIV-infected inmates may be intentionally disclosed or, in the concentrated environment of prisons, unwittingly revealed by a number of activities associated with HIV care such as standing in a medication line, attending HIV specialty clinics, and receiving extra meals or nutritional supplements.[63] The consequences of disclosure among inmates have not been well documented, but given that social hierarchies in prison may be reinforced by coerced and consensual sexual activity, disclosure of HIV status can be stigmatizing, diminishing social support and potentially provoking violence or the threat of violence.[63] Institutional consequences of testing positive

may include loss of access to activity programs, visitation, and jobs, as well as housing restrictions.[64]

In the past, some state prison systems have segregated HIV-infected prisoners from the general prison population as a means to prevent intra-prison transmission. Policies of segregation have been criticized for perpetuating stigma, forfeiting confidentiality, and restricting the opportunities (e.g. for education and work-release) of HIV-infected inmates.[63,][64] Most agree that these policies have had little effect on diminishing already low rates of intra-prison transmission,[65] and segregation has now fallen out of use in all but a few state prison systems.

Some prison systems, however, cluster HIV-infected inmates in particular prisons to facilitate the provision of medical care and ancillary services. Policies of clustering differ from those of segregation in that they typically allow for HIV-infected inmates to live among the general prison population, which may reduce the consequences of breeches in confidentiality regarding HIV status.[65] Criticism of clustering has been less vocal than that of segregation, and several state systems that cluster HIV-infected inmates have been noted for excellence in the provision of HIV care.[59] However, like segregation, clustering can in effect breach inmates' confidentiality and result in institutional restrictions, such as those listed above.

Current Prison-Based HIV Testing Policies

HIV testing policies in many prison systems (N=29) have been established by their respective state legislatures.[66] In other states, testing policies have been developed by state health departments or prison administrators. In both cases, financial considerations—costs of

implementing a particular testing policy and providing treatment and care for identified

cases—can play an important role in determining how HIV screening is conducted.[59, 67]

Regardless of their policies' origins, state prison systems can be broadly

dichotomized into those that mandate HIV testing for all inmates and those that provide

voluntary (i.e. consent-based) testing. A Bureau of Justice Statistics (BJS) publication

reported that for the year 2000, 19 state prison systems employed mandatory testing at

intake; four of these states also mandated testing upon release.[33] The other 31 prison systems

implemented voluntary HIV testing, with most of these systems providing opportunities for

testing upon entry. At the time of the survey, four state systems with voluntary testing—

Texas, Florida, New York, and California—contained about half of the nation's known HIV-

infected prison population.[33]

Since the 2000 survey, the Texas[68, 69] and Florida[70, 71] prison systems have changed

testing policies and now mandate HIV testing for all inmates preceding their release;

California is considering such a policy. Other state systems to change testing policies since

2000 include Michigan, which switched from voluntary to mandatory testing,[72] and Nevada,

which switched from mandatory to voluntary testing (see Figure 3.1). [70]

Voluntary testing can be offered in many different ways. In most systems inmates

must request to be tested ("opt-in" testing) whereas in a few states, inmates are routinely

provided testing unless they actively refuse ("opt-out" testing). Also, testing may target

particular populations: 11 of the 31 systems with voluntary testing in 2000 specifically

targeted "high risk" inmates[33] (e.g. injection drug users, commercial sex workers) for HIV

testing. As such, prison systems with policies of voluntary HIV testing encourage testing to

different degrees. Not unexpectedly, the rates of HIV testing in prisons with voluntary testing vary widely (39-71%).[31, 42]

Some systems have different testing strategies depending on inmate status. For example, Rhode Island, which has a single correctional facility that serves as both the state's prison and jail, provides routine opt-out testing to arrestees; if convicted, inmates who refused testing at arrest undergo mandatory testing.[73] Texas routinely tests inmates as they enter the prison system and mandates testing of all inmates upon release.

Regardless of mandatory or voluntary policies, most prisons test inmates under the following circumstances: at an inmate's request, if clinically indicated, upon involvement in an incident, such as a fight with blood exposure, and by court order,[33] particularly for crimes of a sexual nature and sometimes for those that involve injection drug use. Testing under these circumstances, however, likely represents only a small proportion of all tests performed.

Mandatory HIV Testing

Of all the testing strategies, mandatory testing offers the greatest opportunity to diagnose HIV-infected inmates. The American Medical Association (AMA) endorsed mandatory HIV testing of prison inmates in 1987.[74] More recently, Braithwaite and Arriola endorsed mandatory testing for inmates provided such testing is conducted in a non-prejudicial manner and adequate treatment and follow-up resources are available.[15] However, guidelines from the American Public Health Association (APHA) suggest that mandatory testing of inmates is inappropriate, and the World Health Organization (WHO) deems mandatory HIV testing in prison unethical and ineffective.[35, 36]

Arguing against mandatory testing, critics cite the inability to preserve confidentiality in prison[63] and the discrimination and stigmatization that HIV-infected prisoners have historically endured, particularly as a result of segregation.[26] Further, some feel that mandatory testing diminishes inmates' opportunities to engage in thoughtful counseling about risk behaviors since testing will be conducted regardless of whether an inmate deems it necessary.[75]

A study by Varghese and Peterman projected the number of HIV cases averted by providing counseling and testing (CT) in prison.[76] The results indicated that in low-prevalence settings (≤1%), the majority of averted cases (80%) resulted from seronegative inmates reducing their likelihood of acquiring HIV following CT; only 20% of cases were averted because newly diagnosed inmates reduced their potential risk of transmission following CT. Although this study was based on a number of assumptions, it implied that in prisons with a low prevalence of HIV, prisons requiring mandatory testing without (or with insufficient) counseling might be less effective at averting future cases of HIV than prisons that provide widespread counseling. It is noteworthy that in 2003, 13 of the 20 prison systems with mandatory testing had prevalence estimates of 1% or less.[70, 77]

Voluntary 'Opt-In' HIV Testing

Voluntary testing wherein the individual must actively consent (i.e. opt in) to HIV testing may preserve inmates' autonomy, but existing literature, though dated, suggests that a substantial proportion of infected inmates remain undetected in systems with voluntary testing. Rates of HIV infection observed in seroprevalence studies exceeded rates of infection observed from voluntary testing in the Maryland, California, Illinois, New Jersey[30]

Wisconsin[37] and Oregon[38] state prison systems. Studies in the Maryland[39] and Wisconsin[37] state prison systems, for example, reported that rates of HIV infection among those tested in blinded studies were twice that of volunteer testers. In Wisconsin, 31% (8/26) of all HIV-infected inmates declined to be tested, and in Maryland 66% (134/204) of all HIV-infected inmates declined testing.

Unlike testing for other communicable infections, before testing for HIV infection, healthcare providers are required to counsel patients about risk behaviors and obtain written informed consent. Although these procedures were initiated to lessen potential, negative psychosocial repercussions of testing HIV-positive, some argue that they create undue obstacles for testing including additional time spent conducting the counseling and paperwork. Further, because the written consent process is unique to HIV, it may in fact further perpetuate stigma associated with being tested.[78]

Additionally, identification of patients at risk for HIV infection who should be offered testing can be challenging. Patients are often reluctant to disclose behaviors related to transmission, and providers can be poor at eliciting information about these behaviors. Although approximately one-third of state prison systems with voluntary testing specifically target "high risk" inmates, the definition of "high risk" has not been well defined and likely varies across, and perhaps within, state prison systems. Several studies have identified factors associated with HIV infection among inmates, but the extent that these factors have been used to screen inmates--and their ability to identify new infections--has not, to our knowledge, been documented. Without validation, targeted testing may divert prevention and testing resources away from inmates at risk for infection.

Routine or Voluntary 'Opt-Out' Testing

Recommendations for routine testing, both in community and correctional populations, have been gaining support over the last several years.[78,59,79] In community settings, the proportion of those tested as a routine part of medical care is on the rise.[80] The CDC's revised HIV testing guidelines, released in 2001, and its 2003 initiative, "Advancing HIV Prevention," both recommend that routine testing be offered in settings with prevalence estimates of ≥ 1%, including correctional settings that fit this prevalence criterion.[50,81] A technical addendum to the 2003 initiative recommends routine testing in prisons without reference to the 1% prevalence cut-off.[82]

Unlike voluntary opt-in testing, routine opt-out testing (i.e. conducting HIV screening unless the individual refuses to be tested) does not depend on patients' self-disclosure of risky behaviors. It may help to normalize the testing process and decrease test-associated stigma, increasing acceptance of offered testing and potentially increasing new diagnoses. To further promote acceptability, some suggest that routine testing should be offered with minimal pre-test counseling; extensive counseling and services would be available for those testing positive.[78]

The provision of routine HIV testing in the Rhode Island Department of Corrections has had a substantial impact on detecting infected individuals in that state. From 1989-1999, diagnoses among prison inmates constituted 33% of all new HIV diagnoses in Rhode Island.[73] While this proportion includes convicted inmates who undergo mandatory testing, 90% of inmates accepted routine testing upon entry.[59]

Some inmate advocates suggest that opt-out testing conducted in prison, an inherently punitive environment, is coercive by nature and akin to mandatory testing.[83] Corrections-

based providers in Rhode Island counter that testing is not coercive, but rather is well-accepted among inmates because it is coupled with comprehensive, prison-based treatment programs.[79] In support of this argument, a study of released Rhode Island inmates found that 77% of respondents endorsed HIV testing.[84] Despite most respondents' endorsement of testing, the high rates of acceptance raise questions about inmates' autonomy; in two community-based studies of routine HIV testing, acceptance rates were 37%[85] and 40%,[86] well below the 90% acceptance rates among Rhode Island inmates. In the Texas correctional system, which incarcerates more inmates than any other system in the United States,[77] refusal of routine testing at intake has been reported to be less than 1%.[68]

Future Research and Evaluation of HIV Testing Policies

A variety of HIV testing policies are practiced in state prisons across the U.S. Each of these policies appears to have different implications for the protection of inmate rights (i.e. autonomy, confidentiality, and access to care) and for prevention of disease transmission in community settings. However, our understanding of these different policies is incomplete, based on anecdotal information and extrapolated from non-prison populations. The application of similar polices may vary greatly by state prison system and by prison. To truly evaluate these programs in regards to their impact on inmate rights and public health, I propose that the following areas be assessed:

- Congruity between testing policies and their applications
- Costs of testing, counseling, and prevention programs
- Inmate, provider, and system characteristics associated with uptake of HIV testing in systems with voluntary testing

- Efficacy of counseling on the acceptance of HIV testing and the reduction of inmate risk behaviors

- The roles of confidentiality and stigma in acceptance of testing

- Psychosocial and physical (e.g. disease-related morbidity, target of assault) consequences of testing positive in prison

- Utility of targeted testing

- Availability of and access to services following release

To our knowledge, only the last of these areas has received any attention. These evaluations could be couched as part of larger assessments of medical care in prison. Although there is certainly a disincentive for prisons to document their own lapses in care, a necessary first step to improving medical care and promoting public health through the prison system is to take a sober look at the services provided. Prison health care experts should work with governmental agencies to develop and implement these evaluations.

Figure 3.1. Prison systems with mandatory HIV testing and known HIV/AIDS cases as a percent of total custody population, 2003

Cases as percent of pop.

- 0.20 - 0.49
- 0.50 - 0.99
- 1.00 - 2.29
- 2.30 - 7.60
- No Data

○ **Mandatory HIV testing**
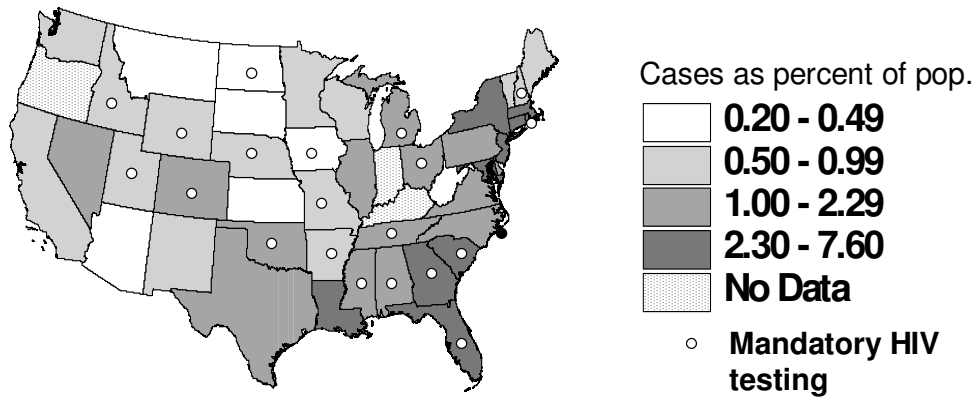
Map created using data collected by the Bureau of Justice Statistics. Please see references 31 and 34.

'Mandatory HIV testing' refers to systems that tested all inmates upon entry, during custody or upon release.

CHAPTER 4

RESEARCH DESIGN AND METHODS

The specific aims of this dissertation are listed below followed by the rationale and

hypotheses for each aim.

Specific Aim 1. Determine system-wide and facility-specific HIV testing rates among inmates

without a pre-existing HIV diagnosis, in a state prison system with voluntary HIV testing

Specific Aim 2. Identify inmate characteristics associated with receipt of an HIV test among

inmates without a pre-existing HIV diagnosis

Specific Aim 3. Identify inmate characteristics associated with HIV serostatus

Specific Aim 4. Estimate the number of HIV-infected prisoners who remain untested in the

North Carolina prison system

<u>*Specific Aim 1*</u>. Determine system-wide and facility-specific HIV testing rates among inmates

without a pre-existing HIV diagnosis, in a state prison system with voluntary HIV testing

<u>Rationale</u>. With an estimated 13-19% of HIV-infected US adults incarcerated annually, state

prisons represent a unique opportunity to test individuals at high risk of infection but who

have little access to regular health care, including HIV screening. Rates of HIV testing in the

NC DOC prison system, as in most systems with voluntary testing, are unknown.

Examination of testing rates is necessary to characterize use of testing services and inform

testing policies. Calculation of annual testing rates can be used to determine if testing

increased with expansion of the prison population and advances in therapeutics. Comparisons of testing rates from the NC DOC with national estimates and with rates from other state prison systems would characterize NC DOC services in the context of "industry" standards. Current literature does not acknowledge that testing rates may vary by facility within state prison systems. A finding of substantial variation may prompt researchers to take a more nuanced view of system-wide testing rates and prompt prison administrators to ensure equal access to testing services. Finally, studies of testing rates have largely been limited to new prison entrants; the additional determination of testing rates among inmates post-entry would more completely describe HIV testing in prison.

Hypotheses

Rate of HIV testing varies from one prison entrance facility to another.

Specific Aim 2. Identify inmate characteristics associated with receipt of an HIV test among inmates without a pre-existing HIV diagnosis

Rationale. Inmate characteristics associated with receipt of testing can be used to identify groups of inmates under-tested for infection. Decreased testing among particular groups may be indicative of systematic barriers suggesting specific interventions. For example, if depression was associated with decreased testing rates at admission, testing could be offered later in one's sentence following the establishment of anti-depressant therapy. More ominously, low rates of testing among inmates reporting high risk behaviors (e.g. injection drug use) could question the effectiveness of pre-test counseling.

Previous studies examining the association between inmate characteristics and receipt of HIV testing have been conducted under the unsupported assumption that testing practices

do not vary among prisons within the same prison systems. Failure to account for testing differences among facilities in the same prison system could result in biased effect estimates and overly-narrow confidence intervals. We plan to improve upon previous studies by controlling for facility in our statistical models.

Hypotheses. HIV testing is associated with entrance facility and is positively associated with greater number of prior incarcerations and history of behavioral risk factors; testing is inversely associated with history of mental health condition and African American race.

Specific Aim 3. Identify inmate characteristics associated with HIV serostatus

Rationale. In addition to assessment of HIV testing, examination of HIV status among those tested may prove useful: inmate characteristics associated with both low probability of testing and high probability of infection would support the need for expansion of targeted testing. Further, the extent of HIV counseling may in large part be dependent on inmates' willingness to report their engagement in high risk behaviors. Given incomplete privacy in the prison, inmates may be reluctant to disclose high risk behaviors. Examination of inmate characteristics associated with HIV infection, beyond self-reported risk behaviors, may be useful for the development of risk scores to improve HIV screening practices, and could be used to estimate the burden of HIV infection among untested inmates.

Hypotheses. HIV infection is positively associated with African American race, female gender, older age, history of behavioral risk factors, history of mental health condition, and greater number of prior incarcerations.

Specific Aim 4. Estimate the number of HIV-infected prisoners who remain untested in the North Carolina prison system

Rationale. In prison systems with voluntary HIV testing, it is likely that HIV cases remain undetected. Quantifying the number of undetected cases could be helpful in determining the need for greater testing and treatment services. Blinded seroprevalence testing is the standard for determining the extent of undetected HIV cases, but this method can be logistically difficult and expensive. I introduce a simple alternative to blinded anonymous seroprevalence testing to estimate the extent of undetected HIV infection based on both community prevalence estimates in NC and on prevalences estimated from the NC DOC prison population tested for HIV. It will be possible to compare these results with those from a blinded seroprevalence study, which is planned in the NC DOC next year.

Hypothesis. At any given time, at least one-third of HIV cases in the prison system have not been detected.

Study overview and analytic approach

The use of voluntary HIV testing was examined among the 54,016 inmates imprisoned in the North Carolina state prison system between January 2004 and May 30, 2006. All analyses were based on existing electronic HIV test records and imprisonment records, which included the following: socio-demographic information, imprisonment history, mental health diagnoses, conviction history, illicit substance use history, and intake prison. These data were used to examine differences in HIV testing across the 8 intake prisons in the North Carolina prison system and to describe the use of HIV testing both during and after the intake process. Associations between HIV testing (yes or no) and inmate

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characteristics were examined. Among inmates voluntarily tested for HIV, associations between prisoner characteristics and HIV serostatus were examined. Age-sex-race specific HIV prevalence estimates among tested inmates. These prevalence estimates and estimates obtained from state health department data were each used separately to estimate the number of undetected HIV cases existing among untested prisoners.

Study setting

The North Carolina Department of Correction (NC DOC) Division of Prisons maintains 76 prisons and at mid-year 2003 incarcerated 33,583 individuals. During 2002-2003, there were approximately 23,000 inmate admissions and a similar number of releases. In 2003, the distributions of race and age among new inmates were similar to those of existing inmates: 60% black, 30% white, and 10% other; 75% of inmates were between the ages of 22 and 45 years. Women comprised 12% of incoming inmates but only 7% of the total inmate population.[87] While state data are not available, national data suggest that 25% of released prison inmates are re-imprisoned for a new crime within 3 years.[48] In 2004, the last year with available data for the NC DOC, 1.8% of all inmates in custody were reported to be HIV infected.[8] Since this estimate is based on voluntary testing, it very likely underestimates the true prevalence.

Study cohort

Adult prisoners, aged 18 years of age or older, admitted to the NC state prison system between January 1, 2004 and May 30, 2006 were eligible for inclusion in the analysis. Seventeen prisoners were excluded because they were admitted to a prison without a

processing center. For Aims 1 and 2, the 631 prisoners who were tested for HIV despite a pre-existing HIV diagnosis (as documented by the N.C. State Health Department) were excluded to focus the analyses on inmates with unknown serostatus. These 631 prisoners were included in the analysis of specific Aim 3.

Intake, Infectious disease testing, and other assessments

Before assignment to one of the 76 prisons in the NC DOC prison system, all incoming inmates are first admitted to one of eight intake prisons with a processing/diagnostic center. Two centers are designated for adult women, four for adult males, and two for younger males (aged less than 22 years). These eight centers assess inmates' vocational skill, educational achievement, illicit substance use, and mental and physical health.

A medical evaluation is completed for all inmates and includes routine testing for syphilis and tuberculosis (TB), and testing for hepatitis C (HCV) based upon clinical evaluation. Inmates are screened for conventional HIV risk behaviors, and voluntary (i.e. consent-based) HIV testing is available. It is NC DOC policy to encourage inmates with known risk behaviors to be tested. Inmates self-reporting a previous HIV diagnosis may receive confirmatory testing before initiation of antiretroviral therapy. HIV testing is also available anytime during incarceration following an incident with blood exposure, such as a fight; following the recommendation of a clinician; or upon inmate self-request.

Assessments of inmates' social (e.g. educational achievement, employment and marital status) and criminal histories are conducted by a NC DOC case analyst, and are informed by data collected prior to sentencing. Psychological assessment is conducted in

several stages, beginning with an interviewer-administered 10-item screening instrument; prisoners responding affirmatively to questions on the screener or displaying unusual behavior are referred to a psychologist for further evaluation and possible diagnosis based on criteria of the Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV.

Electronic records and data linking

The NC DOC provided electronic records of data collected routinely for all inmates entering the state prison system between January 1, 2004 and May 31, 2006. Records included socio-demographic information, conviction offense and sentence, dates of imprisonment, mental health diagnoses, and results from education, substance abuse and HIV-risk screenings. Dates and results of all tests for syphilis, hepatitis C, and HIV conducted during the study period were provided in a separate database by Quest Diagnostics, a private company contracted by the NC DOC to process diagnostic lab work.

Electronic prison data provided by the NC DOC and lab data provided by Quest were linked using a unique prison identification number (PIN) assigned to all inmates upon first admission. The PIN was present in all prison records and missing in less than 3% of lab records. Lab records with missing PINs were excluded from our analyses. Prisoner records which linked to a lab record were coded to indicate the prisoner had been tested; prisoner records without a linked lab record were coded as not-tested.

Through a collaborative arrangement, the North Carolina Department of Health and Human Services provided data indicating whether inmates testing positive for HIV in prison had been previously diagnosed within the state and the original diagnosis date.

Before analysis, each inmate record was assigned a unique study identification number, and all other identifying information (names, date of birth, and PIN) was removed from the data. Only records of inmates 18 years of age or older at the time of prison admission were retained for analysis.

Although interview data can provide a more nuanced understanding of factors affecting HIV testing and serostatus (see Aim 3) than inmate characteristics, strengths of this analysis include substantial sample sizes and the focus on characteristics that are largely free from the biases inherent in respondent self-report.

This project was approved by the Biomedical IRB within the University of North Carolina—Chapel Hill and the IRB of the North Carolina Department of Corrections.

Coding of infectious disease testing and mental health conditions

Inmates were classified as HIV-positive if both an enzyme-linked immunosorbent assay (ELISA) and Western blot were reactive; hepatitis C-positive with a positive antibody test; and syphilis-positive if Rapid Plasma Reagin (RPR) titre was 1:8 or greater. All prisoners were assessed for TB using a Montoux screening test at admission. Since the Montoux results were not electronically available, electronic medication prescription data were used: prisoners prescribed anti-TB medications within 30 days of admission were coded as having TB disease.

Electronic records were used to identify prisoners who had been diagnosed with a mental health disorder within 30 days of admission. The following diagnoses, based on DSM-IV criteria, were included for statistical analysis: (Axis I) psychosis, bipolar disorder,

major depression, generalized anxiety disorder, dementia, and (Axis II) developmental disorders and personality disorders.

Data protection

Electronic data were stored on a secure password-protected server; database files had additional password protection. Paper records were stored in a locked file cabinet within a locked office located in the School of Medicine on the campus of UNC- Chapel Hill. Similar measures to protect confidentiality have been successfully implemented by our research team in the past. All personal identifiers were removed from the data and replaced with study ID numbers. Data connecting patient identifiers and study ID were stored in a separate, password protected file. All results were reported in aggregate to protect confidentiality.

This dissertation is the product of a collaboration between the North Carolina Department of Correction and the UNC Division of Infectious Diseases.

This project has been endorsed by the Medical Director of the NC Division of Prisons, Dr. Paula Smith, and proceeded as a collaboration between the Department of Correction and a team of UNC investigators. Partnerships of this type are mutually beneficial – they are an important mechanism to lend research expertise to resource-poor settings (such as prisons) that are of great public health importance. Conversely, input from prison officials, such as Dr. Smith, were crucial in directing research priorities and in ensuring that this and future projects are logistically compatible with the prison system environment and resources.

Consideration of ethical issues and status of IRB applications

Before IRB submission, Dr. Schoenbach, Dr. Wohl, and I met with several members of the UNC Biomedical IRB to identify and discuss any aspects of the study that could potentially violate inmate rights. This proposal reflects suggestions that arose from that meeting. This study has been approved by the UNC Biomedical IRB, the North Carolina Department of Correction IRB.

Statistical Analyses Aims 1 and 2: HIV Testing is the Dependent Variable

System-wide and center-specific proportions of inmates documented to be tested for HIV during their admission were tabulated. For the 12% of prisoners with multiple imprisonments during the study period, only their most recent admission was included in these tabulations. For all prisoners, admission was uniformly defined as spanning the first 21 days of imprisonment (the admission process can last up to 21 days). All HIV tests performed on or after imprisonment day 22 were defined as post-admission tests. The post-admission incidence rate of HIV testing, expressed as tests per 10 person-years, was estimated by dividing the total number of post-admission tests by the contributed number of post-admission person-days among those inmates not tested during admission.

Testing proportions and rates were estimated separately for men and women. For each gender, the overall proportions of inmates tested were estimated by each of the following characteristics assessed at entry: socio-demographic, intelligence score, imprisonment history, mental health, illicit substance use, syphilis and HCV infection, TB disease, and conventional HIV risk behaviors: 1) blood transfusion between 1978-1985, 2) sex with multiple partners, 3) sex as or with a sex worker, 4) shared needles, and 5) men who

have sex with men (men only). Behaviors assessed exclusively among females included 6) sex with male injection drug users and 7) sex with men who have sex with other men. For each of these prisoner-characteristic variables a test of the null hypothesis "no association with HIV testing" was performed using a chi-square test procedure of size $\alpha = 0.05$.

Associations between testing status and inmate characteristics were further investigated by fitting gender-specific log linear models for testing status (yes or no) conditional on independent variables such as (1) covariates that had statistically significant chi-square tests for associations with testing status, (2) binary covariates identifying the prisoner's intake prison, and (3) a dichotomous ('yes' or 'no') summary variable for risky behavior with value 'yes' if and only if the prisoner had any of the conventional HIV risk behaviors.   The conventional risk behaviors included sex with multiple partners, sexual activity as or with a sex worker, sharing of needles, receipt of a blood transfusion during 1978-1985, or for men, having sex with other men (MSM); for women only, risk behaviors also included sex with MSMs and sex with injection drug users.

Collection of data describing conventional HIV risk behaviors was limited to only one of the two female facilities. As a result, for females these data are included in the bivariate analyses only. Conventional behavioral data were also missing for about 18% of men; missingness ranged between 35-43% in three facilities, but was less than 2% in the other three facilities. To assess the effect of the missing data on the estimates, I conducted a complete case analysis, an analysis restricted to inmates entering the three intake prisons with < 2% missing behavioral HIV data, and an analysis based on multiple imputation. Imputation was carried out using the Amelia II algorithms (used in version 2.5.0 of *R*) because of its facility with categorical variables.[88, 89] All other analyses were conducted

using SAS System Software (version 9.1, Cary, North Carolina). The imputation model included all variables reported in the final model as well as six variables based on self-report indicating whether the prisoner ever 1) was told he or she had AIDS, 2) had a venereal disease, 3) had unexplained tiredness, weight loss, night sweats, diarrhea, 4) drank excessively, 5) used hard drugs, or 6) had TB.

Statistical Analyses Aim 3: HIV Serostatus is the Dependent Variable

The proportion of HIV-infected prisoners was calculated for each level of the following: socio-demographic characteristics, conventional HIV risk behaviors, drug use, conviction history, mental health, TB disease, syphilis infection, and HCV infection. For each prisoner characteristic variable a test of the null hypothesis "no association with HIV serostatus" was performed using a chi-square test procedure of size $\alpha = 0.05$.

Associations between HIV-serostatus and selected inmate characteristics were investigated further using gender-specific logistic regression models for HIV-serostatus conditional on selected covariates representing conventional IHV risk behaviors and variables which had statistically significant associations ($p<0.05$).

Conventional HIV risk behaviors were only recorded for women admitted to one of the two intake facilities which process females. Among men, risk behaviors assessments were recorded in all but 8% of records. The logistic regression analyses were based on those records with recorded risk behavior assessments.

Statistical Analysis Aim 4: Estimating number of HIV cases among the untested prison population

Most female prisoners were tested for HIV, but more than two-thirds of male prisoners remained untested. To estimate the number (N) of HIV cases among untested male prisoners, we stratified the population of untested males by age (5 categories) and race (black, white, other), and multiplied the number (N_i) of untested prisoners within each of these strata by corresponding stratum-specific prevalence estimates ($\hat{P}_i$) obtained from the population of male prisoners tested for HIV. Thus, the estimate of the number of HIV cases ($\hat{N}$) took the form of a weighted sum of prevalence estimates:

$$\hat{N} = \sum_{i=1}^{15} \hat{P}_i N_i$$

Similarly, 95% confidence intervals were estimated as

$$\hat{N} \ -/+ \ 1.96 \left(\sum_{i=1}^{15} N_i^2 \ V_i \right)^{1/2}$$

in which V_i is the stratum specific variance of $\hat{P}_i$. Our estimate assumes that the age distribution of untested prisoners was fixed, the variances for the prevalence estimates were independent, and that the HIV prevalence among the untested population is approximately the same as the prevalance among the tested population.

The same approach was repeated using age- and race- specific prevalence estimates ($\hat{P}_i$) for the general population of men in North Carolina. State prevalence estimates among men were calculated by dividing the age- and race-specific number of North Carolina men known to be living with HIV, as reported to the state health department,[90] by the corresponding stratum-specific population denominators of men derived from census data.

For enhanced stability of these state estimates, we pooled HIV case and census data from 2000-2005.

CHAPTER 5

AN EVALUATION OF HIV TESTING IN A LARGE SOUTHERN PRISON SYSTEM

Abstract

Objective**:** Determine the use of voluntary HIV testing among state prisoners

Methods**:** Among NC prisoners, calculate system-wide and facility-specific proportions and rates of adult inmates tested for HIV and estimate associations between testing status and inmate characteristics

Results**:** Of the 54,016 inmates who entered prison between January 2004 and May 2006, 20,820 (38%) were tested for HIV, 18,574 (89%) at admission. Across the eight intake prisons, testing was >80% in both female facilities, but <15% in four of six male facilities. Prisoners with a documented history of heroin use, crack/cocaine use, conventional HIV risk behavior (e.g. sharing needles, multiple sexual partners, or MSM), or tuberculosis disease were at least 10% more likely to be tested than inmates without these characteristics. Nevertheless, greater than 60% of men reporting conventional risk behaviors were not tested. Before covariate adjustment, black men were 30% less likely than white men to be tested; in the multivariable regression model, this effect was attenuated to 13%.

Conclusions: Receipt of an HIV test ranged widely across intake prisons, and many male inmates with documented risk of infection were never tested.

Background

Rates of Human Immunodeficiency Virus (HIV) are disproportionately high among incarcerated individuals as compared to the general US population.[14] Although there is some evidence that HIV is transmitted within prisons, the majority of infections occur in the community. [91, 92] Given inmates' limited access to community healthcare,[12] prisons provide an important opportunity to conduct HIV testing.

Among the benefits of testing, infected inmates can matriculate into medical care and, if clinically warranted, initiate highly active antiretroviral therapy (HAART). HAART is now widely available in prison systems across the US, and prisoners have experienced declines in HIV-related mortality similar to those in the community.[20, 21] A positive HIV test may also initiate contact tracing to identify infection among inmates' sexual or drug-using partners in the community and in prison.

HIV testing strategies vary across US state prison systems. According to the Bureau of Justice Statistics, 22 state prison systems have instituted mandatory HIV testing. The other 27 prison systems provide consent-based testing (data from one state system, Alaska, were unavailable).[29] Nearly all provide testing upon prisoners' self-request. Among systems with consent-based testing, at least two provide opt-out testing,[93] and 7 target testing at "high risk" prisoners. Yet little is known about the extent of HIV testing in prisons with consent-based testing or the degree that testing in these systems includes prisoners with known risk factors for infection. In addition, most existing US studies examining use of voluntary HIV testing were conducted before the era of HAART and few characterize differences between testers and non-testers.[31, 32, 37, 39, 42, 94]

In 2003, as part of its Advancing HIV Prevention initiative, the Centers for Disease Control and Prevention (CDC) recommended that "[c]orrectional systems should routinely offer HIV testing as a component of the standard medical intake evaluation for all inmates."[47] With the CDC's 2006 recommendations to improve access to HIV testing with implementation of routine opt-out testing across health care settings, including correctional health-care facilities,[95] it is of renewed interest to examine the extent of HIV testing in prisons with consent-based testing. Low rates of testing may indicate missed opportunities to provide needed medical care and social support, reduce infectiousness via treatment, and provide counseling to reduce secondary transmission.

In this study, we examined the use of consent-based HIV testing in a large southern prison system, the North Carolina Department of Correction (NC DOC) Division of Prisons. Like other large prison systems, the NC DOC has several intake prisons into which inmates first enter before being transferred to the greater prison system.[96] At these intake prisons, inmates receive a series of assessments including a medical evaluation and the opportunity to be tested for HIV. Inmates self-reporting a previous HIV diagnosis may receive confirmatory testing before initiation of antiretroviral therapy. HIV testing is also available anytime during incarceration by inmate self-request, clinician recommendation, or after a blood exposure incident.

To assess the use of HIV testing, we determined the proportion of all inmates tested for HIV both during and after admission, examined differences in testing across intake prisons within the state system, and evaluated degree of association between receipt of an HIV test and prisoner characteristics in order to detect disparities in testing, particularly among inmates with documented risk for infection.

Methods

Medical evaluation at intake prisons

Before assignment to one of the 76 prisons in the NC DOC prison system, all

incoming inmates are first admitted to one of eight intake prisons with a

processing/diagnostic center. Two centers are designated for adult women, four for adult

males, and two for younger males (aged less than 22 years). These eight centers assess

inmates' vocational skill, educational achievement, illicit substance use, and mental and

physical health. The medical evaluation is completed for all inmates and includes routine

testing for syphilis and tuberculosis (TB), and testing for hepatitis C (HCV) upon clinical

evaluation. Inmates are screened for conventional HIV risk behaviors, and voluntary (i.e.

consent-based) HIV testing is available; it is NC DOC policy to encourage inmates with

known risk behaviors to be tested.

Assessments of inmates' social (e.g. educational achievement, employment and

marital status) and criminal histories are conducted by a NC DOC case analyst, and are

informed by data collected prior to sentencing. Psychological assessment is conducted in

several stages, beginning with a 10-item screening instrument; prisoners responding

affirmatively to questions on the screener or displaying unusual behavior are referred to a

psychologist for further evaluation and possible diagnosis based on criteria of the Diagnostic

and Statistical Manual of Mental Disorders (DSM)-IV.

Electronic records and data linking

The NC DOC provided us electronic records of data collected routinely for all

inmates entering the state prison system between January 1, 2004 and May 31, 2006.

Records included demographic and social information, conviction offense and sentence, dates of imprisonment, mental health diagnoses, and results from education, substance abuse and HIV-risk screenings. Dates and results of all tests for syphilis, hepatitis C, and HIV conducted during the study period were provided in a separate database by Quest Diagnostics, a private company contracted by the NC DOC to process diagnostic lab work.

Electronic prison and lab data were linked using a unique prison identification number (PIN) assigned to all inmates upon first admission. The PIN was present in all prison records and missing in less than 3% of lab records. Lab records with missing PINs were excluded from our analyses. Prisoner records which linked to a lab record were coded to indicate the prisoner had been tested; prisoner records without a linked lab record were coded as not-tested.

Through a collaborative arrangement, the North Carolina Department of Health and Human Services provided data indicating whether inmates testing positive for HIV in prison had been previously diagnosed within the state and the original diagnosis date. Prisoners with an existing diagnosis, as indicated by state data, were excluded from our study population to focus the analyses on prisoners with unknown serostatus.

Before analysis, each inmate record was assigned a unique study identification number, and all other identifying information (names, date of births, and PIN) was removed from the data. Only records of inmates 18 years of age or older at the time of prison admission were included for analysis.

This project was approved by the Biomedical IRB within the University of North Carolina—Chapel Hill and the IRB of the North Carolina Department of Corrections.

Coding of TB disease and mental health conditions

All prisoners were assessed for TB using a Montoux screening test at admission. Since the Montoux results were not electronically available, electronic medication prescription data were used: prisoners prescribed anti-TB medications within 30 days of admission were coded as having TB disease.

Electronic records were used to identify prisoners who had been diagnosed with a mental health disorder within 30 days of admission. The following diagnoses, based on DSM-IV criteria, were included for statistical analysis: (Axis I) psychosis, bipolar disorder, major depression, generalized anxiety disorder, dementia, and (Axis II) developmental disorders and personality disorders. Prisoners diagnosed with both Axis I and II diagnosis were coded for Axis I only.

Statistical analysis strategy

We calculated the system-wide and prison-specific proportions of inmates tested for HIV during their admission. For the 12% of prisoners with multiple imprisonments during the study period, only their most recent admission was included in the analyses. For all prisoners, admission was uniformly defined as spanning the first 21 days of imprisonment (the admission process can last up to 21 days). All HIV tests performed on or after imprisonment day 22 were defined as post-admission tests. The post-admission incidence rate of HIV testing, expressed as tests per 10 person-years, was estimated by dividing the total number of post-admission tests by the contributed number of post-admission person-days among those inmates not tested during admission. HIV testing proportions, based on testing at any time during imprisonment, were calculated separately for men and women by

levels of the 22 variables derived from the following domains and characteristics assessed at entry: socio-demographic, intelligence score, imprisonment history, mental health, illicit substance use, TB disease, syphilis and HCV infection, and conventional HIV risk behaviors.

Associations between testing status and inmate characteristics were further investigated by fitting gender-specific log linear models for the prisoners' testing status (yes or no) was fitted in a manner which provided a test of size $\alpha = 0.05$ of the null hypothesis "testing rate is invariant across the levels of that independent variable." In the second step, a gender specific log-linear regression model for testing status was fit conditional on the inmate characteristic of interest and also accounting for covariates such as (1) other characteristics that were statistically significant in the first step, (2) binary covariates identifying the prisoner's intake prison, and (3) a dichotomous ('yes' or 'no') summary variable for risky behavior with value 'yes' if and only if the prisoner had any of the following conventional HIV risk behaviors: sex with multiple partners, sexual activity as or with a sex worker, sharing of needles, receipt of a blood transfusion during 1978-1985; men having sex with other men (MSM), which was only assessed among men and two other behaviors, sex with MSMs and sex with injection drug users, which were only assessed among women. The fitted model was then used to perform a test of size $\alpha = 0.05$ of the null hypothesis "covariate-adjusted testing rate is invariant across the levels of that independent variable."

Collection of data describing conventional HIV risk behaviors occurred in only one of the two female intake prisons. As a result, the females with missing data were not included in the multivariable log-linear regression analysis. Conventional risk behavioral data were also missing for about 18% of men. In three of the six intake prisons for men, less than 2%

of data were missing. In the other prisons, between 35% and 43% of behavioral data were missing. To assess the effect of the missing data on the magnitude and precision of our estimates, we conducted a complete case analysis, an analysis restricted to intake facilities with nominal missing data, and an analysis based on multiple imputation of missing data. Imputation was carried out using Amelia II algorithms (using version 2.5.0 version of *R*) because of its facility with categorical variables.[88, 89] The multiple imputation model included the 22 variables evaluated in the complete case analyses; to enhance model saturation, an additional six variables which were of little analytic interest (e.g. Excessive drinking, Ever tired) were also included in the imputation model. Five imputation datasets were generated. The imputed data sets were analyzed using PROC MIANALYZE in SAS System Software (version 9.1, Cary, North Carolina). All other analyses were also conducted in SAS.

Results

During the study period 54,664 inmates aged 18 years or older entered the North Carolina state prison system; 17 of these prisoners were excluded from our analysis because they were admitted to a prison without a processing center. We also excluded the 631 prisoners who were tested for HIV despite state health department records indicating a pre-existing HIV diagnosis, in order to focus our analyses on the testing of prisoners with unknown HIV serostatus.

Eighty-six percent of all inmates were male (Table 5.1). Across socio-demographic and imprisonment domains, a greater proportion of males than females were black, employed

before their incarceration, and recidivists; similar proportions of males and females were married.

Women were nearly three times as likely as men to report heroin use (5.8% vs. 1.9%) and nearly two times as likely as men to report crack or cocaine use (63.0% vs. 32.7%). History of drug-related conviction was only slightly more common among women, but men were nearly five times as likely as women to have ever been convicted of a sex-related conviction. A majority of males, but not females, had been imprisoned before. The median sentence length was 12.2 (25th, 75th percentiles: 3.2, 24.3) months for males and 3.2 (25th, 75th percentiles: 2.0, 14.2) months for females.

Intake facilities differed by median age and percent non-white. In the two female facilities, the median ages were 33 and 35 years, and the percent non-white was 44.9% and 47.2%. In the male facilities, the median ages in the two prisons for young adults were 18 and 21 years, and ranged between 33 and 36 years for the other intake prisons. The proportion non-white in the male intake prisons ranged from 52.3% to 72.9%.

HIV testing

Thirty-four percent (n=18,435) of all entrants received an HIV test during admission (i.e. before day 22 of imprisonment), but the proportion tested varied from 1 to 84% across processing centers: within each female processing center greater than 80% of entrants were tested for HIV; within four of the six male processing centers, fewer than 15% of entrants were tested (Figure 5.1).

The 34,217 inmates not tested for HIV during admission were imprisoned for a total of 20,143 person-years during the study period. Among these inmates, 2,228 (6.5%) were

tested for HIV at a rate of 1.1 tests per 10 person-years imprisoned. Post-admission tests constituted 10.7% (2,228/20,802) of all HIV tests.

Among female prisoners, 85.7% were tested for HIV (Table 5.2) during admission or post-admission. In the first step of the model based analyses for women, statistically significant associations with HIV testing were observed for 5 of the 22 prisoners characteristics: Race, Previous Time Served, and Sentence Length. Compared to white women, non-white non-black (i.e. "other") women were less likely to be tested for HIV (RR=0.86, 95% CI: 0.80, 0.93). Also, women were less likely to be tested if they had never been imprisoned in the NC DOC previously (RR=0.92, 95% CI: 0.90, 0.94). Compared to women with sentences of less than three months, women with sentences of 3-6 months or 7-18 months were more likely to be tested (3-6 months: RR=1.09, 95% CI: 1.06, 1.11; 7-18 months: RR=1.07, 95% CI: 1.04, 1.10), but those with sentences of 19 months or greater were less likely to be tested (RR=0.89, 95% CI: 0.85, 0.93). In the one intake facility that assessed risk behavior, women affirming a history of conventional HIV risk behaviors (defined in the methods section) were no more likely to be tested than women who denied these behaviors.

In the second step of the model-based analyses for women (Table 5.4) estimation of testing rates for levels of each prisoner characteristic of interest accounted for the prisoner's intake facility, and accounted for race, previous time served, sentence length, and the summary variable for risky behavior. Comparisons of the covariate-adjusted testing rates indicated that the largest discrepancy in test was by race: women categorized as "other" were 14% less likely to be tested for HIV than white women (RR=0.86, 95% CI: 0.80, 0.93). There was a modest effect for intake prison (RR=0.94, 95% CI: 0.92, 0.96).

Among male prisoners, 31.7% were tested for HIV during admission or post-admission. Testing rates were higher than average for men reporting risk behaviors such as a history of sharing needles (34.9%), prostitution (37.9%), or MSM (38.8%), but few men (i.e. less than 5%) disclosed participation in any of these behaviors (Table 5.3). In the first step of the model-based analyses for the men, all 22 of the covariates except MSM, needle sharing, and syphilis were associated with test receipt. Notably, males categorized as black and "other" were, respectively, nearly 30% and 40% less likely to be tested for HIV than whites.

In the second step of the model-based analyses for men (Table 5.4), estimation of testing rates by levels of each patient characteristic accounted for the prisoner's intake facility as well as individual characteristics except those 3 variables found to have no association with test receipt in step one. Comparisons of the covariate-adjusted testing rates indicated that male prisoners with a history of heroin use, cocaine/crack use, HIV-specific behaviors, and a medication history indicative of TB disease were at least 10% more likely to be tested for HIV than those without these attributes (Table 5.4). Black males were 13% less likely to be tested for HIV than white males (RR=0.87, 95% CI 0.85, 0.90). After adjustment for covariates, intake prison effects were still substantial: Male intake prison 2 [M2] (RR=0.33, 95% CI: 0.31, 0.35), M3 (RR=0.39, 95% CI: 0.35, 0.44), M4 (RR=0.90, 95% CI: 0.87, 0.92), M5 (RR=0.16, 95% CI: 0.13, 0.19), and M6 (RR=0.14, 95% CI: 0.12, 0.15).

Results from the analysis restricted to intake facilities with nominal missing data (<2%) and the analysis based on multiple imputation were nearly identical to results of the complete case analysis (Appendix Table 5.5). Notable exceptions included the multiple imputation analysis results for "other" race, no previous time served, and positive syphilis

results, all of which were attenuated in comparison to results from the complete case analysis.

Discussion

As national guidelines promote widespread access to HIV testing, it is important to assess the use of testing among high risk populations including prisoners. In this study, we found that nearly forty percent of prisoners were tested for HIV, and the vast majority of tests were conducted as part of the admission process. Although testing varied modestly by prisoner characteristics and reported risk behavior, it varied widely across admission facilities. This is an important observation given that prior studies of HIV testing have been conducted in smaller prison systems with only a single intake facility or without regard to multiple intake facilities.[31, 32, 37, 39, 42, 94] For future evaluations of HIV testing in other large prison systems, we suggest that testing rates be examined both across and within intake facility.

There has been little previous research investigating organizational factors associated with HIV testing in correctional facilities, which might explain the variation in facility testing rates across intake facilities. Results from one study examining the relationship between organizational structure and HIV testing in a national sample of correctional facilities found that organization size was a predictor of testing, but other constructs were not.[97] In our data, there was no apparent relationship between organization size and testing practices. Brief interviews with key informants indicated that facility differences were largely a reflection of different priorities assigned by the chief medical professional at each facility; in the two female facilities, high testing rates were explained by the use of opt-out testing as a standard

component of reproductive healthcare. Formal evaluations of the relationship between organizational structure and HIV testing could yield other useful insights.

In nearly all state prison systems, including North Carolina's, HIV testing is available throughout inmates' incarceration following an incident with blood exposure, upon clinical recommendation, or upon the inmates' request. However, in our study population, the proportion of prisoners tested for HIV following admission was relatively small (6%). Providing periodic opportunities for prisoners to be tested for HIV could increase uptake of testing, and repeat testing of prisoners testing negative at admission could be useful in monitoring intra-prison transmission.[91] In the NC DOC periodic testing of women would be less useful given their high rate of testing upon admission and short sentences.

Of concern, nonwhites were less likely to be tested for HIV compared to whites: women whose race was categorized as other (i.e. neither white nor black) were 14% less likely to be tested than white women, and men categorized as other or black were 40% and 30%, respectively, less likely to be tested than white men.

For men, much of the difference in testing across racial category may be explained by differences in the racial composition and testing rate of the intake prisons. The intake prison with the greatest number of non-whites (M2) tested less than 10% of all inmates. The extent that race affected testing rate, however, is unclear. Nevertheless, after accounting for intake prison and prisoner characteristics associated with testing, black men and "other" women were still less likely to be tested for HIV than whites. Other studies of among prisoners have also reported lower testing rates among non-whites.[37, 39, 41] Given the higher prevalence of HIV among nonwhites as compared to whites,[8] greater testing of nonwhites is an important

step in improving case finding. More effort is needed to understand prisoners' potential reluctance to be tested as well as the institutional barriers to testing.

Among males, prisoner reporting any conventional HIV risk behavior, heroin use, or crack/cocaine use were 10% more likely to be tested for HIV than prisoners not disclosing these behaviors, and prisoners with TB disease were 20% more likely to be tested than prisoners without TB. However, prisoners with active syphilis infection were no more likely to be tested for HIV than those without syphilis infection, and though only a small proportion (~10%) of prisoners was tested for hepatitis C, we found an inverse relationship between hepatitis C seropositivity and HIV testing. With syphilis, hepatitis C, and HIV sharing routes of transmission, greater testing among syphilis- and hepatitis C-infected populations may yield a relatively high proportion of HIV-infected individuals.

The CDC has recommended that HIV testing be available widely and offered routinely (i.e. via opt-out testing) in correctional health care facilities.[47, 95] Routine HIV testing in prisons could potentially have a profound impact on case identification. In Rhode Island, which maintains a jail and prison in a single facility, HIV testing is routinely offered to all individuals pre-trial; those who refuse consent-based testing receive mandatory testing if convicted. Ninety percent of Rhode Island prisoners accept routine testing.[59] Under this system, the Rhode Island Department of Corrections detected about a third of all HIV-infections in the state during the 1990s.[73] In comparison, only about 7% of new HIV cases in North Carolina are detected in correctional facilities.[98] Expanding HIV testing in the NC prison system may be an efficient way to improve case finding in the state.

However, any expansion in testing must be done with caution: in the prison setting, which is designed to limit personal liberties, there is a fine line between encouragement and

coercion. In a recent qualitative study of prisoners' attitudes towards HIV testing in correction facilities, some inmates reported that HIV testing in their prison was mandatory despite residing in prisons with a policy of voluntary testing.[99] With such misperceptions (or inconsistent application of policy), the 90% acceptance rate in Rhode Island causes some concern when compared to the 40% acceptance rate of opt-out testing reported in community settings.[85, 100] Notwithstanding suggestions that Rhode Island prisoners are willing to be tested for HIV because the availability of comprehensive medical care has been well established,[84] state prison systems should ensure that consent-based HIV testing is truly voluntary.

In the NC DOC, prisoners disclosing their positive HIV status to medical staff are frequently provided confirmatory testing before antiretroviral medications are initiated. To focus our analyses on the testing of prisoners with unknown HIV serostatus, we excluded from our main analyses prisoners who were tested for HIV despite state (health department) records indicating a pre-existing HIV diagnosis. We note, however, that these prisoners comprised 80% of all prisoners with an HIV-positive test result (Chapter 6). Although half of these prisoners were first diagnosed in a correctional facility, failure to account for confirmatory testing would have greatly overstated the effectiveness of voluntary testing to detect new cases. It is important for studies of HIV testing to distinguish between new and repeated HIV diagnoses.

This study has a few limitations. We were unable to link a small proportion of lab records (3%) to prison records. It is not possible to determine if these unlinked lab records correspond to inmates in our study population or inmates who entered prison before the study period began. Second, this study relies on routinely collected administrative data. Validation

of administrative data would have been desirable, but was not possible because of the retrospective design of this study. Third, about 23% of data specific to HIV risk behaviors were missing. These missing data limited the scope of our covariate-adjusted analysis of testing among women. For the men, we assessed the effect of the missing data by comparing the results from a complete case analysis, a restricted population with nominal missing data, and an analysis using (multiply) imputed data; the effect estimates across analyses differed little. Finally, data from the state department of health allowed us to exclude from the analyses prisoners testing positive for HIV who previously had been diagnosed in North Carolina; however, we were unable to identify and exclude prisoners who declined testing because of a previous diagnosis.

Prisons have been well recognized as an important point of contact with populations who are at increased risk of disease and who often go without routine medical, dental, and mental health care. Programs to provide these services should be evaluated regularly and modified based on findings. Evaluation of HIV testing programs in prison could lead to improvements in case ascertainment. In this study we found that there were wide variations in testing across intake facilities, racial disparities in testing, and few tests provided after the admission process. The NC DOC is reviewing these findings and working with medical staff to improve and unify testing services. Additional studies are currently being initiated to assess prisoners' and providers' perspectives of the HIV testing process. Other state prison systems with consent-based testing could benefit from similar analyses as the role of prisons expands in HIV case detection.

Table 5.1. Characteristics of adult prisoners entering the North Carolina
state prison system, January 2004 - May 2006

	Women N=6,804	Men N=47,212
Age group (years)		
≥ 45	12.4 %	14.0 %
35 - 44	33.8	25.9
25 - 34	36.3	34.2
18 - 24	17.6	25.9
Race		
Black	42.2	55.5
Other	3.5	6.3
White	54.3	38.1
Education		
College	13.5	7.3
HS degree or GED	46.2	47.0
Less than high school	40.3	45.6
Employed*	34.4	64.0
Married*	15.6	14.6
IQ test result		
≤ 80	13.5	25.2
81 - 100	54.3	55.3
≥ 101	32.3	19.5
Previous time served (months)		
None	60.5	44.0
> 0 - 6	15.0	13.9
7 - 12	10.3	10.1
≥ 13	14.2	32.0
Sentence length (months)†		
≥ 19	16.6	30.9
7 - 18	22.2	25.9
3 - 6	29.9	22.8
< 3	31.3	20.4
Drug-related conviction ever	40.4	37.5
Sex-related conviction ever	1.3	6.2
Cocaine or crack use ever	63.0	32.7
Heroin use ever	5.8	1.9
MSM‡	--	0.7
Multiple sexual partners‡	26.4	21.2
Prostitution‡	16.1	5.9
Share Needles‡	9.0	3.0
Blood transfusion‡	2.8	0.7
Sex with Needle Sharer§	15.6	--
Sex with MSM§	2.9	--
Mental health\		
Axis I	6.5	2.3
Axis II	4.5	2.7

Table 5.1. Characteristics of adult prisoners entering the North Carolina
state prison system, January 2004 - May 2006 (cont.)

	Women N=6,804	Men N=47,212
Hepatitis C		
Positive	7.6 %	3.2 %
Negative	2.1	1.1
No test	90.3	95.7
Syphilis		
Positive	5.2	4.1
Negative	83.4	71.9
No test	11.4	23.9
Tuberculosis		
Positive	1.0	3.8
Negative	99.0	96.2

*data missing for ≤ 20 observations per gender

†data missing for 471 (6.9% of) women and 2376 (5.0% of) men

‡data not collected from 3976 (58% of) women and 8333 (18% of) men

§data not collected from 3976 (58% of) women and all men

\Axis I: psychosis, bipolar disorder, major depression, generalized
anxiety disorder, and dementia; Axis II: personality disorder,
developmental disability

Table 5.2. Associations between HIV test receipt and characteristics of adult female
North Carolina state prisoners, admitted January 2004 - May 2006

	HIV-Tested		
	n	% (n)	RR 95% CI
Age group (years)			
≥ 45	842	84.6 (712)	0.98 (0.94, 1.02)
35 - 44	2,299	85.2 (1958)	0.99 (0.96, 1.02)
25 - 34	2,468	86.3 (2130)	1.00 (0.97, 1.03)
18 - 24	1,195	86.3 (1031)	1
Race			
Black	2,873	85.4 (2454)	0.99 (0.97, 1.01)
Other	236	74.6 (176)	0.86 (0.80, 0.93)
White	3,695	86.6 (3201)	1
Education			
College	919	83.5 (767)	0.96 (0.93, 0.99)
HS grad or GED	3143	85.5 (2687)	0.99 (0.97, 1.01)
Less than high school	2,742	86.7 (2377)	1
Employment*			
Unemployed	4,459	86.7 (3865)	1.03 (1.01, 1.06)
Employed	2,343	83.8 (1964)	1
Marital Status			
Not married/separated	5,743	86.1 (4946)	1.03 (1.00, 1.06)
Married	1,061	83.4 (885)	1
IQ test result			
≤ 80	918	84.9 (779)	1.01 (0.98, 1.04)
81 - 100	3,691	86.8 (3204)	1.03 (1.01, 1.05)
≥ 101	2,195	84.2 (1848)	1
Previous time served (months)			
None	4,114	82.5 (3392)	0.92 (0.90, 0.94)
> 0 - 6	1,019	90.6 (923)	1.01 (0.98, 1.04)
7 - 12	703	92.2 (648)	1.03 (1.00, 1.06)
≥ 13	968	89.7 (868)	1
Sentence length (months)†			
≥ 19	1050	74.4 (781)	0.89 (0.85, 0.93)
7 - 18	1,409	89.3 (1258)	1.07 (1.04, 1.10)
3 - 6	1,892	90.9 (1720)	1.09 (1.06, 1.11)
< 3	1,982	83.7 (1658)	1
Drug-related conviction ever			
Yes	2,748	88.0 (2417)	1.04 (1.03, 1.07)
No	4,056	84.2 (3414)	1
Sex-related conviction ever			
Yes	91	75.8 (69)	0.88 (0.79, 0.99)
No	6,713	85.8 (5762)	1
Heroin use ever			
Yes	396	89.9 (356)	1.05 (1.02, 1.09)
No	6,408	85.4 (5475)	1
Cocaine or crack use ever			
Yes	4,283	87.8 (3761)	1.07 (1.05, 1.09)
No	2,521	82.1 (2070)	1

Table 5.2. Associations between HIV test receipt and characteristics of adult female
North Carolina sate prisoners, admitted January 2004 - May 2006 (cont.)

	HIV-Tested		
	n	% (n)	RR 95% CI
Multiple sexual partners‡			
Yes	748	84.9 (635)	1.00 (0.97, 1.04)
No	2,080	84.8 (1763)	1
Prostitution‡			
Yes	455	85.3 (388)	1.01 (0.97, 1.05)
No	2,373	84.7 (2010)	1
Shared needles‡			
Yes	254	87.8 (223)	1.04 (0.99, 1.09)
No	2,574	84.5 (2175)	1
Blood transfusion‡			
Yes	79	83.5 (66)	0.98 (0.89, 1.09)
No	2,749	84.8 (2332)	1
Sex with Needle Sharer‡			
Yes	442	87.1 (385)	1.03 (0.99, 1.07)
No	2,386	84.4 (2013)	1
Sex with MSM‡			
Yes	82	87.8 (72)	1.04 (0.95, 1.13)
No	2,746	84.7 (2326)	1
Mental health§			
Axis I	440	83.4 (367)	0.97 (0.93, 1.01)
Axis II	308	87.3 (269)	1.02 (0.97, 1.06)
Neither	6,056	85.8 (5195)	1
Hepatitis C			
Positive	517	91.3 (472)	1.02 (0.96, 1.09)
Negative	140	89.3 (125)	1
No test	6,147	85.2 (5234)	
Syphilis			
Positive	353	96.3 (340)	1.00 (0.98, 1.02)
Negative	5,677	96.2 (5460)	1
No test	773	4.0 (31)	
Tuberculosis			
Positive	66	81.8 (54)	0.95 (0.85, 1.07)
Negative	6,738	85.7 (5777)	1

*data missing for ≤ 20 observations

†87.9% (414/471) of prisoners with missing data were tested for HIV

‡ 87.8% (3433/3976) of prisoners with missing data were tested for HIV

§Axis I: psychosis, bipolar disorder, major depression, generalized anxiety disorder,
and dementia; Axis II: personality disorder, developmental disability

Table 5.3 Associations between HIV test receipt and characteristics of adult
male North Carolina state prisoners, admitted January 2004 - May 2006

	HIV Tested		
	n	% (n)	RR 95% CI
Age group (years)			
≥ 45	6604	36.6 (2415)	1.94 (1.84 ,2.03)
35 - 44	12243	38.3 (4690)	2.03 (1.94, 2.12)
25 - 34	16136	34.4 (5557)	1.82 (1.75, 1.90)
18 - 24	12229	18.9 (2309)	1
Race			
Black	26221	27.7 (7272)	0.71 (0.70, 0.73)
Other	2992	23.6 (707)	0.61 (0.57, 0.65)
White	17999	38.9 (6992)	1
Education			
College	3464	35.7 (1237)	1.24 (1.18, 1.30)
HS grad or GED	22209	33.8 (7524)	1.18 (1.14 ,1.21)
Less than high school	21539	28.8 (6210)	1
Employment			
Unemployed	17006	26.9 (4581)	0.78 (0.76, 0.81)
Employed	30187	34.4 (10385)	1
Marital Status			
Not married/separated	40295	31.4 (12644)	0.93 (0.90, 0.97)
Married	6897	33.7 (2325)	1
IQ test result			
≤ 80	11893	26.4 (3141)	0.69 (0.66, 0.71)
81 - 100	26098	31.7 (8280)	0.82 (0.80, 0.85)
≥ 101	9221	38.5 (3550)	1
Previous time served (months)			
None	20793	27.0 (5604)	0.74 (0.72 ,0.77)
> 0 - 6	6540	34.7 (2269)	0.96 (0.92 ,1.00)
7 - 12	4777	34.2 (1634)	0.95 (0.90 ,0.99)
≥ 13	15102	36.2 (5464)	1
Sentence length (months)*			
≥ 19	13860	30.0 (4161)	0.79 (0.76 ,0.82)
7 - 18	11610	31.1 (3615)	0.82 (0.79, 0.85)
3 - 6	10214	28.8 (2938)	0.75 (0.72, 0.78)
< 3	9152	38.2 (3496)	1
Drug-related conviction ever			
Yes	17698	30.0 (5314)	0.92 (0.89, 0.94)
No	29514	32.7 (9657)	1
Sex-related conviction ever			
Yes	2902	28.2 (819)	0.88 (0.83, 0.94)
No	44310	31.9 (14152)	1
Cocaine or crack use ever			
Yes	15425	36.7 (5667)	1.26 (1.22, 1.29)
No	31787	29.3 (9304)	1
Heroin use ever			
Yes	872	39.7 (346)	1.26 (1.16, 1.37)
No	46340	31.6 (14625)	1

Table 5.3. Associations between HIV test receipt and characteristics of adult male North Carolina sate prisoners, admitted January 2004 - May 2006 (cont.)

		HIV Tested	
	n	% (n)	RR 95% CI
MSM†			
Yes	268	38.8 (104)	1.10 (0.95, 1.28)
No	38611	35.3 (13622)	1
Multiple sexual partners†			
Yes	8224	29.3 (2410)	0.79 (0.77, 0.82)
No	30655	36.9 (11316)	1
Prostitution†			
Yes	2276	37.9 (863)	1.08 (1.02, 1.14)
No	36603	35.1 (12863)	1
Shared needles†			
Yes	1163	34.9 (406)	0.99 (0.91, 1.07)
No	37716	35.3 (13320)	1
Blood transfusion†			
Yes	277	45.1 (125)	1.28 (1.12, 1.46)
No	38602	35.2 (13601)	1
Mental health‡			
Axis I	1107	40.1 (444)	1.28 (1.19, 1.37)
Axis II	1263	34.3 (433)	1.09 (1.01, 1.18)
Neither	44842	31.4 (14094)	1
Hepatitis C			
Positive	1485	55.4 (822)	0.89 (0.82, 0.97)
Negative	531	62.0 (329)	1
No test	45196	30.6 (13820)	
Syphilis			
Positive	1956	39.8 (778)	1.01 (0.95, 1.07)
Negative	33962	39.4 (13380)	1
No test	11294	7.2 (813)	
Tuberculosis			
Positive	1797	35.5 (637)	1.12 (1.05, 1.20)
Negative	45415	31.6 (14334)	1

*32.0% (761/2376) of prisoners with missing data were tested for HIV
†14.9% (1245/8333) of prisoners with missing data were tested for HIV
‡Axis I: psychosis, bipolar disorder, major depression, generalized anxiety disorder, and dementia; Axis II: personality disorder, developmental disability

Table 5.4 Covariate-adjusted associations between HIV test receipt and characteristics of adult male and female North Carolina state prisoners, admitted January 2004 - May 2006

	Women	Men
	RR (95% CI)	RR (95% CI)
Age group (years)		
≥ 45	0.98 (0.95, 1.02)	0.95 (0.91, 0.99)
35 - 44	0.99 (0.96, 1.01)	0.98 (0.94, 1.02)
25 - 34	1.00 (0.97, 1.02)	0.95 (0.91, 0.99)
18 - 24	1	1
Race		
Black	0.98 (0.96, 1.00)	0.87 (0.85, 0.90)
Other	0.86 (0.80, 0.93)	0.99 (0.93, 1.05)
White	1	1
Education		
College	0.98 (0.95, 1.01)	1.04 (0.99, 1.09)
HS grad or GED	0.99 (0.97, 1.01)	1.05 (1.03, 1.08)
Less than high school	1	1
Employment		
Unemployed	1.02 (1.00, 1.04)	0.97 (0.94, 0.99)
Employed	1	1
Marital Status		
Not married or separated	1.03 (1.00, 1.05)	1.02 (0.99, 1.05)
Married	1	1
IQ test result		
≤ 80	1.01 (0.98, 1.05)	0.93 (0.90, 0.97)
81 - 100	1.03 (1.01, 1.05)	0.97 (0.95, 1.00)
≥ 101	1	1
Previous time served (months)		
None	--	1.06 (1.03, 1.09)
> 0 - 6	--	1.04 (1.01, 1.08)
7 - 12	--	1.02 (0.99, 1.06)
≥ 13	--	1
Drug-related conviction ever†	1.03 (1.01, 1.05)	0.98 (0.96, 1.00)
Sex-related conviction ever†	0.90 (0.81, 1.02)	0.97 (0.92, 1.03)
Heroin use ever†	1.02 (0.98, 1.05)	1.12 (1.05, 1.19)
Cocaine or crack use ever†	1.06 (1.03, 1.08)	1.10 (1.08, 1.13)
Conventional HIV risk behavior‡	--	1.10 (1.07, 1.13)

Table 5.4 Covariate-adjusted associations between HIV test receipt and characteristics of adult male and female North Carolina state prisoners, admitted January 2004 - May 2006 (cont.)

	Women	Men
	RR (95% CI)	RR (95% CI)
Mental health§		
Axis I	0.98 (0.94, 1.02)	0.99 (0.93, 1.06)
Axis II	1.00 (0.97, 1.04)	1.05 (0.99, 1.12)
Neither	1	1
Syphilis		
Positive	--	1.00 (0.95, 1.05)
Negative	--	1
Tuberculosis		
Positive	0.99 (0.90, 1.10)	1.21 (1.16, 1.26)
Negative	1	1

*model includes variable for intake facilities and covariates with reported estimates
†referent: never
‡includes MSM (men only), multiple sexual partners, prostitution, needle sharing, sex with MSM (women only), sex with injection drug user (women only), blood transfusion 1978-1985
§Axis I: psychosis, bipolar disorder, major depression, generalized anxiety disorder, and dementia; Axis II: personality disorder, developmental disability
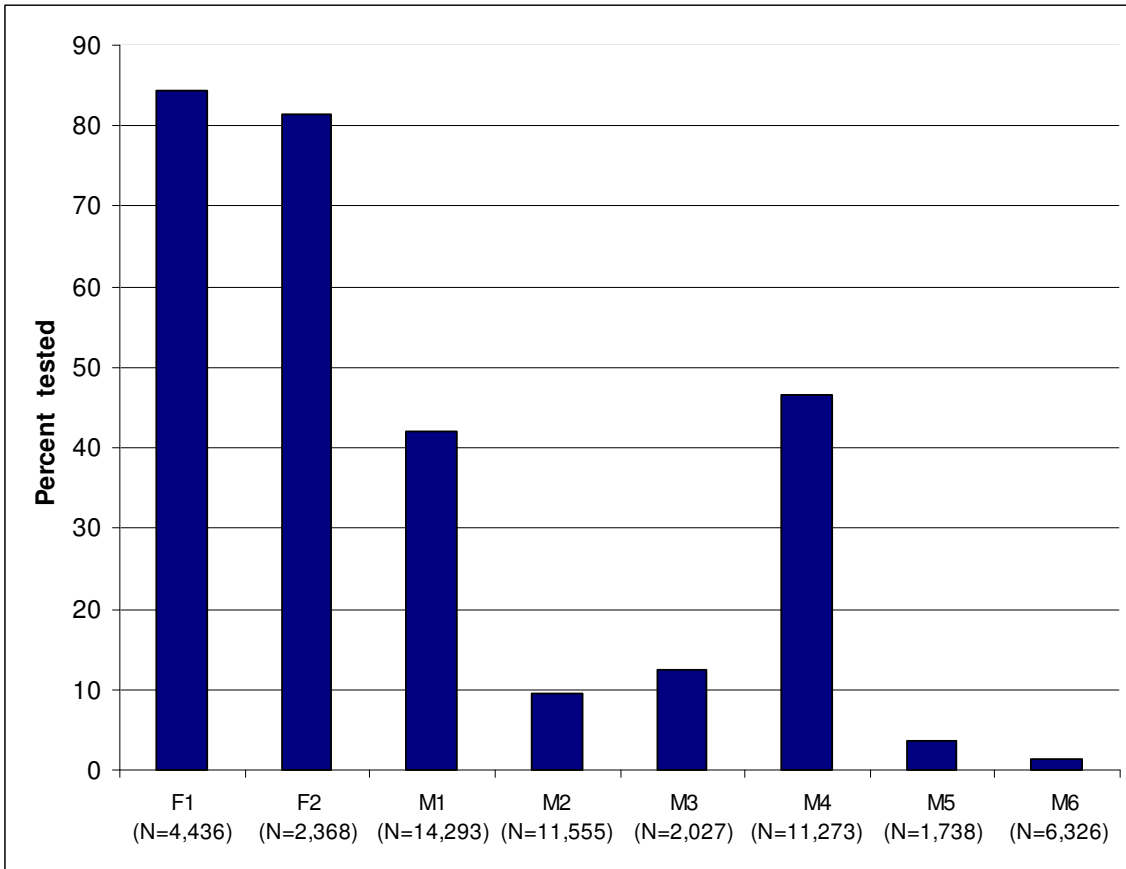
Figure 5.1. Proportion of newly admitted inmates tested for HIV within the two female (F) and six male (M) intake facilities of the North Carolina state prison system, January 2004 - May 2006

Note: Total intake population in parentheses

CHAPTER 6

CHARACTERISTICS AND BEHAVIORS ASSOCIATED WITH HIV INFECTION IN A
LARGE SOUTHERN PRISON SYSTEM

Abstract

Objective: In a prison system with voluntary HIV testing, identify factors associated with testing HIV-positive, and estimate the number of undetected cases

Methods: Using records of prisoners entering the NC DOC from January 2004 to May 2006, associations between HIV serostatus and conventional HIV-risk behaviors, mental health, coinfection status, and socio-demographic characteristics were estimated using logistic regression. The number of undetected cases was estimated based on age-sex-race specific HIV prevalences from tested prisoners and from statewide HIV reporting.

Results: Nearly 3.4% (718/21,419) of tested prisoners were HIV+. Among men, infection was most strongly associated with MSM (OR=8.0), Black race (OR=6.2), other non-white race (OR=7.4), and age group 35-44 years (OR=4.1). The strongest risk factor among women was Black race (OR=3.8). Modest associations were observed for several other risk factors (ORs < 3.0). 65% of HIV+ prisoners were coinfected with HCV. We estimated between 23% (220) and 63% (1215) of HIV cases remained undetected.

Conclusions: Modest to moderate associations highlight potential limitations of risk factor based HIV testing in prisons. At least one-fourth of all cases may have remained undetected.

Background

The prevalence of HIV among correctional populations in the US is several times that of the general population, and it has been estimated that between 13% and 19% of all HIV-infected individuals in the US pass through a correctional facility each year.[14] The vast majority of these infections are acquired in the community.[92] Given the limited community access to routine healthcare available to prisoners prior to their arrest, prisons are an important venue for HIV prevention, testing, and treatment services.[13] To facilitate the evaluation and improvement of these services, however, it is useful to accurately characterize the HIV-infected prison population.

As of 2005, 27 state prison systems provided voluntary (i.e. consent-based) HIV testing, and 7 (~25%) of these systems targeted "high risk" prisoners for testing.[29] In the wake of the Centers for Disease Control and Prevention's (CDC) 2003 and 2006 recommendations to expand the use of routine opt-out HIV testing,[47, 95] prison systems which traditionally targeted HIV testing at "high risk" inmates now face some pressure to revise their testing policies. Moreover, legislation expanding HIV testing in the federal prison system is now under consideration.[101] Greater understanding of the characteristics of the HIV-infected prison population will be helpful to evaluate and improve testing policies.

Only a few studies have examined characteristics and behaviors of HIV-positive prisoners, and most of these studies were conducted in relatively small prison systems in the Northeast. In studies of Connecticut prisoners, for example, Altice *et al.* reported that HIV-infection among males was positively associated with injection drug use, psychiatric illness, history of a sexually transmitted disease, black race, and Hispanic origin; among female prisoners, HIV-infection was associated with injection drug use, sex with a known HIV-

positive person, syphilis infection, black race, Hispanic ethnicity, as well as laboratory findings of leucopenia and hypoalbuminemia.[41, 94] A study of male prisoners in Rhode Island found that HIV infection was strongly associated with race and injection drug use,[92] and a study of Maryland prisoners found that nearly 65% of HIV-infected prisoners were hepatitis C (HCV)-infected.[102]

Similar studies have rarely been conducted in other parts of the country, including the South, which of all US regions has the highest rate of incarceration,[103] the greatest number of new AIDS diagnoses, and the greatest number of people living with—and dying from—AIDS.[46]

The purpose of this study is to examine associations between HIV-infection and socio-demographic characteristics, conventional HIV risk behaviors, drug use, conviction history, mental health and coinfections among a population of inmates voluntarily tested for HIV in a large southern prison system, the North Carolina Department of Correction (NC DOC). We also use prevalences derived from tested prisoners and those derived from state health department data for the entire state to estimate a plausible range of undetected HIV cases. Together, this information could be useful in improving the provision of HIV services in prison.

Methods

The source data are described in detail in an accompanying article (Chapter 5). In brief, the study population included adult prisoners entering the NC DOC between January 1, 2004 and May 30, 2006 who received a voluntary HIV test anytime during their incarceration.

When prisoners are incarcerated in the NC DOC, they are first sent to one of eight intake prisons and assessed for vocational skill, educational achievement, illicit substance use, and mental and physical health. The medical evaluation includes routine testing for syphilis and tuberculosis (TB), and testing for HCV upon clinical indication. Inmates are screened for conventional HIV risk behaviors including: 1) blood transfusion between 1978-1985, 2) sex with multiple partners, 3) sex as or with a sex worker, 4) needle sharing, 5) sex with men (only asked of men), which we refer to as MSM; two behaviors are only assessed among women: 6) sex with injection drug users and 7) sex with MSMs. Following this assessment, inmates of unknown serostatus are suppose to have an opportunity to test for HIV; inmates self-reporting a previous HIV diagnosis typically receive confirmatory testing before initiation of antiretroviral therapy. Inmates may also receive an HIV test anytime during their incarceration upon clinical indication, following an incident with blood exposure, such as a fight, and upon their own request. All HIV-positive inmates are tested for HCV.

Assessments of inmates' social and criminal histories are conducted by a NC DOC case analyst, and are informed by data collected prior to sentencing. Psychological assessments are conducted in several stages, beginning with a 10-item screening instrument. Prisoners responding affirmatively to questions on the screener or displaying unusual behavior are referred to a psychologist for further evaluation and possible diagnosis based on criteria of the Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV.

Electronic records and data linking

The NC DOC provided electronic records of the data described above. Dates and results of all tests for syphilis, HCV, and HIV conducted during the study period were provided in a separate database by Quest Diagnostics, a private company contracted by the NC DOC to process diagnostic lab work.

Electronic prison and lab data were linked using a unique prison identification number (PIN) assigned to all inmates upon first admission. The PIN was present in all prison records and missing in less than 3% of lab records. Lab records with missing PINs were excluded from our analyses; only records of prisoners tested for HIV were included for analysis.

Before analysis, each inmate record was assigned a unique study identification number, and all other identifying information (names, date of births, and PIN) was removed. Only records of inmates 18 years of age or older at the time of prison admission were included for analysis. This project was approved by the Biomedical IRB within The University of North Carolina—Chapel Hill and the IRB of The North Carolina Department of Corrections.

Coding of infectious disease test results and mental health conditions

Inmates were classified as HIV-positive if both an enzyme-linked immunosorbent assay (ELISA) was reactive and the Western blot was interpreted as positive; HCV-positive with a reactive antibody test; and positive for active syphilis if the Rapid Plasma Reagin (RPR) titre was 1:8 or greater.[104] All prisoners were assessed for TB using a Montoux

screening test at admission. Since the Montoux results were not electronically available, electronic medication prescription data were used: prisoners prescribed anti-TB medications within 30 days of admission were coded as having TB disease.

Electronic records were used to determine whether prisoners had been diagnosed with a mental health disorder within 30 days of admission. The following diagnoses, based on DSM-IV criteria, were included for statistical analysis: (Axis I) psychosis, bipolar disorder, major depression, generalized anxiety disorder, dementia, and (Axis II) developmental disorders and personality disorders. Prisoners diagnosed with both Axis I and II diagnosis were coded for Axis I only.

Model-based analyses

The proportion of HIV-infected prisoners was calculated by each of the following: socio-demographic characteristics, conventional HIV risk behaviors, drug use, conviction history, mental health, TB disease, syphilis infection, and HCV infection.

Associations between HIV-serostatus and inmate characteristics were evaluated via a stepwise model-fitting strategy. In the first step, for each of the 22 independent variables of interest, a gender-specific logistic regression model for the prisoner's HIV-serostatus (+ or -) was fit in a manner which provided a test of size $\alpha = 0.05$ of the null hypothesis "prevalence is invariant across the levels of that independent variable." In the second step, a gender-specific logistic regression model for HIV-serostatus was fit conditional on the inmate characteristic of interest and also accounting for other characterics that were statistically significant in the first step.

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Conventional HIV risk behaviors were only recorded for women admitted to one of the two intake facilities which process females. Among men, risk behavior assessments were recorded in all but 8% of records. Prisoners lacking records with the risk behavior assessments were excluded from step 2 analyses.

Estimating prevalence of HIV cases among the untested prison population

Most female prisoners were tested for HIV, but more than two-thirds of male prisoners remained untested. To estimate the number (N) of HIV cases among untested male prisoners, we stratified the population of untested males by age (5 categories) and race (black, white, other), and multiplied the number (N_i) of untested prisoners within each of these strata by corresponding stratum-specific prevalence estimates $(\hat{P_i})$ obtained from the population of male prisoners tested for HIV. Thus, the estimate of the number of HIV cases $(\hat{N})$ took the form of a weighted sum of prevalence estimates:

$$\hat{N} = \sum_{i=1}^{15} \hat{P_i} N_i$$

Similarly, 95% confidence intervals were estimated as

$$\hat{N} -/+ 1.96\left(\sum_{i=1}^{15} N_i^2 V_i\right)^{1/2}$$

in which V_i is the stratum specific variance of $\hat{P_i}$ derived from the exact confidence intervals. Our estimate assumes that the age distribution of untested prisoners was fixed, the variances for the prevalence estimates were independent, and that the HIV prevalence among the untested population is approximately the same as the prevalance among the tested population.

The same approach was repeated using age- and race- specific prevalence estimates ($\hat{P}_i$) for the general population of men in North Carolina. State prevalence estimates among men were calculated by dividing the age- and race-specific number of North Carolina men known to be living with HIV, as reported to the state health department,[90] by the corresponding stratum-specific population denominators of men derived from census data. For enhanced stability of these state estimates, we pooled HIV case and census data from 2000-2005. For estimates based on the state data, V_i was estimated from asymptomtic confidence intervals. All analyses were conducted using SAS vs. 9.1 (Cary, North Carolina).

Results

During the study period, 54,644 prisoners aged 18 years or older entered the NC prison system. Of these prisoners, we included in our study population the 21,419 (39%) prisoners with an HIV test result.

In table 6.1, characteristics of the HIV-tested population are presented. About one third of the population was female, and nearly half the population was black. More than 40% of males and females did not have a high school degree or GED, and about 60% of males and 40% of females had been previously imprisoned. More than one-third of men and nearly two-thirds of women had used crack or cocaine. Only 1% of males reported having sex with males (MSM), but 3% of males and 9% of females reported sharing needles; 17% of females also reported sex with men who shared needles.

Overall, 3.4% (718) of the 21,419 prisoners tested for HIV were positive, including 3.6% of men and 2.6% of women. Eighty-four percent of prisoners testing positive had been previously diagnosed with HIV in North Carolina.

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The proportion of male prisoners infected with HIV, by race and age, ranged between 0 and 9.5%, was greatest among those aged 45-54 years, and was highest among non-whites (Table 6.2). The age- and race-stratified proportions of infected female prisoners generally followed the same pattern as the men. Across ages, blacks comprised 82% of HIV-infected males and 75% of HIV-infected females.

The proportions of HIV-infected prisoners co-infected with TB, syphilis, and HCV, were 2.5%, 9.2%, and 67.8%, respectively, and varied little by gender.

HIV prevalence was greater among those with a history of any conventional HIV risk behavior (men: 6.5%, women: 4.0%) compared to those without (men: 2.6%, women: 1.7%), but the majority of cases arose from the 79% of males and 57% of females without a history of HIV risk behaviors. Of the 718 HIV cases, 242 (34%) had a history of at least one conventional HIV risk behavior, 317 (44%) had no history of any conventional risk behaviors, and 159 (22%) had no assessment data.

Among male prisoners reporting MSM, the proportion infected with HIV was nearly 30%, and among those who reported either sharing needles or having sex with a sex worker, the proportion infected was about 10% (Table 6.3). Five percent of male cocaine users were HIV-positive. Sixty percent of HIV-positive males (293/492) denied all conventional HIV risk behaviors.

In step one of the model-based analyses for men, most of the prisoner characteristics variables of interest appeared to be associated with HIV status; exceptions included the following: marital status, sex or drug-related conviction, mental health diagnosis, blood transfusion history, and TB disease.

In step two of the model based analyses for men (Table 6.3), all age groups greater than the referent (18-24 years) were associated with greater prevalence of HIV infection, and men with the racial categories black (Odds ratio [OR] =6.02, 95% Confidence Interval [CI]: 4.48, 8.10) and other (OR=7.40, 95% CI: 4.43, 12.36) were more likely than whites to be infected. HIV infection was also more likely among high school (or GED) and college graduates than among those who did not complete secondary school; men previously incarcerated 7 or more months were at greater risk for infection than those never incarcerated. Heroin use, cocaine/crack use, co-infection with syphilis, and several HIV risk behaviors (MSM, multiple partners, sex with prostitutes, and needle sharing) were all associated with increased risk of HIV infection (Table 6.3).

Information for conventional HIV risk behaviors was only collected in one of the two female intake facilities. Among women with available data, 10% reporting sex with a MSM partner and 8% reporting blood transfusions prior to 1986 were HIV-positive, but the number of cases for each was less than 10. About 5% of women reporting multiple sexual partners or prostitution were HIV-infected (Table 6.4). Thirty-six percent of HIV-positive women with behavioral assessment data (24/67) denied all conventional HIV risk behaviors.

In the step one of the model-based analyses for women, likelihood of HIV-infection was associated with age group 35-44 years, black and other race, unemployment, IQ less than 100, previous imprisonment, crack/cocaine use, drug crimes, syphilis infection, and HIV risk behaviors except for needle-sharing.

In step two of the model-based analyses for women (Table 6.4), association with age was not detected but women with the racial categories black (OR= 4.34, 95% CI: 2.86, 6.59) and other (OR= 2.68, 95% CI: 1.02, 7.02) were more likely to be HIV-infected than whites.

Crack or cocaine use, drug crime conviction, and 13 or more months previously incarcerated were also associated with increased risk for HIV infection, although point estimates for these effects were all relatively modest, i.e. OR < 2.

Hepatitis C testing was limited to about 10% of the study population, but was provided to almost all HIV-infected prisoners and to prisoners previously diagnosed with HCV. With such an unrepresentative sample of the population tested for HCV, associations between HCV and HIV do not warrant presentation here.

Based on data of known HIV diagnoses in the state, we estimated that 223 (95% CI: 220, 225) HIV-infected prisoners remained untested; when this estimate was based on the prevalence of HIV among tested prisoners, we estimated 1,101 (95% CI: 987, 1215) HIV-infected prisoners remained untested.

Discussion

In an accompanying article, we examined system- and individual-level differences in the use of voluntary (i.e. consent-based) HIV testing in the North Carolina state prison system. This article extends those findings by 1) describing the burden of HIV infection among tested prisoners, 2) examining individual characteristics and behaviors associated with HIV infection among prisoners, and 3) estimating a plausible range of HIV cases among the untested prison population.

As we reported in the accompanying article, 85% of women and 31% of men were tested for HIV during the study period (Chapter 5). Of those inmates, 2.6% of women and 3.6% of men were HIV-infected. These estimates are greater than prevalence estimates from the neighboring state prison system in South Carolina (female: 2.1%, male 2.2%),[8] which

tests all inmates for HIV. The estimates are also greater than 6 times those for the general

NC and US populations (our calculation)[105-107].

Because the vast majority of the female prisoners received an HIV test and there were

only modest differences in testing across demographic and behavioral characteristics

(Chapter 5), our estimate of the proportion testing positive, 2.6%, reasonably estimates the

prevalence in female inmates. For males, however, elective testing combined with a

moderate testing rate likely resulted in an estimate of seropositivity unrepresentative of the

general male prison population. Supporting this supposition, we previously found large

differences in testing across intake facilities, which resulted in differences in testing by,

among other characteristics, race and age (Chapter 5).

With less than a third of all males tested for HIV, we estimated the number of HIV

cases among untested male prisoners by assuming that HIV risk was homogeneous within

race-age category. Our estimates of undetected HIV cases ranged widely, with the estimate

based on statewide diagnoses lower than that based on diagnoses in the prison system.

Nevertheless, this range of estimates provides a useful guide when considering the potential

public health benefits and the financial costs of expanded HIV testing, as is now

recommended by the CDC.[95] In settings with voluntary HIV testing, this estimation method

provides a simple and inexpensive alternative to blinded sero-testing as a means to gauge the

extent of HIV infection.

In addition to HIV, infectious diseases such as TB, syphilis, hepatitis B, and HCV are

all common among correctional populations. Coinfection of these diseases with HIV can

complicate therapies and lead to greater morbidity and mortality. Of these infections, HCV

is typically the most prevalent in correctional populations.[14] Untreated HIV/HCV

coinfection leads to shorter survival times and greater mortality than HIV-infection alone,[108] and in comparison to HCV-infection alone, coinfection leads to more rapid progression of liver fibrosis. HCV may also exacerbate the side effects of some antiretrovirals used to treat HIV, limiting their use.[108] National estimates suggest that about 20% of the prison population is HCV-infected.[14] We found that greater than 65% of HIV-positive prisoners were coinfected with HCV, a result similar to that reported among Maryland inmates.[102] The high prevalence of HCV among HIV-positive prisoners underscores the need to coordinate HIV and HCV care, both in prison and after release.

Among male prisoners, most of the characteristics and behaviors we assessed were associated with HIV serostatus, but the majority of these associations were modest in magnitude (i.e. OR less than 2). Exceptions included MSM (OR=8.04), and to a lesser degree, history of sharing needles (OR=2.14). Demographic variables age and race were moderately associated with HIV infection, with non-whites and those aged 35-44 years at greatest risk of infection compared with other inmates.

Among female prisoners, ORs ranged between 2 and 3 for the associations between HIV infection and multiple sexual partners, blood transfusion pre-1986, sex with MSM, and drug-related imprisonments. Black race had the strongest association with HIV status (OR=3.57). In a study of females incarcerated in the Connecticut prison system, Altice *et al.* found that the strongest behavioral risk factors for HIV infection were sex with an HIV-positive partner (OR=9.1) followed by injection drug use (OR=6.1). In that population, associations between HIV status and other risk factors such as non-injection drug use and race were of a similar magnitude to those in our study population; two routine clinical laboratory markers, leucopenia (OR=9.4) and hypoalbuminemia (OR=7.2) were also

associated with HIV infection among female Connecticut prisoners, but these data may not be routinely available in some correctional settings, particularly at intake.

The goal of targeted testing is to increase the efficiency of case detection. Seven prison systems with voluntary HIV testing services report that they target HIV testing at "high risk" inmates, but the specific criteria for testing has not been reported. In our study population, the modest strength of associations for most prisoner characteristics and behaviors suggest that targeted testing based on conventional HIV risk behaviors may result in limited case finding. This method of case detection is also reliant upon prisoner's willingness to disclose sensitive behaviors. Among our study population, greater than half of HIV-positive prisoners with a recorded HIV risk assessment failed to disclose any risk behaviors. The high proportion of HIV-positive prisoners coinfected with HCV strongly suggests that, at the very least, injection drug use was greatly under-reported.

Echoing the CDC's 2006 recommendations, we suggest that testing should be widely encouraged among all prisoners, since many are unlikely to disclose risk behaviors. Encouragement, however, should not extend into coercion. As in the community, prisoners should maintain their right to accept or decline HIV testing. It is also imperative that, with expanded testing, prison systems provide adequate treatment services and bridge the divide between correctional and community healthcare. In the North Carolina prison system, HIV treatment is widely available and programs to bridge correctional and community HIV care are currently being expanded.

This study has a few limitations. As we have discussed, data specifically designed to assess HIV risk were not collected for all prisoners. Risk assessments were not documented in one of two intake facilities for women. As a result, more than half of all electronic records

among women were missing HIV risk data. These records, however, corresponded to only about 6% of the total study population.

While most prisoners were assessed for HIV risk behaviors, reluctance to disclose risk behaviors likely attenuated the magnitude of associations between risk behaviors and HIV status. And although our data suggests the limited usefulness of targeted HIV testing, a more definitive assessment should include construction of receiver operator curves to evaluate the potential trade-off between sensitivity and specificity of different risk-factor based testing algorithms. Also, in future investigations, collection of sensitive data could be improved using audio computer assisted interviews (ACASI),[109] but that was not possible for this retrospective investigation.

Additionally, we were limited to serostatus results among prisoners voluntarily tested for HIV. While our estimate of HIV infection among women was based on testing results from the majority of the female prisoners, our estimate for males was based on less than a third of the population. Finally, according to state records, greater than 80% of the population testing HIV-positive had an existing HIV diagnosis. Assuming that most of these prisoners disclosed their HIV status in order to prompt confirmatory HIV testing before initiating HIV care in prison, our results could have been biased by differential disclosure of seropositivity across groups of prisoners.

Prison systems continue to grapple with HIV testing and treatment in their facilities. The increased prevalence of HIV in correctional settings has been demonstrated repeatedly, but varies regionally and across different demographic and risk groups.[8, 37, 40, 41, 102] This study has improved upon existing estimates of HIV burden among inmates in a large prison system in the Southeast, and estimates that between 23% and 63% of all HIV cases may be

undetected. With only moderate associations between HIV serostatus and most reported risk behaviors, and relatively few prisoners acknowledging behaviors strongly associated with infection, testing dependent on prisoners' disclosure is likely to miss a substantial number of HIV infections. Prison systems predominantly testing "high risk" inmates should re-evaluate their testing policies in light of the 2003 and 2006 CDC recommendations.

Table 6.1. Characteristics and behaviors of adult inmates tested for HIV following incarceration in the North Carolina state prison system, January 2004 - May 2006

	Women (N=5,958)	Men (N=15,461)
Age group (years)		
45+	12.2 %	16.5 %
35-44	33.9	31.8
25-34	36.4	36.7
18-24	17.5	15.1
Race		
Black	42.8	49.7
Other	3.0	4.7
White	54.2	45.6
Education		
College	13.1	8.4
HS degree or GED	46.0	50.3
Less than high school	40.9	41.3
Unemployed*	66.5	31.3
Married*	15.1	15.5
IQ test results		
≤ 80	13.7	21.4
81 - 100	55.0	55.2
≥ 101	31.4	23.3
Previous time served (months)		
None	57.8	36.8
> 0 - 6	15.8	15.1
7 - 12	11.3	10.9
≥ 13	15.2	37.3
Sentence length (months)†		
≥ 19	14.5	29.4
7 - 18	23.1	25.5
3 - 6	31.8	20.7
< 3	30.7	24.4
Drug-related conviction ever	41.8	35.6
Sex-related conviction ever	1.2	5.5
Cocaine or crack ever	64.9	38.4
Heroin ever	6.1	2.4
Same-sex sexual partner‡	15.2	1.0
Multiple sexual partners‡	27.1	18.0
Prostitution‡	16.7	6.8
Share Needles‡	9.4	3.2
Blood transfusion‡	2.9	0.9
Sex with Needle Sharer§	16.2	--
Sex with MSM§	3.2	--

Table 6.1. Characteristics and behaviors of adult inmates tested for HIV following incarceration in the North Carolina state prison system, January 2004 - May 2006 (cont.)

	Women	Men
Age	(N=5,958)	(N=15,461)
Mental health\		
Axis I	6.4	3.0
Axis II	4.6	2.9
Hepatitis C		
Positive	9.4	7.5
Negative	2.7	3.1
No test	87.9	89.4
Syphilis		
Positive	5.9	5.3
Negative	93.5	89.4
No test	0.6	5.3
Tuberculosis	1.0	4.2

*Data missing for ≤ 5 observations per gender

† Data missing for 421 (7% of) women and 778 (5% of) men

‡Data not collected from 59% of women and 9% of men

§Data not collected from 59% of women and all men

\Axis I: psychosis, bipolar disorder, major depression, generalized anxiety, and dementia; Axis II: personality disorder, developmental disability

Table 6.2. HIV test results by age, race, and sex of adult inmates entering the North Carolina state prison system, January 2004 - May 2006

	Age	Black		Other		White	
		Total	HIV+ % (n)	Total	HIV+ % (n)	Total	HIV+ % (n)
Male	55+	203	6.9 (14)	3	0.0 (0)	124	0.0 (0)
	45-54	1275	9.5 (121)	56	5.4 (3)	885	1.1 (10)
	35-44	2513	8.2 (206)	178	5.6 (10)	2226	1.4 (31)
	25-34	2592	4.0 (103)	356	3.9 (14)	2720	1.0 (26)
	18-24	1098	1.7 (19)	138	2.2 (3)	1094	0.2 (2)
	Total	7681	6.0 (463)	731	4.1 (30)	7049	1.0 (69)
Female	55+	33	6.1 (2)	0		36	2.8 (1)
	45-54	307	4.2 (13)	15	6.7 (1)	338	0.9 (3)
	35-44	913	6.5 (59)	64	4.7 (3)	1045	1.8 (19)
	25-34	846	3.7 (31)	79	1.3 (1)	1241	0.6 (8)
	18-24	449	2.7 (12)	23	0.0 (0)	569	0.5 (3)
	Total	2548	4.6 (117)	181	2.8 (5)	3229	1.1 (34)

Table 6.3. Covariate-adjusted associations between characteristics of adult male
North Carolina state prisoners and HIV infection, January 2004 - May 2006

| | HIV-positive | | Adjusted | |
	n	% (n)	OR	95% CI
Age group (years)				
45+	2546	5.8 (148)	3.88	(2.30, 6.54)
35-44	4917	5.0 (247)	4.07	(2.46, 6.74)
25-34	5668	2.5 (143)	2.63	(1.59, 4.37)
18-24	2330	1.0 (24)	1	
Race				
Black	7681	6.0 (463)	6.21	(4.60, 8.41)
Other	731	4.1 (30)	7.36	(4.36, 12.42)
White	7049	1.0 (69)	1	
Education				
College	1294	4.9 (64)	1.45	(1.01, 2.08)
HS grad or GED	7776	3.7 (284)	1.28	(1.02, 1.59)
Less than high school	6391	3.3 (214)	1	
Employment				
Unemployed	4836	5.8 (279)	1.68	(1.37, 2.06)
Employed	10620	2.7 (283)	1	
Marital Status				
Not married/separated	13071	3.8 (491)	1.21	(0.89, 1.63)
Married	2388	3.0 (71)	1	
IQ test (Beta)				
≤ 80	3312	5.8 (193)	1.83	(1.30, 2.57)
81 - 100	8540	3.5 (299)	1.21	(0.89, 1.63)
≥ 101	3609	1.9 (70)	1	
Previous time served (months)				
≥ 13	5765	5.7 (326)	1.84	(1.39, 2.44)
7-12	1680	3.4 (57)	1.46	(1.01, 2.13)
≤ 6	2330	3.0 (70)	1.11	(0.76, 1.61)
None	5686	1.9 (109)	1	
Sentence length (months)				
≥ 19	4311	4.0 (172)	1.74	(1.31, 2.32)
7 - 18	3745	4.0 (150)	1.81	(1.36, 2.42)
3 - 6	3044	4.0 (121)	1.96	(1.45, 2.65)
< 3	3583	2.8 (99)	1	
Heroin				
Yes	369	6.8 (25)	1.80	(1.07, 3.02)
No	15092	3.6 (537)	1	
Cocaine or crack				
Yes	5932	5.0 (298)	1.30	(1.06, 1.60)
No	9529	2.8 (264)	1	
MSM				
Yes	144	29.9 (43)	8.04	(5.17, 12.51)
No	14008	3.2 (446)	1	

Table 6.3. Covariate-adjusted associations between characteristics of adult male
North Carolina state prisoners and HIV infection, January 2004 - May 2006 (cont.)

	HIV-positive		Adjusted	
	n	% (n)	OR	95% CI
Multiple sexual partners				
Yes	2548	5.9 (150)	1.41	(1.08, 1.84)
No	11604	2.9 (339)	1	
Prostitution				
Yes	961	10.7 (103)	1.64	(1.20, 2.24)
No	13191	2.9 (386)	1	
Shared needles				
Yes	447	9.4 (42)	2.14	(1.38, 3.31)
No	13705	3.3 (447)	1	
Blood transfusion				
Yes	130	3.8 (5)	0.40	(0.15, 1.07)
No	14022	3.5 (484)	1	
Sex-related conviction ever				
Yes	846	3.5 (30)	0.86	(0.53, 1.41)
No	14615	3.6 (532)	1	
Drug-related conviction ever				
Yes	5503	4.0 (219)	0.79	(0.64, 0.98)
No	9958	3.4 (343)	1	
Mental health*				
Axis I	465	4.9 (23)	1.17	(0.65, 2.10)
Axis II	453	5.1 (23)	1.60	(0.96, 2.66)
Neither	14543	3.5 (516)	1	
Hepatitis C				
Positive	1161	33.2 (385)	--	
Negative	473	34.7 (164)	--	
Syphilis				
Positive	816	6.3 (51)	1.50	(1.05, 2.13)
Negative	13823	3.6 (498)	1	
Tuberculosis				
Yes	650	2.3 (15)	0.42	(0.22, 0.80)
No	14811	3.7 (547)	1	

*Axis I: psychosis, bipolar disorder, major depression, generalized anxiety,
and dementia; Axis II: personality disorder, developmental disability

Table 6.4. Covariate-adjusted associations between characteristics of adult female
North Carolina state prisoners and HIV infection, January 2004 - May 2006

	n	HIV-positive % (n)	Adjusted OR	95% CI
Age group (years)				
45+	729	2.74 (20)	1.78	(0.44, 7.15)
35-44	2022	4.01 (81)	2.55	(0.73, 8.86)
25-34	2166	1.85 (40)	1.97	(0.56, 6.97)
18-24	1041	1.44 (15)	1	
Race				
Black	2548	4.59 (117)	3.57	(1.89, 6.73)
Other	181	2.76 (5)	2.38	(0.53, 10.74)
White	3229	1.05 (34)	1	
Education				
College	780	2.18 (17)	--	
HS degree or GED	2742	2.48 (68)	--	
Less than high school	2436	2.91 (71)	--	
Employment				
Unemployed	3962	2.98 (118)	1.50	(0.78, 2.87)
Employed	1994	1.91 (38)		
Marital Status				
Not married/separated	5057	2.71 (137)	0.75	(0.37, 1.54)
Married	901	2.11 (19)		
IQ test (Beta)				
≤ 80	813	4.67 (38)	2.00	(0.86, 4.68)
81 - 100	3276	2.72 (89)	1.33	(0.64, 2.79)
≥ 101	1869	1.55 (29)	1	
Previous time served (months)				
≥ 13	904	4.87 (44)	1.01	(0.49, 2.09)
7-12	670	3.88 (26)	0.98	(0.44, 2.17)
≤ 6	942	2.34 (22)	0.61	(0.28, 1.36)
None	3442	1.9 (64)	1	
Sentence length (months)				
≥ 19	803	3.11 (25)	--	
7 - 18	1277	2.51 (32)	--	
3 - 6	1758	2.45 (43)	--	
< 3	1699	2.71 (46)	--	
Heroin use ever				
Yes	366	3.55 (13)	0.50	(0.11, 2.19)
No	5592	2.56 (143)	1	
Cocaine or crack use ever				
Yes	3869	3.33 (129)	1.21	(0.59, 2.50)
No	2089	1.29 (27)	1	
Multiple sexual partners				
Yes	666	4.95 (33)	2.16	(1.13, 4.14)
No	1788	1.90 (34)	1	

Table 6.4. Covariate-adjusted associations between characteristics of adult female
North Carolina state prisoners and HIV infection, January 2004 - May 2006 (cont.)

		HIV-positive	Adjusted	
	n	% (n)	OR	95% CI
Prostitution				
Yes	410	5.61 (23)	0.93	(0.46, 1.86)
No	2044	2.15 (44)	1	
Shared needles				
Yes	231	3.46 (8)	1.04	(0.42, 2.54)
No	2223	2.65 (59)	1	
Blood transfusion				
Yes	71	8.45 (6)	2.64	(1.02, 6.81)
No	2383	2.56 (61)	1	
Sex with Needle Sharer				
Yes	397	4.03 (16)	1.38	(0.63, 3.01)
No	2057	2.48 (51)	1	
Sex with MSM				
Yes	79	10.13 (8)	2.21	(0.85, 5.73)
No	2375	2.48 (59)	1	
Sex-related conviction ever				
Yes	71	2.82 (2)	--	
No	5887	2.62 (154)	--	
Drug-related conviction ever				
Yes	2488	3.58 (89)	2.13	(1.21, 3.75)
No	3470	1.93 (67)	1	
Mental health*				
Axis I	379	3.69 (14)	1.83	(0.72, 4.69)
Axis II	272	1.10 (3)	0.68	(0.09, 5.23)
Neither	5307	2.62 (139)	1	
Hepatitis C				
Positive	557	18.31 (102)	--	
Negative	162	29.01 (47)	--	
Syphilis				
Positive	352	4.26 (15)	1.33	(0.55, 3.25)
Negative	5573	2.49 (139)	1	
Tuberculosis				
Positive	57	5.26 (3)	--	
Negative	5901	2.59 (153)	--	

*Axis I: psychosis, bipolar disorder, major depression, generalized anxiety,
and dementia; Axis II: personality disorder, developmental disability

CHAPTER 7

DISCUSSION

The importance of prisons in detecting and providing care for HIV-positive inmates has been well known for nearly twenty years.[51-54] Despite this recognition by public health practitioners and correctional medical personnel, efforts to systematically evaluate the provision of HIV-services in correctional settings have been quite limited. This dissertation assessed voluntary (i.e. consent-based) HIV testing services in the North Carolina state prison system. In addition to expanding our understanding of HIV services in the North Carolina system, this assessment provides a useful model for research and evaluations in other prison systems.

To begin the assessment process, I reviewed the existing literature addressing mandatory and consent-based HIV testing services in state prison systems. I then identified key research areas relevant to consent-based testing. Focusing on a few of these areas, I defined specific research questions to better understand the delivery of voluntary testing services and following institutional approval, obtained relevant data from the NC prison system and the state health department. The analyses of these data describe inmate HIV testing between the years 2004-2006 in the North Carolina prison system and provide recommendations to improve testing services.

The Chapter 3 literature review, published in *Infectious Diseases in Corrections Report*,[93] describes the heavy burden of HIV among correctional populations and provides a

discussion of the three major HIV testing policies currently implemented in state prison

systems across the US: mandatory testing, voluntary opt-in testing, and voluntary opt-out

(routine) testing. The rationale and consequences of each of these policies are explored both

from the perspective of the individual prisoner and from the utilitarian perspective of

preventing the greatest number of HIV infections. The conclusion outlines several research

areas that could inform the provision of voluntary HIV testing services in correctional

settings:

1. Describe HIV testing coverage across the entire prison system, within each intake

    prison, and among high risk groups of prisoners.

2. Assess congruity between testing policies and their applications.

3. Examine inmate and system characteristics associated with uptake of HIV testing

4. Assess the role of the nurse-counselor in acceptance of testing.

5. Determine the roles of confidentiality and stigma in the acceptance of testing.

6. Evaluate the efficacy of counseling on the acceptance of HIV testing and the

    reduction of inmate risk behaviors.

7. Document psychosocial and physical (e.g. disease-related morbidity, target of assault)

    consequences of testing positive in prison.

8. Estimate costs of HIV testing, counseling, and prevention programs in prison.

9. Evaluate availability of and access to services following release of HIV-infected

    prisoners.

Of these research areas, the analytic portion of the dissertation focuses on the first

three items since these address questions central to voluntary testing services and could be

approached with existing data and financial resources. Grant funds have recently been

awarded to conduct additional research projects, including studies initially proposed as part

of this dissertation, to address other research priorities outlined above. Grant funded projects

are described below in the section *Future Research*.

Chapters 5 and 6 provide the results from two analyses of voluntary HIV testing.

Together, the analyses focused on four aims. Below, each aim is presented with a hypothesis

(or expected result) followed by a summary of the findings.

Specific Aims and Findings

Specific Aim 1. Determine system-wide and facility-specific HIV testing rates among

inmates without a pre-existing HIV diagnosis, in a state prison system with voluntary HIV

testing

Hypothesis: Rate of HIV testing varies from one prison entrance facility to another.

Findings:

- Approximately 40% of prisoners were tested for HIV.

- Most prisoners tested for HIV were tested at an intake prison as part of the admission

  process.

- In the two intake prisons for women, HIV testing was provided routinely (i.e. opt-

  out), and testing rates were greater than 80%.

- In the six intake prisons for men, opt-in HIV testing was available; rates in the intake

  prisons ranged between 1-47%.

Specific Aim 2. Identify inmate characteristics associated with receipt of an HIV test among inmates without a pre-existing HIV diagnosis

Hypotheses: HIV testing is positively associated with greater number of prior incarcerations and history of behavioral risk factors; testing is negatively associated with history of mental health condition and African American race.

Findings:

- Demographic differences across intake populations and differences in intake testing rates contributed to differential testing by demographic characteristics.

- Among males, non-whites were between 30%-40% less likely than whites to be tested for HIV.

- There was at least a 10% increase in testing among males disclosing conventional HIV risk behaviors, but most of these prisoners were not tested.

- First-time prisoners were more likely than recidivists to be tested for HIV, but the difference was very modest.

- Inmates with a DSM Axis II mental health condition were slightly more likely to be tested than those with no diagnosis, but this difference was small; there was no relationship between testing and an Axis I diagnosis.

Specific Aim 3. Identify inmate characteristics associated with HIV serostatus

Hypotheses: HIV infection is positively associated with African American race, female gender, older age, history of behavioral risk factors, history of mental health condition, and greater number of prior incarcerations.

Findings:

- 3.4% of prisoners (2.6% of women, 3.6% of males) tested for HIV were infected.

- Greater than 80% of prisoners with a positive HIV test had been previously diagnosed with HIV in North Carolina.

- Black men aged 45-54 years had the highest HIV prevalence of any demographic group (9.5%).

- Non-white males were 6-7 times as likely as whites to be HIV-infected.

- Less than 1% of males tested for HIV reported same-sex sexual activity, but of these, about 30% were HIV-infected.

- About 10% of males reporting needle sharing or intercourse with a sex-worker were HIV-infected.

- Ten percent of women reporting sex with a MSM partner and 8% reporting blood transfusions prior to 1986 were HIV-positive, but the number of cases for each was fewer than 10.

- Five percent of women reporting multiple sexual partners or prostitution were HIV-infected.

- Greater than two-thirds of HIV-positive prisoners were coinfected with hepatitis C.

- Syphilis was twice as common among HIV-positive prisoners.

Specific Aim 4. Estimate the number of HIV-infected prisoners who remain untested in the North Carolina prison system

Hypothesis: At any given time, at least one-third of existing HIV cases among prisoners will remain undetected.

Finding: Greater than 25% of HIV-infected prisoners remain undetected (i.e. untested). This result assumes that the rate among untested prisoners is at least as large as the rate among tested prisoners. This assumption has not been verified.

Data Concerns

To my knowledge, this dissertation constitutes the largest study of voluntary HIV testing among US prisoners. Inclusion of such a large study population (~53,000) would not have been possible without the use of existing administrative and lab data from the NC DOC and Quest diagnostics, a private company contracted by the prison system to process diagnostic lab work. However, use of existing data did present some challenges.

Although most of the administrative data from the NC DOC were available, HIV risk assessment data were not collected in one of the two intake prisons for women. These missing data corresponded to a relatively small proportion of all prisoners in the study population, but did affect greater than half of all female prisoners. As a result of these missing data, the number of women who could be included in the multivariable regression analyses, for both testing and serostatus, was severely reduced. Among the men, about 18% of data describing HIV risk behaviors were missing. To assess potential selection bias due to exclusion of subjects with incomplete data, I conducted an analysis which relied on multiple imputation, and then compared the results to those from a complete case analysis. These results were also compared to an analysis restricted to inmates who entered the three intake prisons with less than 2% missing HIV behavioral data. There were no important differences in the results from the three analyses (see Appendix Table 6.5).

In addition to problems caused by missing data, it was not possible to validate the existing data. Validation is of particular concern for the HIV behavioral data since prisoners may have been reluctant to disclose stigmatizing and, in some cases, illegal behaviors. Indeed, it appears that these behaviors were under-reported. For example, with most HCV infections acquired percutaneously,[108] the high rate of HCV infection among the HIV-positive population suggests that needle sharing was not limited to the 9% of HIV+ prisoners who disclosed this behavior. Similarly, the low frequency of MSM behaviors reported by prisoners as compared to that reported by community populations, suggest that this behavior was also under-reported. Under-reporting of these conventional HIV risk behaviors attenuated their associations with both HIV testing and HIV serostatus.

There were also some issues specific to the Quest lab data. Data requests for research are uncommon at Quest, and several iterations were necessary before the data managers at Quest compiled the desired database. Once the database was compiled, it was evident that the unique prison identification number was not consistently included in lab records before 2004 so it was necessary to limit the study period to 2004-2006. Initial examination of the daily frequency of labs (HIV, HCV, syphilis) for the years 2004-2006 indicated that data were missing for a few discrete time periods. Quest provided data for those missing periods, but ultimately it was not possible to verify whether other lab data were inadvertently omitted. Of some reassurance, the frequency of labs documented in the Quest database was consistent with a preliminary analysis of aggregate data from each of the intake facilities.

Finally, we were unable to link a small proportion of lab records (3%) to prison records. It is not possible to determine if these unlinked lab records correspond to inmates in our study population; it's possible that some unlinked records corresponded to inmates who

were incarcerated during the study period, but were excluded because they entered prison before the study period began.

Discussion and recommendations

In the Chapter 3 literature review, I examined different approaches to HIV testing, namely voluntary opt-in testing, routine opt-out testing, and mandatory testing. As explained in the chapter, CDC, World Health Organization, and American Public Health Association all advocate that HIV testing of prisoners should be consent-based. The position of these groups is that basic human rights must be preserved for prisoners, and among these rights is the freedom to make autonomous medical decisions such as HIV testing. Echoing this position, I recommend that HIV testing remain consent-based in the NC DOC to preserve inmates' rights as well as to reflect community practice.

The nature of HIV testing in the community, however, is changing. In September 2006, the CDC released revised HIV testing recommendations. The new recommendations, which are applicable to a variety of health care settings including correctional facilities, call for routine opt-out HIV testing, in which testing is to be provided as a standard part of medical care; patients are notified that they will be tested unless they explicitly decline. In contrast to past recommendations, pre-test counseling and informed consent are no longer required. (For persons with a confirmed positive test result, post-test counseling and referral are still recommended.) Despite the new recommendations, financial concerns, issues of confidentiality, and in some states, existing legislation mandating pre-test counseling have all slowed the transition to routine-opt out testing.[110, 111] Prison systems, including the NC DOC, should follow the lead of their individual states as they transition to opt-out testing.

As expected from a preliminary analysis, HIV testing varied greatly across intake prison. Testing rates were high in the two intake prisons for females, but lower and more variable among the six intake prisons for men. High rates of testing in the prisons for women were due to the implementation of opt-out testing, which was provided as a component of reproductive health evaluations. Similar testing rates have been described in the Rhode Island state prison system, which conducts opt-out testing for both men and women.[59]

According to informal interviews of key informants, differences in testing rates across intake prisons for men were in part explained by differing priorities amongst the chief medical administrator at each facility. A formal evaluation of the relationship between organizational structure and HIV testing could yield other useful insights. In a national sample of correctional facilities, Oser *et al.* found few relationships between components of facility organizational structure and the availability of HIV testing services.[97] Despite national guidelines for correctional health services established by the National Commission on Correctional Health, factors determining testing policy may be idiosyncratic to each state prison system. Therefore, it may be more productive to conduct future analyses within, rather than across, state prison systems.

Regardless of the forces shaping HIV testing policy, it is evident that the vague system-wide testing policy in the NC DOC has been implemented differently across intake prisons. HIV testing services in NC DOC should be unified across intake prisons, and the provision of services should be defined by a clear, rational, and equitable policy. Moreover, testing rates should be reflective of testing among other populations in high risk settings. If,

as recommended by the CDC, HIV testing expands in community settings, similar expansion of testing services would be appropriate for correctional populations.

In Chapter 5, I found that the vast majority of all HIV tests were conducted at intake. Testing after intake accounted for only about 6% of all HIV-tests. Most female prisoners are tested for HIV, and their sentences tend to be brief, so it is not necessary to expand testing for this population. On the other hand, more than 60% of male prisoners are never tested for HIV. Providing periodic opportunities for male prisoners to be offered testing could increase uptake. Considering that male prisoners are sentenced for a median of 12 months, I recommend that HIV testing be offered at six month intervals across all 76 prisons. Those without an HIV test in the preceding six months would be eligible. Periodic offers of testing could not only increase overall acceptance of testing, but repeat testing of prisoners tested at admission could be useful in monitoring intra-prison transmission.[91]

In the Chapter 5 analyses, I also examined the association between individual characteristics and HIV testing after controlling for testing differences across intake prison. Based on the existing literature, I hypothesized that HIV testing is positively associated with greater number of prior incarcerations and history of behavioral risk factors, and is negatively associated with history of mental health condition and black race. Of these hypotheses, those for behavioral risk factors and race were correct, but those for incarceration history and mental health were not supported.

First-time prisoners were more likely than recidivists to be tested for HIV, but the difference was modest. Since many prisoners are tested for HIV, it may be that recidivists were more likely to have previously received a negative test, and therefore felt little incentive to be tested again, regardless of their time since testing. My rationale for the original

hypothesis was that prisoners would be more accepting of HIV testing upon repeated entry because they would have more familiarity with the prison system, but of course the opposite could also be true: recidivists could be less trusting of medical services in prison as compared to first-time prisoners.

The interest in mental health and HIV testing originated from several studies that indicate that serious mental health problems are associated with increased risk of HIV, and other studies indicating that increased risk of infection was associated with decreased testing rates.

In our data, selected Axis I and Axis II mental conditions were associated with an increased risk of HIV, but these associations were modest and did not remain statistically significant after controlling for other covariates. These results differ from a study by Altice et al., which found significant associations between mental health conditions and HIV-infection, but that study included a much broader spectrum of disorders in its definition of mental health condition.[41] Inmates with a DSM Axis II mental health condition, which includes personality disorders and developmental disabilities, were slightly more likely to be tested for HIV than those with no diagnosis, but this difference was small. There was no relationship between testing and an Axis I diagnosis.

Among males, HIV testing varied by race, with blacks less likely to be tested than whites. In part, this finding is a consequence of large populations of black males in the intake facilities with the lowest overall testing rates. Nevertheless, even after controlling for intake facility, black males were about 13% less likely than white males to be tested for HIV. This is concerning in the context of the much higher HIV prevalence in black men nationally, in North Carolina, and among tested prisoners (Chapter 6). Among both men and women,

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race was one of the strongest predictors of HIV infection, and both blacks and "others" were more likely to be infected than whites. I note, however, that these racial disparities are attenuated compared to infection rates in the state, in which black men and women, respectively, are 7 and 16 times as likely as white men and women to be infected with HIV.

Adjusting for testing differences across intake prisons, high risk behaviors were associated with about a 10% increase in the rate of testing. At the same time, a high proportion of those disclosing conventional HIV risk behaviors were likely to be infected, but the frequency of disclosure for most of these behaviors was uncommon. In the most extreme example, 30% of males disclosing MSM behaviors were infected with HIV. However, very few prisoners disclosed these potentially stigmatizing behaviors, and the adjusted relative risk for other conventional HIV risk behaviors was modest.

In fact, greater than half of all HIV-positive prisoners were without documentation of conventional HIV risk behaviors. This finding suggests that prisoners, regardless of documented risk history, should be offered the opportunity to be tested for HIV. However, it is important to put in place safeguards so that decisions to be tested are autonomous choices and not the result of coercion or misperceptions that testing is mandatory. Such safeguards could include periodic focus groups conducted by outside organizations, which explore prisoners' perspectives of the HIV testing process, without eliciting individual reasons for opting in or out of testing.

Another potential explanation for the large number of HIV diagnoses not linked to documented risk behavior is the possibility that, upon prison entry, these inmates were aware of their serostatus from prior testing. It is possible that nurse-counselors did not document risk behaviors for prisoners disclosing their positive HIV-serostatus upon entry. However, if

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risk assessments were skipped for this population, it is more likely that these data would be missing rather than coded to indicate an absence of risk behavior history.

Finally, prison systems are struggling to find an appropriate response to HCV. HCV is common among prisoners and its sequalae can lead to hepatic cancer, but such outcomes are rare, and the treatment is both difficult to tolerate and expensive. As a result, many prison systems have been reluctant to screen for HCV. For HIV-infected prisoners, HCV is particularly relevant because it can limit antiretroviral HIV medication options and lead to worse outcomes. My findings demonstrate that the HIV-infected population is being appropriately screened for HCV. The next step in evaluation is to ensure that there is proper coordination of treatment services for co-infected prisoners.

<u>Summary of recommendations</u>

1. To reflect community practice, HIV testing should remain consent-based

2. Safeguards are necessary to ensure that testing is not coercive

3. HIV testing policy and practice should be unified across intake facilities

4. Testing should be widely available and encouraged among prisoners disclosing no risk behaviors

5. Testing should be periodically offered to male prisoners

6. Testing history should be documented in prisoners' medical records

7. Linkages between HIV care and care for other coinfections, particularly hepatitis C, should be strengthened

A few other recommendations are derived from the literature. In a study assessing provider perspectives of HIV testing in prisons across 4 states, many reported that negative

test results were often not reported to inmates.[112] Report of negative test results could be facilitated using rapid testing. Though not addressed in my results, rapid testing should be considered.

Others have recommended that prison systems with HIV testing must also provide comprehensive medical treatment and programs which effectively bridge correctional and community care.[15] In the North Carolina prison system, these conditions are being met. HIV treatment is widely available and is supported by three infectious disease clinics and a team of mobile nurses dedicated exclusively to providing HIV care throughout the prison system. A program to enhance continuity of care has been piloted in the North Carolina prison system, and with its success, has now been expanded to provide services to most HIV-infected prisoners as they transition from the NC DOC back to their communities.

Future Research Directions

In this dissertation, I examined risk factors associated with HIV test receipt and, among those voluntarily tested for HIV, risk factors associated with seropositivity. These results provided information about groups of prisoners who were at increased risk of HIV infection and groups of prisoners at decreased likelihood of testing; however, our analyses did not include serostatus data for those prisoners who declined testing.

Recently a large grant was awarded by that National Institute of Mental Health to build upon the research presented in this dissertation. A blinded seroprevalence study is planned to examine the relationship between infection status and prisoners' behavioral risk factors, demographic characteristics, and decision to accept/decline voluntary testing. This study will provide a clearer characterization of the population of HIV-infected prisoners who

decline testing. This serosurvey will also provide unbiased estimates of HIV prevalence and an estimate of the number of HIV cases declining HIV testing. This latter estimate will inform the utility of the method I used to estimate undetected cases.

Studies to investigate barriers and facilitators to HIV testing in correctional settings are also planned. In-depth interviews will be conducted with both prisoners and the nurse-counselors who provide HIV testing services. Psychosocial (perceptual) factors associated with testing can be conceptualized using theoretical models of health behavior. Explicit use of these models helps organize relevant constructs and provides a systematic framework for advancing both empirical and theoretical work aimed at understanding HIV testing. Specific constructs to be measured will be formulated based on data from in-depth interviews, but will likely include the following constructs derived in part from the Health Belief Model and the Theory of Planned Behavior: risk of HIV acquisition, severity of HIV-infection, social repercussions of infection, benefit of testing, perceived testing barriers, social norms, actual testing barriers, imprisonment history, and HIV test experience. Similar interviews with providers are also planned to determine their influence on the HIV testing process.

Another important area of study is the consequences of an HIV diagnosis in prison. Anecdotal evidence and individual lawsuits brought by HIV-infected prisoners incarcerated outside of the North Carolina prison system suggest that an HIV diagnosis may result in discrimination and harassment from both correctional staff and other prisoners. To explore this issue, administrative data will be used to conduct a retrospective study examining the association between HIV serostatus and indicators of harassment such as physical trauma and administrative punishments.

In addition to the funded studies described above, research is needed to determine the effectiveness of HIV-counseling and testing on the reduction of risk behaviors following inmates' release. The preventative effect of these services is questionable given the lag between counseling and testing at entry and inmates' release several months, if not years, later. After the restrictions of prison life, inmates may be particularly recalcitrant to prevention messages as they reestablish their sexual lives in the community. Better estimation of the preventive effect of counseling and testing among inmates would improve cost-benefit analyses of HIV-testing among this population.

Concluding thoughts

Beginning in the late 1970's and continuing for the next two decades, the US prison population experienced tremendous growth. With the expansion and aging of correctional populations, prisons have become an increasingly important source of health care in the US. The eventual return of most prisoners to the community suggests that prisons also have an important public health role. This role is particularly relevant for detecting and treating infectious diseases such as HIV. The potential of that role, however, cannot be achieved without systematic evaluation of services. The will to conduct these evaluations must come from the state legislature and medical administrators in departments of corrections, as in North Carolina. Departments of corrections not equipped to conduct service evaluations can benefit from collaborations with outside organizations, such as academic centers, state and county health departments, and non-profit organizations with research capabilities. Aside from providing skills and resources to conduct evaluations, these collaborations are an important step in bridging the divide between prison and community health services.

Table 5.5 Comparison of complete case, multiple imputation, and restricted population multivariate analyse
of HIV testing among adult males admitted to the North Carolina Department of Corrections,
January 2004 - May 2006\

	Complete Case	Multiple Imputation	Restricted population
	RR (95% CI)	RR (95% CI)	RR (95% CI)
Age group (years)			
≥ 45	0.95 (0.91, 0.99)	0.94 (0.90, 0.99)	0.96 (0.91, 1.00)
35 - 44	0.98 (0.94, 1.02)	0.99 (0.94, 1.03)	0.98 (0.94, 1.02)
25 - 34	0.95 (0.91, 0.99)	0.96 (0.92, 1.00)	0.95 (0.91, 0.99)
18 - 24	1	1	1
Race			
Black	0.87 (0.85, 0.90)	0.85 (0.83, 0.87)	0.88 (0.85, 0.90)
Other	0.99 (0.93, 1.05)	0.78 (0.73, 0.83)	1.00 (0.94, 1.06)
White	1	1	1
Education			
College	1.04 (0.99, 1.09)	1.04 (0.99, 1.09)	1.02 (0.97, 1.07)
HS degree or GED	1.05 (1.03, 1.08)	1.05 (1.02, 1.08)	1.04 (1.02, 1.07)
Less than high school	1	1	1
Employment			
Unemployed	0.97 (0.94, 0.99)	0.97 (0.94, 1.00)	0.96 (0.94, 0.99)
Employed	1	1	1
Marital Status			
Not married or separated	1.02 (0.99, 1.05)	1.05 (1.01, 1.08)	1.03 (0.99, 1.06)
Married	1	1	1
IQ test result			
≤ 80	0.93 (0.90, 0.97)	0.92 (0.88, 0.96)	0.92 (0.89, 0.96)
81 - 100	0.97 (0.95, 1.00)	0.99 (0.96, 1.02)	0.97 (0.95, 1.00)
≥ 101	1	1	1
Previous time served (months)			
None	1.06 (1.03, 1.09)	0.91 (0.88, 0.93)	1.06 (1.03, 1.09)
> 0 - 6	1.04 (1.01, 1.08)	1.01 (0.97, 1.05)	1.05 (1.02, 1.09)
7 - 12	1.02 (0.99, 1.06)	0.99 (0.95, 1.04)	1.02 (0.98, 1.06)
≥ 13	1	1	1
Drug-related conviction ever†	0.98 (0.96, 1.00)	0.97 (0.95, 1.00)	0.98 (0.96, 1.01)
Sex-related conviction ever†	0.97 (0.92, 1.03)	0.96 (0.91, 1.01)	0.95 (0.89, 1.01)
Heroin use ever†	1.12 (1.05, 1.19)	1.15 (1.07, 1.24)	1.10 (1.03, 1.18)
Cocaine or crack use ever†	1.10 (1.08, 1.13)	1.16 (1.13, 1.19)	1.10 (1.08, 1.13)
Conventional HIV risk behavior‡	1.10 (1.07, 1.13)	1.13 (1.10, 1.17)	1.07 (1.03, 1.10)

Table 5.5 Comparison of complete case, multiple imputation, and restricted population covariate-adjusted analyses of HIV testing among adult males admitted to the North Carolina Department of Corrections, January 2004 - May 2006\ (cont.)

	Complete Case	Multiple Imputation	Restricted population\
	RR (95% CI)	RR (95% CI)	RR (95% CI)
Mental health§			
Axis I	0.99 (0.93, 1.06)	1.04 (0.97, 1.11)	0.99 (0.92, 1.06)
Axis II	1.05 (0.99, 1.12)	1.04 (0.97, 1.12)	1.04 (0.97, 1.10)
Neither	1	1	1
Syphilis			
Positive	1.00 (0.95, 1.05)	0.83 (0.79, 0.89)	0.99 (0.94, 1.04)
Negative	1	1	1
Tuberculosis			
Positive	1.21 (1.16, 1.26)	1.27 (1.20, 1.35)	1.21 (1.15, 1.27)
Negative	1	1	1

*model includes variable for intake facilities and covariates with reported estimates
†referent: never
‡includes same-sex sexual partner (men only), multiple sexual partners, prostitution, needle sharing, sex with MSM (women only), sex with injection drug user (women only), blood transfusion 1978-1985
§Axis I: psychosis, bipolar disorder, major depression, generalized anxiety disorder, and dementia; Axis II: personality disorder, developmental disability
\complete case: N =31232, multiple imputation: N=47212, restricted N=20695

Table 6.5. Estimated number of HIV cases among male prisoners who declined HIV testing

| | Age | NC DOC population | | | | | | | Estimated cases - NC DOC | | | |
| | | Not Tested | | | | HIV-positive | | | | | | |
		(Ni)	Tested	HIV+	Pi	95% CI*		V_i*	N_{est}	V_c	CI_L	CI_U
Black	18-24	6025	1098	19	1.73	1.04	2.69	0.4898	104.23	870.0922		
	25-34	6189	2592	103	3.97	3.25	4.80	0.4235	245.70	680.6683		
	35-44	4349	2513	206	8.2	7.15	9.34	0.5816	356.62	642.7989		
	45-49	1328	851	82	9.64	7.74	11.82	1.1122	128.02	219.0280		
	50+	1058	627	53	8.45	6.40	10.91	1.2551	89.40	175.9086		
Other	18-24	738	138	3	2.17	0.45	6.22	2.0663	16.01	232.0978		
	25-34	999	356	14	3.93	2.17	6.51	1.3163	39.26	172.5789		
	35-44	390	178	10	5.62	2.73	10.09	2.2806	21.92	79.1817		
	45-49	97	36	2	5.56	0.68	18.66	6.6837	5.39	42.0599		
	50+	61	23	1	4.35	0.11	21.95	8.9796	2.65	30.0110		
White	18-24	3157	1094	2	0.18	0.02	0.66	0.2449	5.68	59.0758		
	25-34	3391	2720	26	0.96	0.62	1.40	0.2245	32.55	59.0391		
	35-44	2814	2226	31	1.39	0.95	1.97	0.2959	39.11	68.7133		
	45-49	870	666	9	1.35	0.62	2.55	0.6122	11.75	28.3081		
	50+	775	343	1	0.29	0.01	1.61	0.6735	2.25	27.1783		
Total									1100.6	3386.7	1229.6	5543.8

*based on exact confidence intervals

Pi = HIV+ / Tested

$N_{est} = P_i N_i$

$V_c = N_i^2 V_i$

$(CI_L, CI_U) = \sum N_{est}$ -/+ 1.96* sqrt ($\sum V_c$)

Table 6.5. Estimated number of HIV cases among male prisoners who declined HIV testing (continued)

| | Age | NC population | | | | | | | Estimated cases- state | | | |
| | | Not Tested | | | | HIV-positive | | | | | | |
		(Ni)	Census pop†	HIV+†	Pi	95% CI‡		V_i‡	N_{est}	V_c	CI_L	CI_U
Black	18-24	6025	610,266	1503	0.246	0.23	0.26	0.0063	14.84	0.1456		
	25-34	6189	774,821	7190	0.928	0.91	0.95	0.0109	57.43	0.4542		
	35-44	4349	781,696	16248	2.079	2.05	2.11	0.0161	90.40	0.4930		
	45-49	1328	358,335	6943	1.938	1.89	1.98	0.0230	25.73	0.0935		
	50+	1058	1,022,745	7799	0.763	0.75	0.78	0.0086	8.07	0.0083		
Other	18-24	738	97,820	137	0.140	0.12	0.16	0.0120	1.03	0.0078		
	25-34	999	150,305	1043	0.694	0.65	0.74	0.0214	6.93	0.0458		
	35-44	390	124,243	1116	0.898	0.85	0.95	0.0268	3.50	0.0109		
	45-49	97	48,474	297	0.613	0.54	0.68	0.0355	0.59	0.0012		
	50+	61	123,214	380	0.308	0.28	0.34	0.0158	0.19	0.0001		
White	18-24	3157	1,878,849	351	0.019	0.02	0.02	0.0010	0.59	0.0010		
	25-34	3391	2,845,195	3314	0.116	0.11	0.12	0.0020	3.95	0.0046		
	35-44	2814	2,943,125	7513	0.255	0.25	0.26	0.0029	7.18	0.0068		
	45-49	870	1,361,720	2711	0.199	0.19	0.21	0.0038	1.73	0.0011		
	50+	775	5,203,678	2969	0.057	0.06	0.06	0.0010	0.44	0.0001		
Total									222.6	1.3	220.4	224.8

†data pooled from 2000-2005; HIV+: number of living cases at mid-year

Pi = (HIV+) / Census

$N_{est} = P_i N_i$

$V_c = N_i^2 V_i$

$(CI_L, CI_U) = \sum N_{est}$ -/+ 1.96* sqrt ($\sum V_c$)

‡ based on asymptotic confidence intervals

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