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# Applied machine learning analysis: Factors correlated with injection drug use and post-prison medication for opioid use disorder treatment engagement

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**ABSTRACT**

**Objectives:** This study aimed to classify the factors that were correlated with injection drug use (IDU) and with medications for opioid use disorder (MOUD) treatment engagement among individuals who were recently released from prison.

**Methods:** Data for this study were obtained from a Midwestern reentry program for incarcerated individuals with co-occurring opioid use and a mental health disorder between May 1, 2017, and April 30, 2020. CHAID decision tree modeling was utilized to classify IDU and MOUD treatment engagement.

**Results:** Those most likely to report IDU were individuals with a Hepatitis C diagnosis and a history of overdose, and those least likely to report IDU were not diagnosed with Hepatitis C, identified as a person of color, and never overdosed on opioids. The subgroup of that were most likely to report MOUD treatment engagement were individuals taking psychiatric medication and who had a history of IDU. The subgroup of participants least likely to report MOUD treatment engagement were individuals prescribed psychiatric medication, without had a history of IDU, and were not participating in substance-use treatment.

**Conclusion:** Our findings indicate that, to protect vulnerable populations and to flatten the overdose mortality curve, an increased focus is required within criminal/legal systems to facilitate linkages to care at reentry.

**KEYWORDS**
opioid; reentry; medication for opioid use disorder; incarceration

## Introduction

The overdose epidemic continues to be one of the most pressing public health crises in US history, with approximately 100,000 overdose deaths in the 12-month period ending in April, 2021 (Ahmad et al., 2023). Among individuals involved in the criminal/legal system, persons with opioid use disorder (OUD) are overrepresented and recent increases in the

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prevalence of injection drug use (IDU) among this population is another concerning trend because it is associated with adverse health outcomes (e.g., infectious disease transmission and fatal overdose) and an increased risk of recidivism (Brinkley-Rubinstein & Cloud, 2020; Håkansson & Berglund, 2012; Ivsins et al., 2020). The two-week period immediately following release from incarceration (Victor et al., 2022) is particularly high risk for those with OUD and for those who also inject drugs. For example, the risk of a fatal overdose is estimated to be 129-times greater for individuals who were recently released from prison compared to the general population (Binswanger, 2013), and a recent meta-analysis found that people who inject drugs (PWID) and who had a recent incarceration encounter were 81% more likely to transmit HIV and 62% more likely to transmit HCV (Stone et al., 2018).

Medications for opioid use disorder (MOUD; i.e., methadone, buprenorphine, and naltrexone; Pivovarova et al., 2022) are considered the gold-standard evidence-based treatment for those with OUD. These medications have demonstrated effectiveness in decreasing the prevalence of IDU and decreasing the risk of experiencing an accidental overdose compared to nonpharmacological treatments (Larochelle et al., 2018; Wakeman et al., 2020). Medication for opioid use disorder treatment engagement is also associated with a decreased risk of recidivism among those with OUD who were incarcerated (Evans et al., 2022). As such, there has been an increased emphasis on implementing programs that provide MOUD in correctional facilities (Ray et al., 2022; Weizman et al., 2022).

For instance, Farrell-MacDonald et al. (2014) found that individuals who were engaged in methadone treatment post-release had a significantly lower risk of returning to custody compared to those who terminated treatment and non-methadone controls with OUD. Other studies have demonstrated similar findings—such that methadone treatment during incarceration was associated with reduced likelihood to report IDU in the 12-month period post release (Brinkley-Rubinstein et al., 2018; Rich et al., 2015), while Zaller et al. (2013) found that individuals who initiated buprenorphine treatment while incarcerated were significantly less likely to report IDU at the 6-month follow-up. A recent literature review showed that MOUD treatment engagement following release from incarceration is strongly associated with MOUD treatment engagement during the incarceration period (Cates & Brown, 2023). Collectively, these studies have demonstrated that MOUD treatment engagement during incarceration improves treatment and criminal/legal outcomes post-release; however, little is known about the factors associated with MOUD treatment engagement immediately following release.

There is research that has demonstrated pathways to MOUD treatment engagement among non–criminal/legally involved individuals. These pathways include emergency department and primary-care provider encounters

(Macmadu et al., 2021), having insurance coverage (Cantone et al., 2019), being of White race (Cantone et al., 2019; Lagisetty et al., 2019), having a psychiatric diagnosis (Cantone et al., 2019), and experiencing fewer nonfatal overdoses (Macmadu et al., 2021); all have been associated with MOUD treatment engagement. Taken together, pathways that link reentry populations to community-based MOUD may differ from patients with no criminal/legal exposure More knowledge is needed to understand the underlying factors that facilitate MOUD treatment engagement postrelease among those with OUD and those who inject drugs (Brinkley-Rubinstein et al., 2017).

## Current study

To contribute to this body of literature, we applied a decision tree machine learning methodology to describe the associations between IDU preincarceration and MOUD treatment engagement postrelease (i.e., 1 month). This study aimed to explore (1) factors that are correlated with injection drug use compared to non-injection drug use 12 months prior to incarceration; and (2) factors that are correlated with MOUD treatment engagement 1 month postrelease from prison. Factors that were included in this study were informed by Joudrey et al., (2019) post-release opioid-overdose risk conceptual model, which identified underlying factors (e.g., HIV/HCV infection, race), intermediate determinants (e.g., disrupted social support networks, interruptions in health care), proximate determinants (e.g., interrupted OUD treatment, opioid use history), and biological effects (e.g., nonfatal overdose experiences). We explored preincarceration associations with IDU, given the increased risk of infectious disease transmission, other health consequences (e.g., fatal overdose), and potential recidivism, as well as to inform the triaging of services among correctional health-care providers for this vulnerable subpopulation. Furthermore, understanding the factors that promote MOUD treatment engagement in the acute postrelease period is of critical importance, given the risk of fatal overdose during this time and the relatively nascent literature dedicated to those with criminal/legal exposure.

## Methods

### *Procedures and sample*

Data for this study were obtained from a Midwestern reentry program funded by the Substance Abuse and Mental Health Services Administration for incarcerated individuals with co-occurring opioid use and a mental health disorder. This study was designed to identify predictors of injection opioid use among a sample of individuals who voluntarily enrolled in the reentry

project between May 1, 2017, and April 30, 2020. Department of Corrections facility coordinators at the only women's facility in the state or a men's parole center in the state's largest county identified potential participants and completed a referral form with the inmate to screen them for eligibility.

This reentry program was created to fill a service gap for individuals in prison who have co-occurring opioid use and mental health disorders. The reentry program had four goals: (1) expand the availability of OUD treatment and recovery options for reentering individuals, (2) reduce opioid overdoses and other substance use relapses, (3) improve mental health outcomes, and (4) reduce recidivism. Once enrolled in programming, participants were assigned case manager and peer support services for up to 3 months prerelease from prison or jail and up to 6 months postrelease in the community. Services included dual recovery therapy (DRT) sessions (Ziedonis & Stern, 2001), risk-needs-responsivity assessments to gauge recidivism risk and motivation for change, and linkages to needs related to social determinants of health (i.e., housing, transportation, employment, education, health care). Case managers and peer support specialists also communicated with participants' parole and probation officers, participants' treatment agencies, and participants' families to provide wrap-around support and encourage engagement in community treatment for OUD.

Eligibility criteria required participants to be at least 18 years of age, enrolled in a reentry program within approximately 3 months prior to their release date, and be released to one of the three eligible metropolitan counties. Additionally, individuals must self-report opioid use at least once in their lifetime and mental health symptomology at time of program referral. After review of the referral, a case manager meets with the individual to complete a more in-depth screening to confirm eligibility. Participants who were eligible and consented to MOUD treatment were offered vivitrol while incarcerated as part of the reentry program. At the time of this program, the Department of Corrections in this Midwestern state only allowed for new inductions of vivitrol, though it has since begun to implement methadone and buprenorphine medications available as well. Upon release, the reentry program would then assist an individual to engage in any type of MOUD treatment (e.g., methadone, buprenorphine, or vivitrol) by assigning a case manager to facilitate appointments with MOUD providers.

After eligibility and interest are confirmed, the participant signs a treatment contract and completes an in-depth baseline psychosocial assessment with their assigned case manager. This study used a subset of ($N = 160$) participants who reported either no lifetime opioid use by injection (non-IDU group; $n = 89$) or opioid use by injection in the year prior to incarceration in their baseline assessment (IDU group; $n = 71$). Administering drugs via injection was not an eligibility requirement and there were no

programmatic differences between those who reported IDU versus those who did not. Informed consent was provided to everyone, and participation was voluntary. Finally, this reentry program did not provide additional incentives for an individual's participation, nor were participants penalized for not completing the program postrelease. Participants who completed the program were considered "graduates" and there were no stipulations in which participants could be revoked from the program, although some may abscond. This research project was reviewed and approved by the Wayne State University Institutional Review Board (IRB).

### Outcome measures

Model 1: *Injection drug use:* Participants with OUD were asked if they had ever used any opioid by injection and if they had, had they injected in the year prior to incarceration (0 = No; 1 = Yes). As mentioned in the design/sample section, those who had injected opioids in their lifetime, but not in the year prior to incarceration, were excluded from the current sample.

Model 2: *Medication for opioid use disorder*: Participants were asked at 1 month postrelease if they were currently receiving one prescribed form of MOUD (0 = No; 1 = Yes).

### Model 1: IDU independent variables

#### Demographic variables

Demographic variables included; age, gender (0 = female; 1 = male), race (0 = White; 1 = POC), and previous homelessness (0 = No; 1 = Yes). Race was dichotomized into White and persons of color. those who reported themselves as any race other than white were recoded as a persons of color.

#### Severity of opioid use in year prior to incarceration

Participants were asked how often they had used street or prescription opioids in the year prior to their incarceration. Responses were dichotomized (0 = daily/almost daily; 1 = less than daily).

#### Age of first opioid use

Opioid use history was measured as a ratio variable by the age of first reported opioid use.

#### Overdose history

Lifetime history of opioid overdose was measured dichotomously (0 = No; 1 = Yes).

#### HCV status

An individual's HCV status was measured dichotomously (0 = No; 1 = Yes).

#### Substance use treatment history

At time of program enrollment, participants were asked to report if they had been ever housed in an inpatient substance use/detoxification treatment center prior to incarceration (0 = No; 1 = Yes).

#### Age of first arrest

Criminal/legal involvement was measured as a ratio variable by using the age of first reported arrest.

#### Lifetime convictions

The number of lifetime convictions included all prior convictions and the current incarceration.

#### Serious mental illness

At time of program screening, participants completed the Kessler Psychological Distress Scale (K10), which is a series of 10 questions regarding their mental health over the past 30 days. The K10 is summed into a score intended to measure the individual's likelihood of having a mental disorder. Scores range from 10 to 50, with $< 20$ = likely to be well, 20–24 = mild likelihood, 25–29 = moderate likelihood, and 30+ = severe likelihood.

#### Peer recovery support specialist encounters

This variable measured the total number of peer recovery support specialists encountered prior to the current incarceration.

### Model 2: MOUD independent variables

#### Demographic variables

Demographic variables included in the analyses were age, gender (0 = female; 1 = male), race (0 = White; 1 = POC), and previous homelessness (0 = No; 1 = Yes). Race was dichotomized into White and persons of color such that those who reported themselves as multi-racial or black were classified as persons of color.

### *Employment assistance*

In the 30 days postrelease, did you receive help with employment problems, like job training or assistance in looking for a job (0 = No; 1 = Yes)?

### *Prior MOUD utilization*

At baseline, participants self-reported whether they had received any MOUD in the 12 months prior to their most recent incarceration (0 = No; 1 = Yes).

### *Alcoholics/Narcotics Anonymous recovery supports*

In the 30 days postrelease, have you received support from AA or NA (0 = No; 1 = Yes)?

### *Familial recovery supports*

In the 30 days postrelease, have you received support from familial social networks (0 = No; 1 = Yes)?

### *Time to treatment*

The number of weeks to the first medical/clinical encounter was measured as a ratio variable.

### *Substance use behavioral therapy recovery support*

In the 30 days postrelease, have you received support from substance use behavioral treatment (0 = No; 1 = Yes)?

### *Peer recovery support services*

In the 30 days postrelease, what is the total number of structured and unstructured peer recovery support services used?

### *Discharge SUD services*

In the 30 days postrelease, have you received clinical services related to SUD problems (0 = No; 1 = Yes)?

### *Mental health pharmacology*

In the 30 days postrelease, have you been regularly taking any prescribed psychiatric medication (0 = No; 1 = Yes)?

### *Physical health treatment*

In the 30 days postrelease, have you been treated by a medical doctor for a physical health problem (No = 0; 1 = Yes)?

### Medicaid

In the 30 days postrelease, did you receive Medicaid (0 = No; 1 = Yes)?

### Transportation

In the 30-days post-release, did you have access to an automobile? (0 = No; 1 = Yes)?

## Data analysis

Differences in demographic, criminal justice, substance use, and mental health variables among the IDU and non-IDU group were analyzed using *t*-tests and chi-squared tests. We utilized chi-squared automatic interaction detection (CHAID) decision tree modeling to analyze the characteristics of IDU and MOUD treatment engagement. CHAID models construct a decision tree by repeatedly splitting the entire sample into subsets (or nodes) using independent variables that best identify the outcomes of interest. This type of analysis makes no assumptions about the underlying distribution, minimizes the effects of outliers, and accommodates categorical and ordinal data. The strongest correlations of these cross-tabulation results are then incorporated into a classification tree, which splits the data into mutually exclusive subsets that best describe the dependent variable (Kass, 1980). All analyses were conducted in Stata 13 (StataCorp, 2019).

## Missing data

Of the 160 individuals in the sample, 45 participants (28.13%) responded to the 1 month postincarceration survey. The missingness of these data reflects individuals who absconded, disenrolled, or moved out of state within the follow-up period. To assess the effects of missing data on the results of the analyses, we conducted *t*-tests and chi-squared tests of the independent variables selected by the CHAID model across individuals with and without missing data. Individuals who did not respond to the second survey had a greater number of peer recovery support services postrelease, began using opioids at a younger age, and used more opioids in the prior year. They were also disproportionately non-White, less likely to have tested positive for Hepatitis C in the initial interview, less likely to have ever overdosed, and less likely to report IDU, indicating that the data were missing not at random (MNAR). The results of these tests are documented in the Appendix. Missing data notwithstanding, we continued with the analysis for several reasons. First, CHAID models are especially robust to missing data because of the independent nature of the statistical testing (Tan et al., 2021). Second, CHAID models are largely unaffected by reductions in sample size; as such, there were no

resulting changes in statistical power that often accompany missing data in multivariate analyses.

## Results

### Descriptive statistics for key variables

Table 1 outlines descriptive statistics of dependent variables and independent variables tested in the CHAID models. In our sample, approximately 46.25% ($n = 74$) of individuals reported IDU. Most of the sample were White (51.88%; $n = 83$) and male (52.50%; $n = 84$), with an average age of 37.46 years ($SD = 9.76$). Of the individuals who responded to the follow-up survey, the majority (88.89%; $n = 40$) reported receiving MOUD. The following sections outline the results of CHAID analyses and the determinants of IDU and MOUD.

### Model 1: CHAID Decision tree model correlated with IDU

Figure 1 presents the results of the CHAID decision tree model for IDU. As shown in the root node (layer 1), 44.38% of participants reported IDU. The most significant correlate of reported IDU 12 months prior to

**Table 1.** Descriptive statistics of key variables.

| Variable | *N* | x̄ or n (%) | *SD* | Min | Max |
|---|---|---|---|---|---|
| Dependent variables | | | | | |
| IDU | 160 | 74 (46.25%) | – | – | – |
| MOUD | 45 | 40 (88.89%) | – | – | – |
| Baseline characteristics | | | | | |
| Race (Persons of Color) | 160 | 77 (48.12%) | – | – | – |
| Sex (Woman) | 160 | 76 (47.50%) | – | – | – |
| Age | 160 | 37.46 | 9.76 | 21 | 61 |
| Age of first opioid use | 156 | 22.1 | 8.05 | 8 | 60 |
| Age of first arraignment | 160 | 18.24 | 6.51 | 10 | 45 |
| Lifetime convictions | 155 | 18.68 | 6.69 | 10 | 53 |
| K10 Score | 149 | 8.19 | 7.39 | 0 | 35 |
| HCV status | 147 | 39 (26.53%) | – | – | – |
| Overdose history | 160 | 77 (48.12%) | – | – | – |
| PRSS exposure | 159 | 8.4 | 13.73 | 0 | 59 |
| 1 month postrelease characteristics | | | | | |
| AA support | 45 | 28 (62.22%) | – | – | – |
| Familial support | 45 | 29 (64.44%) | – | – | – |
| Recovery support | 45 | 30 (66.66%) | – | – | – |
| Medicaid | 45 | 0.95 | 0.21 | 0 | 4 |
| Access to vehicle | 45 | 11 (24.44%) | – | – | – |
| Currently housed | 45 | 23 (51.11%) | – | – | – |
| Discharge SUD services | 45 | 28 (62.22%) | – | – | – |
| Time to treatment (weeks) | 45 | 17.78 | 11.95 | 0 | 62 |
| Employment assistance | 45 | 21 (46.67%) | – | – | – |
| MH treatment | 45 | 32 (71.11%) | – | – | – |
| MH prescription | 45 | 27 (60.00%) | – | – | – |
| Physical health treatment | 45 | 97 (60.62%) | – | – | – |

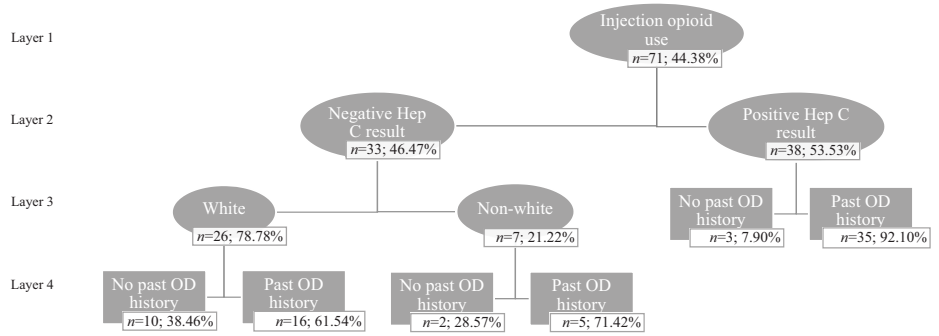


**Figure 1.** Decision tree of characteristics of injection drug use in the 12 months prior to incarceration.

*Note*: Decision tree produced using CHAID modeling. Ovals indicate internal nodes; squares indicate terminal nodes.

incarceration was whether a participant had contracted HCV (layer 2). Namely, individuals who had contracted HCV were strongly correlated with reporting IDU. The second most significant correlate of IDU was race, followed by whether an individual had ever overdosed on opioids. That is, individuals who identified as White and had a history of nonfatal overdose were most likely to report IDU. Conversely, individuals who identified as persons of color and had never overdosed previously were least likely to report IDU.

Taken in tandem, the subgroup of participants most likely to report IDU were individuals with a Hepatitis C diagnosis (53.53%) and a history of overdose (92.10%; layer 3, terminal node 2). The subgroup of participants least likely to report IDU were individuals who were not diagnosed with Hepatitis C (46.47%), identified as a person of color (21.84%), and never overdosed on opioids previously (26.51%; layer 4, terminal node 3).

### *Model 2: CHAID Decision tree model for MOUD treatment engagement*

Figure 2 presents the results of the CHAID decision tree model for MOUD treatment engagement in the 1 month postrelease period. Most of the individuals reported participated in MOUD 1 month post incarceration (73.91%, layer 1). Psychiatric medication treatment engagement was the most important variable in determining MOUD treatment engagement (layer 2); individuals who reported utilizing psychiatric medication were more likely to report MOUD treatment engagement. This was followed by whether a person reported IDU (layer 3) and participation in substance use treatment (layer 4). Individuals who reported IDU were more likely to report MOUD treatment engagement, while individuals who did not participate in substance use treatment were least likely to report MOUD treatment engagement.

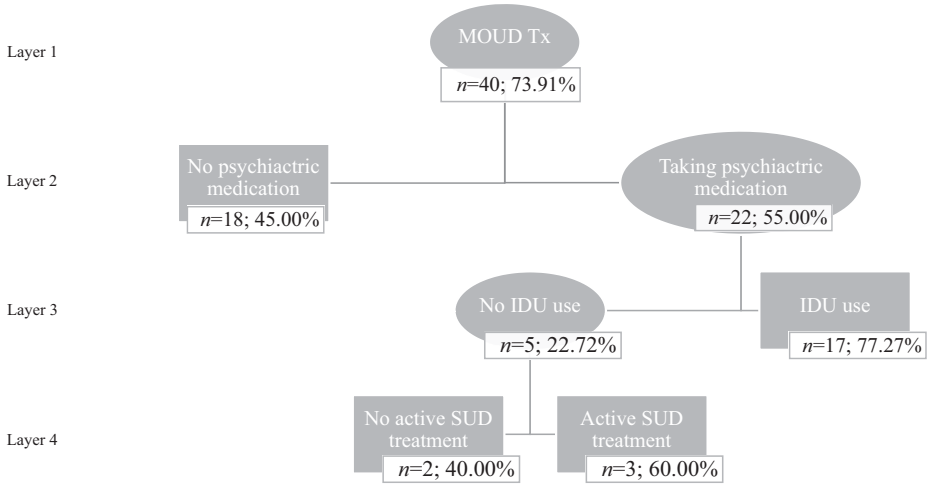


**Figure 2.** Decision tree of characteristics predicting MOUD treatment engagement.
*Note*: Decision tree produced using CHAID modeling. Ovals indicate internal nodes; squares indicate terminal nodes. SUD = substance use disorder, Tx = treatment engagement

Based on the results of the analysis, the subgroup of participants that were most likely to report MOUD treatment engagement were those taking psychiatric medication (55.00%) and who had a history of IDU (77.27%; layer 3, terminal node 1). The subgroup of participants least likely to report MOUD treatment engagement were individuals prescribed psychiatric medication (55.00%), without had a history of IDU (22.72%), and were not participating in substance use treatment (40.00%; layer 4, terminal node 1).

## Discussion

The aims of this study were to classify the factors that were correlated with IDU and with MOUD treatment engagement among individuals who were recently released from prison. Our findings demonstrate that HCV positivity was strongly correlated with IDU. We also found that the most important factor correlated with postrelease MOUD treatment engagement was whether an individual was prescribed psychiatric medication following release from incarceration. Medication for opioid use disorder treatment engagement was also correlated with a participant's IDU status, where those who reported IDU were more likely to report postrelease MOUD treatment. These findings may reinforce the need to expand safe syringe services within correctional facilities, because they not only improve treatment engagement (Kidorf et al., 2011) but are also effective in mitigating the transmission of infectious diseases (Bluthenthal et al., 2007; Winetsky et al., 2020). It is important to reiterate the missing data in this study.

Our study is one of the few that has described the positive relationship between psychiatric pharmacology treatment and MOUD treatment

engagement among a reentry population. Information on reentry populations is limited, but there is evidence that psychiatric encounters are a critical point for engaging individuals with OUD with MOUD treatment (Cantone et al., 2019). It is important to connect recently released individuals with OUD to MOUD treatment, given the evidence suggesting that MOUD is more effective than nonpharmacologic treatments (e.g., inpatient treatment or intensive outpatient behavioral interventions; Cates & Brown, 2023; Wakeman et al., 2020) in reducing the risk of overdose and is also associated with positive outcomes related to injection drug use and recidivism.

Consistent with prior research (Cates & Brown, 2023), an interpretation of this finding may be that the benefits of receiving medical care during the incarceration period, including MOUD treatment induction or continuation, can significantly improve postrelease outcomes on treatment engagement postrelease. The participants in the current study were part of a reentry program that coordinated MOUD treatment induction during the incarceration period, so it is difficult to draw broad conclusions on whether those incarcerated in the same facilities but not in the reentry program would have similar MOUD treatment engagement pathways after release.

The implications of our findings related to IDU could inform correctional screening and treatment programming based on the specialized needs of PWID. Our findings demonstrate that the strongest correlate with IDU was HCV positivity. Prior research has identified that incarceration considerably enhances the risk of HIV and HCV transmission—particularly among those who inject drugs (Stone et al., 2018). The possible mechanisms through which this transmission is enabled to occur may reflect poor screening and triaging of care for those with infectious diseases in correctional facilities, as well as the lack of harm reduction services in prisons (Merrall et al., 2010; Victor et al., 2022). It is important for correctional facilities to have comprehensive screening protocols in place and to provide adequate medical care and treatment to those who test positive for infectious diseases.

While there is limited evidence supporting the effectiveness of MOUD treatment engagement and syringe service programs in decreasing the transmission of HIV and HCV among PWID in prisons, studies have shown that MOUD treatment in prisons reduces the risk of injection drug use and increases treatment entry and retention after release—important given that we found those who reported IDU were HCV positive and had a greater number of nonfatal overdoses (Stöver & Hariga, 2016). Additionally, syringe service programs in prisons effectively reduce syringe sharing among PWID without promoting drug use or endangering safety and could alleviate the burden placed on the often-strained standard of

health care in correctional facilities (Saloner et al., 2022). Therefore, it is likely that prison-based harm reduction interventions, coupled with proper service linkage upon release by peer support (Enich et al., 2023; Ray et al., 2021; Victor et al., 2021) can mitigate the postrelease risks associated with incarceration (Gordon et al., 2008, 2017). There is evidence suggesting that it is feasible to implement standardized OUD screening and MOUD induction and continuation in correctional facilities (Cates & Brown, 2023; Ray et al., 2022), and this cascade of care should be extended to the robust screening and triaging of services for those with HCV or HIV. Minimum standards of OUD care suggest that all correctional facilities ought to provide MOUD to those in custody (Fiscella et al., 2018; Wakeman & Rich, 2015) and naloxone at release, in addition to scaling the continuity of care services to the needs of those in custody.

Practices like forced detoxification in prison facilities within the US may be deterring individuals that are reentering the community from utilizing effective treatments for OUD (Cates & Brown, 2023). Individualized treatment and policy planning are recommended, as this study builds on previous research that illustrates the unique needs of PWID in the criminal/legal system. Both policy changes and interventions are urgently needed to reduce the negative consequences of incarceration on morbidity and mortality (Brinkley-Rubinstein & Cloud, 2020; Zaller & Brinkley-Rubinstein, 2018).

## Limitations and future research

These data were part of a larger multisite reentry project, and participation in this project was voluntary; thus, motivation, readiness for change, and perceptions about OUD treatment utilization in this sample may not be reflective of populations in other reentry programs, particularly mandated and supervised programs, or among populations who do not have access to any reentry programming. The missingness in these data may reduce generalizability, statistical power of the analyses, and bias the results given that those with missing data on the follow-up interview were disproportionately non-White, less likely to have tested positive for Hepatitis C in the initial interview, less likely to have ever overdosed, and less likely to report IDU. Additionally, our sample may have overrepresented the proportion of incarcerated women to men. We were unable to control for the type of MOUD dispensed at reentry; therefore, our findings should not be generalized to specific antagonist or agonist pharmacotherapies. Although our analysis was robust, it could not account for causality or the temporal relationship between health services in the postrelease period. These data could not be used to measure reincarceration during the follow-up period, and more research is needed to account for the censoring of

reincarceration events and MOUD dispensation within and outside of the current study's jurisdiction. We were unable to control for treatment retention, and future research should consider the best practices for maximizing MOUD retention among reentry populations beyond the 1 month postrelease period. Future studies should consider exploring approaches that will serve the complex needs of those with incarcerated OUD, including best practices that harmonize pharmacological treatment for those with co-occurring psychiatric and OUD conditions. Additionally, future research is needed on the implementation of harm reduction programs in carceral settings with the intent of reducing the risk of disease transmission within the prison population (Armstrong-Mensah et al., 2021).

## Conclusion

There is an important intersection among individuals in the criminal/legal system, PWID, and OUD. This study demonstrated the factors that are most important in facilitating MOUD treatment in the period immediately following community reentry. Our findings support growing evidence indicating that to protect vulnerable populations and to flatten the overdose mortality curve, an increased focus is required within criminal/legal systems to divert individuals with OUD and other behavioral health concerns away from the criminal/legal systems and to provide access to appropriate care. Further research is needed to demonstrate the efficacy of best practices for the treatment of opioid use disorders (i.e., harm reduction, MOUD, naloxone distribution, etc.) to be used in prison or jail settings as well as immediately upon reentry.

## Declarations

Ethics approval and consent to participate. The primary designated single Institutional Review Board of Wayne State University reviewed and approved all human subjects procedures for this study. All study participant provided written informed consent prior to study participation.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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**Appendix.** Results of missing data assessment.

| Variable | Missing | Non-missing | Test Statistic | Significance |
|---|---|---|---|---|
| *Continuous variables* | *M* (*SD*) | *M* (*SD*) | *t* | |
| PRSS exposure | 23.1 (15.9) | 2.5 (6.56) | 11.56 | $p < 0.01$ |
| Age of first opioid use | 19.6 (5.6) | 23.1 (8.67) | −2.51 | $p = 0.01$ |
| Age | 39.2 (9.7) | 36.7 (9.71) | 1.42 | $p = 0.15$ |
| Total convictions | 75.8 (249.6) | 34.5 (162.3) | 1.21 | $p = 0.22$ |
| K10 score | 21.4 (7.3) | 20.5 (7.4) | 0.67 | $p = 0.50$ |
| Age of first arraignment | 18.3 (6.1) | 18.1 (6.6) | 0.17 | $p = 0.87$ |
| *Categorical variables* | Frequency (%) | Frequency (%) | Pearson $\chi^2$ | |
| IDU | 28 (62.22%) | 46 (40%) | 6.42 | $p = 0.01$ |
| Race | 14 (31.11%) | 55 (54.78%) | 7.25 | $p < 0.01$ |
| HCV status | 18 (41.86%) | 21 (18.26%) | 7.33 | $p < 0.01$ |
| Overdose history | 30 (66.67%) | 47 (40.87%) | 8.62 | $p < 0.01$ |
| Discharge services | 36 (80.00%) | 61 (53.04%) | 9.84 | $p < 0.01$ |
| Gender | 21 (46.67%) | 55 (47.82%) | 0.02 | $p = 0.90$ |