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Examining The Effectiveness Of Multiple Imputation: A Case Study On Hiv Risk Behaviors In Women Receiving Treatment For Substance Use Disorders

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EXAMINING THE EFFECTIVENESS OF MULTIPLE IMPUTATION: A CASE STUDY ON HIV RISK BEHAVIORS IN WOMEN RECEIVING TREATMENT FOR SUBSTANCE USE DISORDERS

by

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Abstract

Women in the United States are becoming infected with HIV more quickly now than ever before; many of whom are at higher risk because of their substance use habits or that of their partners. (CDC, 2010) This study analyzes cross sectional data regarding the risk behaviors and addiction severity of a sample of women receiving treatment for substance use disorders (SUDs). The data was gathered between 2006 and 2010 at a women's substance use treatment center in St. Louis, Missouri (MO), the name of which cannot be disclosed. We develop a scale, the HIV Risk Scale (HRS), to quantify a woman's risk of contracting HIV at the time of presenting for rehabilitation based on self-reported sexual and drug behaviors. We then, using the seven interviewer-ratings of the Addiction Severity Index (ASI) as predictors of the HRS, examine the results of regression using two methods to adjust for missing data: (1) case-wise deletion and (2) multiple imputation. Results suggest that using several of the ASI, a tool already implemented in rehabilitation efforts, interventions can be tailored to address more closely all of the issues regarding the health and safety of substance abusing women seeking relief from addiction. Results show that specifically looking at the interviewer's assessment of how severely addiction impacts legal, drug-related, alcohol-related, employment-related and medical aspects of a woman's life may enable treatment centers to help her alleviate the HIV to which she maybe exposed.

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Introduction

The *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)* specifies the criteria for alcohol and drug dependence and abuse. According to these criteria, the Missouri Department of Mental Health reports that for each year from 2002 to 2008, between 9.40% and 10.58% of MO residents age 12 or older were either substance dependent or abused substances over the preceding year (Smith, Lundy, Schauer, & Lister, 2010). Moreover, the report shows that for each of these years the estimated rate of substance abuse/dependence among MO residents was higher than that of the nation. This report also shows that of the 40,049 people admitted to substance abuse treatment centers in Missouri during 2010, less than 30% were women. This was not only true of the state, but also for the St. Louis metropolitan area. Here, out of the 10,441 admissions only 3,099 were female (Smith et al., 2010). Note that that is nearly 30% of all women admitted for the entire state.

From the statement above, one can clearly see that there is a need for intervention among substance-using women in the State of Missouri; especially since the number of women receiving treatment is probably less than the number of women who actually need it (Greenfield, et al., 2007). Its also worth mentioning; several authors have noted that women tend to have more adverse and more intense physical and psychosocial outcomes caused by addiction than men do . The health problems associated with substance use disorders range greatly. In fact, dental damage, some cancers, mental disorders, Human Immunodeficiency Virus (HIV) and other sexually transmitted diseases (STD), and a

menagerie of other issues have been shown to have increased prevalence among people suffering from substance use disorders (NIDA, 2011; Johnson, 1987). In particular, the occurrence, risk and spread of HIV among this population has been examined and documented in scholarly studies (Amaro, 2007; Basso, 2000; Compton, 1995; Cottler, 1990; Epperson, 2010 ; Meade, 2008; Ramsey, 2010) within medical, sociological, psychological, and epidemiological contexts. As earlier noted, the state of Missouri also acknowledges the importance of collecting data, performing research and developing both preventative and treatment services centered both around substance abuse and HIV. In the state's annual report on the epidemiology of HIV, Hepatitis and other STDs, an often arising topic is substance abuse . Similarly, their reports and services regarding substance abuse often mention the associations between HIV contraction and substance abuse (Smith et al., 2010). Being the most populous metropolitan city within the state, we find little surprise in the fact that Saint Louis also recognizes the need to address issues of HIV and substance abuse among its constituents. And although the number of newly diagnosed people with HIV amongst the general population of St. Louis who are exposed to the virus via self-reported heterosexual contact or injecting drugs is trending downward over the past few years, (Missouri Department of Health and Senior Services, 2007, 2009) there are no studies documenting whether this effect is similar within our target population.

This is an especially valid concern since several authors have documented a positive association of substance abuse/dependence with behaviors that increase risk of contracting HIV (Amaro et al., 2007; Cottler, Helzer, & Tipp, 1990; Hoffman, Klein,

Eber, & Crosby, 2000; Meade, Graff, Griffin, & Weiss, 2008; Meade & Weiss, 2007). Many substance abuse treatment centers make prevention of HIV transmission an important component of the treatment system. However, not all do. In this paper, we explore whether a tool already implemented by many substance abuse rehabilitation centers, may also be used to predict HIV risk behaviors and therefore tailor interventions to address this additional issue in the lives of women seeking rehabilitation from substance abuse. We use secondary data from a women's rehabilitation center located in St. Louis, MO; the name of which we do not disclose at the request of its Executive Director.

The psychological instrument referred to in the previous paragraph is the Addiction Severity Index (ASI); which is used to assess and quantify the severity of the impact addiction has on several aspects of a patient's life (McGahan, 1986). Unfortunately, many of the women presenting for rehabilitation come in with far more problems than just substance abuse. ASI can be used to pinpoint some of these problems and assure that they are addressed in a suiting manner. For example, Jones showed that some ASI composite scores may be used to predict HIV sexual and drug risk behavior among pregnant women presenting for rehabilitation (2010). Our goal in this paper, we show that this tool may be even more useful when generalized to the general population of women presenting for rehabilitation. However, in the next section, we review and critique the available literature on these issues. (Talk about the factors within ASI, rather than talking about ASI itself)

Literature Review

In order to understand HIV risk in our target population, we must first understand HIV in a general sense; especially how it affects women. Since its classification about 30 years ago, people organizations and even entire industries around the world, especially here in the States, have developed means to monitor, test for, treat and prevent HIV. In the U.S. these developments were accompanied by a national effort to educate the general population about HIV as scientists learned more; keeping them up-to-date as new information became available. As a result, we understand the rate and incidence of infection in the general population. “CDC [Center for Disease Control and Prevention] estimates that more than one million people are living with HIV in the United States. One in five (21%) of those people living with HIV is unaware of their infection.” (CDC, 2010) We also understand how the virus is contracted/transmitted. In fact, it has been well documented and may even be considered common knowledge: HIV can only be transferred through an exchange of bodily fluids, such as blood, semen or vaginal secretions.

Historically in America, blood exposure has happened most often trough medical transfusions and sharing materials used to inject recreational drugs. To combat exposure via transfusions, agencies and organizations that collect and disseminate blood have taken several steps. They've developed more stringent limitations and on who can donate blood, accompanied by more stringent means of screening their donors. They've also improved the means by which they monitor the blood they collect, checking each donation for any possible blood-borne parasites or infections that could sicken those who depend on this

vital service. Contraction via blood transfusions has become nearly non-existent since the late eighties and early nineties, when these changes were adopted. According to the University of California, San Francisco, in 2003, the risk in the United States of HIV-1 transfusion transmission per unit transferred was between 1 and 1.4 million and 1 in 1.8 million units (Donegan, 2003). As for combating exposure via sharing of injections materials, several states and municipalities have made efforts to draft and enact policies that act toward this end; from lessening criminal punishment for carrying syringes to permitting the operation of syringe exchange programs. Many others look to the War on Drugs to mitigate use of injection drugs in the first place, thereby mitigating this form of HIV transmission. In either case, one recent study (Des Jarlais, 2007) suggests that the "relative importance of injection-related and sexual transmission" may be changing (p. 232). Des Jarlais (2007) found that HIV seroprevalence was nearly the same amongst population samples of injecting and non-injecting heroine and cocaine users in New York City: suggesting that although injection-related transmission of HIV is much more efficient than heterosexual transmission, preventing the latter may be more important to the fight against HIV/AIDS than previously thought.

Upon its arrival and discovery in the states, this epidemic almost exclusively affected only men who have sex with men (Osmond, 2003). Since, then however sexual transmission of HIV has been found to occur in people of all sexualities and genders and various walks of life (CDC, 2010). The attempts to mitigate sexual transmission most often seen have come in the form of distribution, including education about the use, of condoms. These attempts, however, are only one part in the current most widely used and

disseminated framework or education strategy referred to as the "ABC" approach. ABC stands for *Abstinence, Being* (italics added) faithful, and correct/consistent use of *Condoms* (italics added). For certain, the best and only way to completely protect one's self from sexual transmission of HIV or any other sexually transmitted disease for that matter is to not have sex. For those who choose not to abstain, the next best means of avoidance is remaining faithful to a single uninfected sexual/romantic partner who also remains faithful: that is for two people to refrain from sexual contact with anyone other than each other. The next best line of defense, although not quite as failsafe as the previous two, is the consistent and correct use of condoms. Even if used correctly during 100% of sexual encounters, condoms only reduce, not eliminate, the risk of sexual transmission. "Studies of sexually active couples for example, in which one partner is infected with HIV and the other partner is not, demonstrate that latex condoms provide approximately 80-90 percent protection, when used consistently" (Office of the U.S. Global AIDS Coordinator, n.d., p. 4).

For women however, the practices encouraged by ABC are not always entirely under their control. For some women, even the choice of abstinence is taken away by assault or even marital rape. Being faithful to one person does not imply that person is faithful to you. And male condoms are just that, *male*; leaving the final decision whether or not to where a condom during sex to the man. This is especially true if the woman is being forced upon, or even if there the power structure within the relationship does not allow for the her to have input in making decisions that affect both her and her partner. Moreover, since a relatively small number of Americans wait until marriage to become

sexually active, ABC might not have the impact its designed to have. This is probably even more true amongst our target population since 99% of our sample reported having sex with a man at least once. In particular, Biello et. al (2010) note that "Because male condom use is not directly under a woman's control, gender inequalities may be particularly important in shaping this sexual risk behavior (p 416)." The same can be said for "being faithful." A person can only directly control their own actions and not those of others. So even if a woman is faithful to a single male partner, she may be at an increased risk of contraction because of his behaviors, whether or not they use condoms.

The route of infection for many is sexual contact with a person who has HIV where such an exchange occurs. In fact, women who become infected most often encounter the virus via sex with a man who is HIV positive. The second most common cause of infection in women is sharing injection drug works (needles, syringes, etc.) used by someone with HIV (CDC, 2010). CDC also documents the impact HIV has on women in this country; noting that HIV infection affects women in many of the same ways it does men. That is to say, minority women, especially African-Americans, are affected most often; younger women are more likely to become infected than older women; and the only diseases that take more women's lives than AIDS are cancer and heart disease (CDC, 2010). Many differences do remain however. A study done in San Francisco (Chen, Raymond, McFarland, & Truong, 2010) showed that many heterosexual women are put at most at risk by their primary sexual/romantic partners and that many of these women under-assessed the risky behaviors of their partners while also engaging in behaviors with said partners that increase their risk; e.g. frequent unprotected sex and

frequent use of drugs and/or alcohol during sex.

Within different contexts, the risks of contracting HIV that are associated with substance abuse may be characterized differently; but these characterizations are often are very similar. Basso and Bornstien (2000) for example, put risk and comorbidity (simultaneous HIV infection and substance abuse disorder) in a psycho-physiological context. In this study the authors note that while substance abuse can act as a route of HIV transmission, through the sharing of injection materials, there are also signs that the neurological and immunological issues caused by HIV are confounded by substance abuse and vice versa. In particular their findings, as well as those they cite, suggest that HIV may yield brain dysfunction by affecting pathological changes on neuronal functions. More pertinent to our causes, they conclude by suggesting "potential mechanisms whereby substance use may potentiate and exacerbate the onset and severity of neurobehavioural abnormalities in HIV infection" (Basso & Bornstein, 2000): painting the picture of a vicious cycle of causation between HIV, substance abuse disorders and mental disorders. As we exhibit now, many other authors examine these associations from a sociological perspective.

In order to address these issues within our target population, we must also understand a bit about that population and why they are at an increased risk for contracting HIV. Its estimated that one of the fastest growing groups with HIV in the country is women in communities with high drug use rates (Des Jarlais, et al., 2007; Tross, et al., 2008). Moreover, substance abuse is known to be associated with both impaired judgment and risk-taking (Meade et al., 2008). Both of which may allow for

environments conducive to HIV contraction/transmission According to the staff at the rehabilitation center whose data we use, (Define, personal communication, August 5, 2010) many of the women seeking help for addiction there live in and come from low-income neighborhoods. In northern California, prevalence of HIV, sexually transmitted infections (STIs) and Hepatitis as well as related risk behaviors were found to be associated with living in a lower-income neighborhood among a sample of more than 2,500 women less than 30 years in age. In particular, seroprevalence of HIV in this sample of women was 4-fold higher than what is estimated for CA women overall at 0.3% versus 0.06% (Ruiz, et al., 2000). Not all the women in Ruiz's study were substance abusers, or even substance users for that matter. Adding this layer to the context increases the likelihood of risky behaviors. In fact, Amaro et. al (2007) state that, women with severe drug dependency tend to engage in many behaviors that increase their risk of contracting HIV, including unsafe sex with multiple partners, having sex for money or drugs, and having sex with an injection drug user. The authors also point out that women with sever mental illnesses tend to have both higher rates of these risky behaviors and also lower rates of condom use. Seeing as intense substance abuse has been shown to be associated, and sometimes even cause, mental illnesses, we must take this issue into consideration as well. Putting these facts together, it is easy to recognize that a large proportion of the women who seek help for substance use treatment are at an increased risk for contracting this potentially deadly virus.

Another unfortunate trend amongst women presenting for rehabilitation is their involvement with the criminal justice system. And according to Weir et. al (2009), not

only are women involved in the corrections system at an elevated risk for HIV, but the seroprevalence of HIV at the time of this study is higher in female inmates (3%) than in male inmates (2.5%). A recent study (Des Jarlais, et al., 2007) set in New York City suggests that women in methadone treatment programs who were either recently arrested or incarcerated are more likely to engage in high risk sexual behaviors such as multiple sex-partners, sex-trading and sex with a risky-individual (Des Jarlais et al., 2007; Epperson, et al., 2010). One could hypothesize why many substance dependent women are involved in the corrections system. For example, it could possibly be because America's *War on Drugs* (italics added) often targets those afflicted by addiction as much as those peddling the substances that cause addiction. An alternative hypothesis may be that many of the women within this population use sex as a means to gaining income and therefore have been jailed for prostitution. In both Africa and the U.S. It has been shown (Weiser et al., 2009; Weiser et al., 2007) that food insecurity is associated with engaging high risk behaviors. Moreover, Chaudhury et. al (2010) have shown that a measure of how much addiction causes legal problems to be a significant predictor of sexual risk in pregnant women presenting for addiction rehabilitation.

The same study by Chaudhury, et. al (2010) finds that the impact of addiction on pregnant women's receipt of and retention in medical care is a significant predictor of risk behavior regarding consumption of drugs: particularly injection drugs. It's also been noted that women tend to have more numerous and acute medical problems associated with substance abuse, but receive less outpatient care and total lifetime care for substance abuse than do men (Westermeyer & Boedicker, 2000). They also hypothesize that less

treatment could be due to several deficiencies in the treatment system, including; a tendency for physicians not to refer women to treatment for substance abuse, a general unavailability of treatment for women due to lack of insurance and/or gender specific programs and lastly, not having surrogates to take the responsibilities of caring for home and children in their absence. Another study (Korthuis, et al., 2008) reported that people in treatment for HIV tend to under-utilize treatment modalities for substance abuse. Since substance abuse treatment tends to be more intensive than HIV treatment alone and is often in-patient, the issue of addressing risky behaviors among people in such treatment may be be easier to resolve than the issue of addressing substance abuse amongst people in treatment for HIV (Korthuis et al., 2008).

For those suffering from substance abuse/dependence maintaining consistent legal employment is often difficult (Meara, 2006). The stigma associated with substance abuse compounded with the fact that many of the women enrolled in this substance abuse treatment facility are the primary, and sometime only, caregivers for their children, led us to expect a low rate of employment among our population. Studies have shown lack of employment often implies economic dependence on a male partner and/or trading sex for both sustenance and substances in our target population (Campbell, et al., 2009; S. Weiser, et al., 2009; S. D. Weiser, et al., 2007; Westermeyer & Boedicker, 2000). We have also seen a study showing young mothers who are economically dependent on a male partner were 1.6 times more likely to report not using a condom during their most recent sexual encounter (Biello, Sipsma, Ickovics, & Kershaw, 2010).

Many studies have addressed co-occurring substance abuse and psychiatric

disorders as well as the relationship such compounded disorders have on behavior related to the risk of contracting HIV. Results tend to show a reciprocating cycle between substance abuse and psychiatric disorders: often one is an influential factor in the occurrence of the other (Amaro et al., 2007; Johnson, Cunningham-Williams, & Cottler, 2003; Meade, Kershaw, Hansen, & Sikkema, 2009; Meade et al., 2008; Sikkema, Hansen, Meade, Kochman, & Fox, 2009). Johnson et. al (2003, p. 174) found that reported history of an STD and having multiple sex partners were both associated with simultaneous occurrence of substance abuse and depression as well as the "burden of...a lifetime exposure to a violent event..."

Many communities in our society marginalize substance dependent persons. In addition, women tend to suffer stiffer social consequences associated with substance abuse. (Greenfield, et al., 2007) More specifically, Greenfield (2007) notes that "Women may face lack of family or partner support to enter treatment [more often than men] and greater social stigma and discrimination." Greenfield's study also notes that women are more likely than men to report having friends, family or partners who abuse drugs themselves and/or support these women's continued use of them. Suggesting that social stigma seems to present a barrier to women seeking treatment for substance abuse, Greenfield (2007) also proposes that:

> while women had more severe family and social problems at treatment entry in a study of cocaine dependent individuals admitted to an inpatient treatment program (Weiss et al., 1997), there were no gender differences in family and social problems at follow-up, and women were more likely than men to have remained

abstinent at 6 month follow-up. (p. 10)

This statement seems to imply that if the barriers that prevent women from seeking and receiving treatment can be overcome, then that treatment is more likely to be successful for them than for their male counterparts. However, child abuse, intimate partner violence and sexual victimization have been shown to both commonly occur among women with substance using disorders and precipitate risky sexual behaviors (Meade et al., 2009; Morokoff et al., 2009; Riley, Gandhi, Bradley Hare, Cohen, & Hwang, 2007; Shannon et al., 2008). Moreover, the occurrence of either of these tragedies has been shown to be associated with adverse psychosocial consequences such as post traumatic stress disorder and suicide ideation, even long after the occurrence of the incident itself (Lawoko, Dalal, Jiayou, & Jansson, 2007; Meade et al., 2009; Morokoff et al., 2009; Shannon et al., 2008).

Many authors have noted that numerous physical and psychosocial health hazards are associated with SUDs (Amaro, et al., 2007; Campbell, et al., 2009; Chaudhury, et al., 2010; Cottler, et al., 1990; Greenfield, et al., 2007; Hoffman, et al., 2000; Meade & Weiss, 2007; Schacht, et al., 2010). Many of these cite that the mere use of substances, especially when leading up to or while having sex, increases the odds of behaving in a manner that may expose one to HIV. Some also cite that the frequency and intensity of use of a few particular substances, such as cocaine in both powder and crack form, are both positively correlated with risky behavior (Amaro, et al., 2007; Cottler, et al., 1990; Hoffman, et al., 2000).

As stated earlier, the population we aim to study is one of the fastest growing

segments of HIV positive people in the US. Both women and substance dependent people in general have been particularly impacted by the current trend of HIV infections. As there is not yet a cure for this potentially deadly virus, creating means to stifle the risk that any particular population is exposed to remains vital. Seeing that the ASI has been well established as a means to assess the severity of addiction; if one could also use it to help assess the level of risk substance dependent women are exposed to, interventions might be tailored to address issues affecting her whole life more closely. As outlined by the literature, most of the ASI domains not only address life issues associated with addiction, but also many that are associated with risky behaviors; sometimes directly, other times indirectly. In the following section we discuss how we've used theses associations to model risky behaviors using the ASI domains for our particular dataset. The ASI has already been shown as a way to assess this risk in pregnant substance abusers (Chaudhury et al., 2010), but not in the general population of substance abusing women. We aim to do so in this study.

Methods

In the previous section we note that several authors have shown that childhood sexual and/or physical abuse, level and severity of addiction, intimate partner violence, economic dependence and involvement with the criminal justice system have all been associated with engaging in risky behaviors. These are also all captured at some level by the Addiction Severity Index (ASI). Moreover, within many treatment centers, including the one providing our data, the ASI is a tool already implemented to help tailor treatments for substance abuse. The above seems to suggest this tool can also be used to develop and tailor interventions with the goals of improving and ultimately eliminating sexual and drug risk behaviors among women seeking treatment for substance using disorders. This study aims to show that, in fact, the ASI domains may be used to predict patterns of risky behaviors and therefore may be used to develop interventions with the aforementioned goals.

All researchers involved in this study are CITI (Collaborative Institutional Training Initiative) certified to analyze data dealing with human subjects. In addition, all data used in this study was de-identified to ensure confidentiality. That is to say, upon receipt and before releasing the data to myself and my advisor, the treatment center removed all identifying information. Therefore, the only data available to us regarding their identities were state-issued identification numbers from which actual identifying information is not recoverable.

Sampling

Substance abuse treatment centers that operate through and/or comply with the regulations of Missouri Department of Mental Health (DMH) enroll many of their patients in the Comprehensive Substance Treatment And Rehabilitation (CSTAR) (Missouri Department of Health and Senior Services, n. d.). The program, developed by the DMH Division of Alcohol and Drug Abuse (ADA),

> provides a full continuum of care approach to substance abuse treatment [and also] offers a flexible combination of clinical and supportive services, to include temporary living arrangements when appropriate, that vary in duration and intensity depending on the needs of the consumer." (Missouri Department of Health and Senior Services, n. d.)

In compliance with the CSTAR program and in order to retain funding from the Missouri DMH, women presenting for rehabilitation are given three clinician conducted surveys in order to assess their health and behavior which increases risk of contracting HIV; the severity of the impact addiction has on her life; and to provide diagnoses of the addiction related and psychological conditions for which she will undergo treatment. The survey assessing the impact addiction has is a standard psychological tool called the Addiction Severity Index (ASI). The other two surveys are labeled HIV Risk Assessment and Diagnoses. The present study analyzes the data gathered from these ASI and HIV Risk assessment from October 01, 2006 to July 30, 2010 at a substance abuse treatment center in St. Louis, MO.

Sample Description

To treat those seeking their help, our data provider implements the CSTAR Women and Children Program, which is designed to address the unique physiological and psychological effects of substance abuse in women, with priority given to those who are pregnant, postpartum or have children in their physical care and custody. The data we received from the above described surveys had varying sample sizes, the smallest of which was 3726. However, because of the discrepancies between the DMH ID numbers and treatment entry dates across surveys, the size of the dataset analyzed was considerably smaller. Its size is given below in the Statistical Methods section. The The next section describes the measures used in our analyses.

Measures

The data included survey questions pertaining to sociodemographic, behavioral and clinical factors relevant to women in SUD treatment. The sociodemographic information included categorical data such as race/ethnicity, zip code and career information, as well as continuous variables such as age and the ASI ratings. All of the variables used from the HIV Risk Assessment survey are categorical and describe provide clinical and behavioral information outlined in the sections below.

In those sections, we first give a description of the Addiction Severity Index; the domains of which will act as our predicting variables. Next we develop our dependent variable the HIV Risk Scale, a scale we use to quantify the level of risk for contracting HIV at which one's behaviors place him/her.

Addiction Severity Index

The ASI is composed of seven domains; medical, legal, family/social, employment, psychiatric, alcohol and drug. Each of the domains within ASI is composed of several questions, the answers of which are used to determine how severely addiction causes problems in that "domain" of the patient's life. After the survey has been conducted, two numerical values are assigned to each of the domains to quantify the findings of the assessment. One of those is the Composite Score (CS). The calculation of this value includes preassigning numerical values to the answers the patient chooses from within each domain, so as to be as objective as possible, and can be any number between zero and one: where zero means no severity and one, extreme severity. The second is the Interviewer's Rating (IR), which is given by the clinician conducting the survey and is therefore much more subjective. The value of the IR ranges from zero to nine, with higher ratings corresponding to more severe addiction problems. Since we do not use the former in this study, we do not elaborate on how it is calculated. However, the reader can find this information in the ASI Composite Manual. (McGahan, 1986) It has been argued in the literature that some ASI scores may be used as predictors of sexual risk behavior (Meade et al., 2009). We, however, now examine how the IRs may be used as predictors, with the belief that because clinicians tend to take into account extenuating circumstances that may not captured in the calculation of the CS, as well as their experience in the field, the IRs will serve as more efficient.

HIV Risk Scale

The scale we used to quantify a woman's behaviors increasing her risk of

contracting HIV was developed from the HIV Risk Assessment, which consists of questions concerning the patient's general sexual/drug risk behaviors, including behaviors of her partner(s), history of sexually transmitted diseases (STDs), history of intravenous (IV) drug use, drug/alcohol use with sex, as well as use of condoms and other methods of birth control, to mention a few items. We did not use each of the questions on the survey in developing our scale; rather only those that we felt actually described behaviors that might lead to contracting the virus based on our published clinical and behavioral research. We then split these questions into two categories describing her HIV risk: (1) drug risk and (2) sexual risk. We assigned point values to the available responses for each of the survey items and summed them within their respective categories to develop the Drug Risk Score (DRS) and Sexual Risk Score (SRS). The sum of these two scores gives our HIV Risk Scale. Most of the items in the scale have yes/no answers. For these, the response was converted into binary, with 1 for yes and 0 for no. The questions in the DRS were “Have you ever:”(1) had sex with IV drug user (2) injected drugs (3) shared needles (4) used other drugs (5) used crack cocaine. A person who has participated in all of these activities, and therefore answered yes to each question, would be given a Drug Risk Score of (1+1+1+1+1=) 5, whereas someone who's done none of the above would receive a Drug Risk Score of 0. The questions in the SRS included “Have you ever:” (1) had sex with a male (2) paid for sex (3) had sex while using alcohol (4) had sex with an HIV positive partner (whose status you where of at the time of the sexual encounter) (5) had sex with a high risk partner (6) received drugs/money for sex (7) been a victim of sexual assault (8) reported sexual assault to the police. For this last item, the score was

reversed; i.e. yes=0, no=1, since if the participant had not reported sexual assault it can be assumed there was no intervention and therefore she is more likely be a victim again. SRS also included information about former STD contractions, including: “Have you ever been diagnosed with any of the following” (9) Gonorrhea (10) Genital Warts (11) Herpes (12) Chlamydia (13) Syphilis (14)Yeast (15) PID (Pelvic Inflammatory Disease.) We also included (16) the number of sex/needle partners the participant has had in the past 6 months. This item was scored by the following: no partners=0, one partner=1, more than one partner=2. The final item asked (17)“How often do you use condoms?” The possible answers and their given values were “always”=0, “sometimes”=1 and “never”=2. Our overall HIV Risk Score, combined the two scores described above to form a scale ranging from 0 to 25 with higher values indicating a higher risk of contraction. Note: although the score can vary from 0 to 25 the effective range begins at 1 since nearly every woman in the study has had sex with a male.

To address the reliability of the scale we created, we implemented the SAS procedure *Proc Corr* including Cronbach's alpha as output for each of the scales. The respective values of the reliability coefficients for the Drug Risk Score (DRS), Sexual Risk Score (SRS) and HIV Risk Score (HRS) were found to be 0.59, 0.42, and .60. Given that the DRS only consists of 6 items we expect the value of its reliability coefficient to be rather small. Similarly, since the because of the lack of variety in some of the responses for the (e.g. 99.5% have had sex with a male, only 2% had sex with an HIV+ partner, and most STD responses) we expected the value of the SRS reliability coefficient to be a bit low as well. So the HRS coefficient is acceptable at 0.6 for the given data.

For most of the variables used in calculating the DRS, its obvious that such activities may expose one to HIV, e.g. sharing needles. We include the variables "Other Drug Use" and "Crack Use" because it has been documented that use of hard illegal drugs can cloud judgment and cause mental deterioration, which increases the chances of having multiple partners and unprotected sex. In particular, Hoffman concluded that crack use itself increases the risk of contraction, and that this risk rises proportionately with frequency and intensity of use. Moreover, the treatment facility has seen an increase of use in heroin and other drugs with high addiction and mental deterioration rates. (Define, 2010, Personal Correspondence) Additionally, a study conducted by the Missouri State Department of Health and Senior Services showed that, among women study participants, 82% reported unprotected sex at their last heterosexual encounter with their main partner, 63% with a casual partner and nearly 71% with a partner whom they've traded sex for physical goods, e.g. money/drugs. (MO DHSS, 2009) An assumption in the analysis, then, is that a good percentage of those reporting "Other Drug Use" use one of the drugs that have been shown to be associated with high risk behaviors as outlined above.

The SRS calculation is a bit more intuitive, however some variables can use justification. Paid sex is high risk partly because the payment is seen as a power and control issue where partners may not have the ability to exercise safer choices. Also, such encounters usually are heavily influenced by drugs and alcohol, which has been shown to impair judgment and promote risky behaviors.

A preliminary finding, that Age at admittance positively, significantly correlates

with six of the seven ASI Interviewer Ratings and also slightly, positively correlates with the HRS, prompts us to develop an Age-Adjusted HRS as well. To do so, we regress Age onto the HRS, that is $HRS=\mu+\beta*Age+\varepsilon$. Taking the estimated regression coefficient $\beta\approx0.023$, we calculate the Age-AdjHRS=HRS+0.023*(Mean(Age)-Age). Since older women in this sample seem to have more severe addiction problems, this scale will adjust for those.

The following section outlines the statistical methods undertaken in our analyses of the above described data.

Statistical Methods

While talking to the staff at the community based organization and looking over the original data as it was given to us, one of the most unfortunate realizations we had was that many of the data were repeated according to the number of times the client was admitted to the program. However, the data pertained to administrative clinical information taken upon intake; leading us to analyze the data as cross-sectional, treating each particular visit as a unique case. That is to say, we do not account for repeat visits in our analysis since the person's life situations may not be the same from one intervention to the next and the data were not collected as longitudinal. For example, if ID# 12345 was admitted in both April and December of 2007, then in our analysis each admittance is considered a different case. Making this distinction allows for a cross-sectional analysis of the data and hence provides a snapshot look into the general lives of women seeking treatment for SUDs. Matching IDs and treatment entry dates resulted in a final sample size of N=1832 cases.

Missing Observations

One of the most imposing challenges of the study was the huge amount of missing data. For only 965 cases, around 53% of the entire sample, were we able to calculate HRS's. All of the ASI IRs were missing at least a few cases, but one in particular stood out amongst the group. Nearly 14% of the cases had no family/social IR. The others were all missing no more than 5% of all cases.

To address this, we implemented the technique of multiple imputation using the SAS procedures *Proc MI* and *Proc MIANALYZE*. The method of multiple imputation is described in full detail in Schafer's *Analysis of Incomplete Multivariate Data.* (Saunders, et al., 2006; Schafer, 1997) The aforementioned procedures both make several assumptions about the structure and distribution of the dataset. The first assumption is that the data are from a multivariate normal distribution. The second assumption is that the missing data may depend on what was observed, but not on the missing data. The first of these assumptions is often relaxed; that is to say, data that may not seem to fit a normal distribution perfectly can still be subjected to this method with generally reliable results. (Schafer & Graham, 2002)

The *Proc MI* procedure produces m implicate data sets. Each of which has differing values in all of missing entries based on a Bayesian process involving Monte Carlo Markov Chains. The purpose in producing more than one implicate dataset lies in an attempt to model the uncertainty in the missing values. As we have no means of recovering the missing values, replacing them without accounting for that fact can cause statistical inferences to be incorrect. For our analyses the data were imputed m=10 times,

producing ten data sets with possible values for the missing data. We chose ten imputations rather than the standard five because of the large amounts of data missing. The *MIANALYZE* Procedure in SAS takes the inferential information produced from analyzing the imputed data by imputation and "rolling-up" the p-values and coefficient estimates according to Rubin's Rule. The data were imputed five times resulting in five sets of coefficient estimates, t-statistics and p-values.

The most commonly used procedure for dealing with missing data is incomplete case deletion. This procedure is exactly what it says: cases without a complete set of variables are completely ignored in analysis; effectively reducing the sample size and therefore limiting the ability to generalize to the general population being studied or modeled. Other ad hoc procedures such as single imputation with mean replacement of regression allow the analyst to keep for example cases that have most of the variables but are only missing a few. These procedure, however, have also been shown to attenuate error measurements and variability, which can lead to inflated p-values and incorrect statistical inferences. (Saunders, et al., 2006; Schafer, 1997; Schafer & Graham, 2002) Depending on the dataset, of course, these procedures may be useful and can often lead to completely unbiased and valid inferences. Especially when the amount of missing data is relatively small, say 5% of the sample. Other times, these are the only methods available; indeed all univariate analyses performed in this study use incomplete case deletion. In particular, this method is the default means of perform analysis on data with missing entries for most statistical software, including SAS 9.2 (Cary, NC) which was used in this study. To explore the differences in the results the above methods would yield, we

implemented both the default missing data methods and the multiple imputation method described above. The following section reviews the results of these analyses.

Results

This section presents details pertaining to the results of our data analyses and discusses findings in context of the relationship to the conceptual model. All statistical procedures were carried out using SAS Proprietary Software 9.2 (Cary, NC).

Table 1 presents the univariate analyses of the three Risk Scores, our dependent variables, as well as that of our independent variables, the seven ASI Interviewer Ratings (IR) along with some basic demographic information. The continuous variables are described by reporting the mean and standard deviation, while frequency and and percentages are reported for the categorical variables. Skewness of ±1.0 was used as an acceptable range for normality of distribution for continuous variables. Participants ranged from ages 16 to 67 at time of admittance and 43.5% of the sample reported receiving at least 12 years of education.

The correlation matrix for HRS, the primary dependent variable of interest, Age at Admittance (AdmAge) and the seven ASI interviewer ratings, our independent variables, is given below in Table 2. Amongst our independent variables there were quite a few significant correlations. However, given the low magnitude of many of these correlations and to maintain the conceptual integrity of the model, which includes all seven domains of ASI, we decided to keep them all.

The results of the first regression model are presented below in Table 3. Here we can see that the model has a fit score of R-square=0.142. Four of the seven interviewer ratings were found to be significant predictors, all with p-values less than 0.001. The significant predictors are from the ASI Medical, Alcohol, Drug and Legal domains. Of

these, the most powerful predictor by far was the Drug domain with a coefficient estimate of whose value is nearly twice that of its closest competitors Alcohol and Legal.

Table 1

Descriptive Statistics of Regression Variables

Variable	Mean=	Standard Dev.=	N=
Age at Admittance	38.03	9.34	1832
HIV Risk Score	9.31	2.99	1468
HIV Drug Risk	1.87	1.27	1658
HIV Sexual Risk	7.48	2.23	1581
Medical IR	2.34	2.51	1785
Employment IR	4.95	2.6	1794
Alcohol IR	2.92	2.8	1827
Drug IR	5.53	2.01	1827
Legal IR	2.25	2.46	1766
Family/Social IR	4.32	2.38	1584
Psychiatric IR	4.06	2.33	1818
African-American	77.13%		1413
Caucasian	20.69%		379
Latina/Hispanic	0.27%		5
Multiracial	1.53%		28
Other	0.38%		7
Injection Drug Use	19.13%		343

Table 2

Correlations of Age at Admittance, HRS and ASI Ratings

Variable:	AdmAge	HRS	Med IR	Emp IR	Drug IR	Alc IR	Legal IR	FamSoc IR	Psych IR
AdmAge	1								
HRS	0.07	1							
Med IR	0.25***	0.14***	1						
Emp IR	-0.11***	0.13***	-0.05*	1					
Drug IR	-0.2***	0.21***	0.002	0.11***	1				
Alc IR	0.28***	0.2***	0.13***	0.6*	-0.08***	1			
Legal IR	-0.15***	0.16***	0.03	0.15***	0.05*	-0.06*	1		
FamSoc IR	-0.007	0.14***	0.6*	0.39***	0.15***	0.15***	0.09***	1	
Psych IR	0.7**	0.1**	0.15***	0.02	0.1***	0.18***	0.03	0.2***	1

p<0.05, ** p<0.01, ***p<0.001

Table 3

Model with given data: N=806, R-Square=0.142, Depend. Var.= HRS

Variable	DF	Parameter Estimate	t-value	Pr>|t|
Medical IR	1	0.14	3.45	0.0006
Employment IR	1	0.1039	2.51	0.0123
Alcohol IR	1	0.1764	4.80	<0.0001
Drug IR	1	0.3430	6.53	<0.0001
Legal IR	1	0.1725	4.25	<0.0001
Family/Social IR	1	0.0530	1.09	0.2753
Psychiatric IR	1	0.0633	1.42	0.1575

As we were not able to compute the HRS for more than 50% of study participants due to missing data, we used multiple imputation via the SAS Procedure *Proc MI* to estimate values for the missing data. Table 6 displays the results of this analysis.

Table 4

Model with given data: N=806, R-Square=0.09, Depend. Var.= DRS

Variable	DF	Parameter Estimate	t-value	Pr>|t|
Medical IR	1	0.3976	2.08	0.0381
Employment IR	1	0.1910	0.99	0.3230
Alcohol IR	1	0.0388	2.26	0.0239
Drug IR	1	0.1720	7.03	<0.0001
Legal IR	1	0.0684	3.61	0.0003
Family/Social IR	1	0.0051	0.23	0.8201
Psychiatric IR	1	-0.0055	-0.26	0.7930

Given the recent findings of Des Jarlais (2007), as aforementioned, we also analyzed our regression model controlling for use of injection drugs. For those who did not use injection drugs, the model fit was slightly worse than for the total sample (R^2=.139 vs R^2=.142), but only Alcohol, Drug and Psychiatric severity ratings were found to be significant in the non-injecting group, with respective p-values listed as $p<0.001$, $p<0.001$ and $p=0.0082$. However, for the injection drug users, the model fit was slightly better (R^2=.145 vs R^2=.142). Here though, only one of the independent variables proved to have significant predictive power: namely Employment severity, with a p-value of $p=0.0006$. An even more interesting find was that the model failed to predict the DRS among injection drug users. No IRs were found to be significant predictors in this sub-model.

The results of our age-adjusted model are presented in Table 7. In comparison to Table 3, the results are nearly the same. They differ most distinctly in that Employment is now a significant domain. One may also notice that the coefficient estimates for the

Table 5

Model with given data: N=806, R-Square=0.118, Depend. Var.= SRS

Variable	DF	Parameter Estimate	t-value	Pr>|t|
Medical IR	1	0.1016	3.28	0.0011
Employment IR	1	0.0848	2.71	0.0068
Alcohol IR	1	0.1376	4.95	<0.0001
Drug IR	1	0.1709	4.31	<0.0001
Legal IR	1	0.1041	3.40	0.0007
Family/Social IR	1	0.0478	1.30	0.1923
Psychiatric IR	1	0.0688	2.04	0.0421

Employment and Drug domains in this model are greater in value than in the original model. Lastly, the Medical and Employment domains have nearly the same predictive power as before; but the predictive power of the Drug domain doesn't change much. Because the age-adjusted model differs so little from the original model, we do not report the results of the imputation analysis of the former in detail. The main difference is that one additional IR is found to have slightly significant predictive power. Imputation of the age-adjusted model yielded a p-value of p=0.0219 for the Psychiatric IR but p-values similar to those in Table 4 for the remainder of the IRs.

Table 6

Results of SAS 'Procedure MIANALYZE': 10 imputations, Average R-square=0.12

Variable	DF	Parameter Estimate	Minimum	Maximum	t-value	Pr>|t|
Medical IR	54.47	0.0964	0.0662	0.1401	2.70	0.0093
Employment IR	32.42	0.0511	-0.0056	0.0937	1.24	0.2240
Alcohol IR	45.64	0.1568	0.1292	0.1907	4.67	0.0000
Drug IR	34.25	0.2505	0.1982	0.3035	5.10	0.0000
Legal IR	40.96	0.1182	0.0807	0.1650	3.08	0.0037
Family/Social IR	38.17	0.0326	-0.0136	0.0754	0.75	0.4591
Psychiatric IR	88.9	0.0725	0.0323	0.0976	1.97	0.0515

Table 7

Age-Adjusted Model: N=809, R-square=0.142, Depend. Var=AgeAdjHRS

Variable	DF	Parameter Estimate	t-value	Pr>|t|
Medical IR	1	0.1196	2.92	0.0036
Employment IR	1	0.1136	2.75	0.0061
Alcohol IR	1	0.1568	4.27	<0.0001
Drug IR	1	0.3587	6.84	<0.0001
Legal IR	1	0.1850	4.57	<0.0001
Family/Social IR	1	0.0532	1.10	0.2730
Psychiatric IR	1	0.0599	1.34	0.1802

Discussion

As the fight against HIV/AIDS wages on, people with substance use disorders have become one of the many communities that has begun to see increased incidence and prevalence of the virus, especially here in the United States. Over the years, we have realized that prevention and education efforts will not entirely eradicate HIV/AIDS, while also recognizing that they certainly have mitigated its spread and quite possibly saved the lives of thousands, if not millions, of people. In particular many of these efforts do not address the unique vulnerabilities of women due to unbalanced power structures in sexual/intimate relationships or male acts of aggression (Amaro et al., 2007; Aral, Adimora, & Fenton, 2008; Lawoko et al., 2007; Shannon et al., 2008; Weiser et al., 2007). Since those with substance use disorders are at a particularly higher risk for contraction than the general population, prevention and education efforts that target this group are extremely important. Developing ways to predict risky behaviors and therefore tailor interventions for those behaviors is a step in the direction of accomplishing this goal. Moreover, using a tool that is already widely implemented as a means of doing this implies that costs associated with training and implementation will be minimal, if not non-existent. ASI, in particular, satisfies this criterion: addiction treatment centers across the country already use it. Thus, if it yields significant predictive power, its use to inform the design of personalized interventions that address HIV/AIDS risks in addition to addiction is not only feasible, but comes at almost no cost.

Our goal was to demonstrate that the Addiction Severity Index can be uilized to predict behaviors in substance abusing women that might lead to contracting HIV. These

behaviors can be classified into two categories: sexual risk behaviors (including behaviors such as having multiple concurrent sex partners and inconsistent use of condoms) and drug risk behaviors, which center mostly around use of injection drugs and sharing the materials (syringes, needles) that are necessary for such use. To be sure, these categories are not mutually exclusive. As aforementioned, several authors (Des Jarlais, 2007; Tross et. al, 2008) have noted that, in recent years, injection drug users are becoming subject to sexual transmission more often than injection transmission. Similarly, using drugs, including alcohol, while or before engaging in sexual acts has been associated with increased risk as well. In particular, we know these substances all impair judgment and can therefore lead to unprotected sex (Patricia A. Cavazos-Rehg, 2009). Clearly neither of these fits distinctly into one or the other of these two categories, since both involve risk of contraction based on sexual and drug behaviors. Thus our scales are subjective and are definitely subject to scrutiny. We believe, however, that they do help in informing one as to how people within our target population may come in contact with the virus.

We assessed the predictive power of ASI in relation to risky behaviors using a linear regression model with the seven IRs of the ASI as independent predictor variables and our developed scales, HRS, SRS and DRS and Age-Adjusted HRS, as separate dependent response variable. However, as expected with real-world data, especially that gathered to assess risky behaviors, many of the observations for several variables were missing. According to Seghal (2005), self-reported data regarding HIV risk behaviors can be as reliable as such data gathered by a face-to-face interview with a clinician. Thus

we can assume that the IRs will have at least as much predictive power as the CSs.

To deal with the sparsity of the data, we chose to impute them and use the "rolled-up" p-values from the regressions on our imputed datasets as our results. Although the raw data seemed to have a better overall fit and the IRs a bit more predictive power, we believe that our imputed results give a more accurate portrayal of the actual distribution(s) from which the data come. Using SAS's *Proc MI*, we imputed nine additional datasets and performed the same regression analysis on each of them. We then combined the information from each of the individual regressions, by taking their mean values, to summarize the analysis. The numerical results of the regression analyses on both the raw and imputed data can be found above in the "Results" section.

Important to note, is that both the imputed and raw data analyses showed that the Medical, Legal, Alcohol and Drug IRs are all highly significant predictors of risk behavior, most with regression p-values of $P \leq 0.001$. The two analyses did differ, however, for the Employment domain. Analysis of the raw data named this domain as slightly significant in contrast to the imputed analysis in which its p-value was greater than 0.2. Moreover, we found that neither of the remaining domains were anywhere close to having predictive ability for the HRS response variable; most p-values were greater than 0.1. By far, as one might suspect the strongest of these predictors was the Drug IR with a regression coefficient whose value is more than twice that of either the Medical or Legal IRs.

Similarly, with the age-adjusted HRS as our dependent variable the differences between the raw regression and imputed lie in only one predictor variable. This time,

though, the Psychiatric domain became significant after imputation. This is not an entirely surprising result since the sample correlations of Age with both Psychiatric IRs and the HRS were positive. The association between Age and the HRS was not significant, but that between Age and the Psychiatric IR was a whopping 0.7, which was highly significant. The imputed result is more in-line with the literature. There several authors note the association of psychiatric disorders with increased risk (Amaro, et al., 2007; Basso & Bornstein, 2000; Cournos, et al., 1994; C. S. Meade, Graff, Griffin, & Weiss, 2008; C. S. Meade & Weiss, 2007). So then if the older women in our sample population tend to have more psychiatric problems, one might expect their risk behaviors to be affected by both their substance abuse and psychiatric issues.

The above analysis seems to confirm both our hypothesis and what many other authors and scholars have been saying: for women with substance use disorders, an increased severity of addiction implies an increased risk for contracting HIV. And among these women, in general, the behaviors that can precipitate, even facilitate, said contraction are definitely associated with poor maintenance of one's general health, legal problems and severe substance addiction and possibly with employment problems. Ongoing difficulties finding and keeping employment often means depending on a man, who is more than likely a sexual partner, for both sustenance and substances among our target population. As mentioned before, note that economic dependence is often associated with unprotected sex (Biello, Sipsma, Ickovics, & Kershaw, 2010). For older women with substance abuse problems, increased risk is also associated with psychiatric problems .

We acknowledge that the issues that each of the ASI domains address are worth intervention on their own, even outside of the context of HIV/AIDS risk and so this tool is already useful. Here, however, we believe that we've shown it to have even more usefulness. Stopping the spread of the virus that causes AIDS in one any particular community, especially those that are disproportionately affected by it is vitally important in stopping its spread the world over. Discovering ways to develop appropriate interventions, from medication to education and prevention efforts is paramount to accomplishing this goal. We believe that ASI can assist in developing those interventions and therefore save thousands of lives.

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