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## Generational Trends and Patterns in Readmission within a Statewide Cohort of Clients Receiving Heroin Use Disorder Treatment in Maryland, 2007-2013

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### Abstract

The recent rise in opioid-related overdose deaths stresses the importance of understanding how heroin use disorders persist and what interventions are best suited for treating these illnesses. Trends show that there are diverse pathways leading to heroin use disorder that span multiple generations, but little is known about **how different generations utilize and respond to treatment**. This study provides additional insight into treatment utilization for young, middle-aged, and older adults by examination of an unusually rich longitudinal dataset of substance use disorder clients in Maryland who were treated for heroin use. Results show that clear **patterns of treatment readmission** emerge across generations in **treatment-naïve clients** with regard to **gender, ethnicity, employment**, geographical **region**, and **treatment type/intensity**. In particular, Millennials comprise the majority of the clients **receiving heroin use disorder treatment and are the largest contributor to these readmission patterns**. Millennials are also given opioid maintenance therapy (OMT) more frequently than other generations, while exhibiting a strong **avoidance to treatment**. Generational differences in treatment decisions and outcomes over the course of a treatment career are important for understanding the nature of the current opioid epidemic, and can play an important role in directing heroin use disorder treatment efforts and improving models of care.

Patrones longitudinales en la readmisión a tratamientos por uso de opioides, en función de la generación y otras variables sociodemográficas.

Los millenials son los que más reciben tratamiento por uso de heroína y contribuyen más a la readmisión, reciben más tratamiento de mantención de opioides OMT y muestran fuerte evitación al tratamiento

### Keywords

Heroin; Readmission; Millennial; Gender; Ethnicity; OMT

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#### Author Contributions

KRZ, RNE, and YC designed the study and performed data analyses. YC and JC performed statistical analyses. KRZ, RNE, RPC, and MTL supervised the project. KRZ wrote the manuscript. RNE, AS, YC, RPC, and MTL helped write the manuscript and assisted with the copy-editing.

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## 1. Introduction

Heroin use disorder remains one of the most significant public health challenges the nation faces. Currently, states across the country are experiencing a surge in opioid-related overdose deaths with fentanyl-laced heroin front and center as the biggest culprit. Altogether, almost 15,000 Americans lost their lives to heroin-related overdoses in 2016, an amount five times greater than that seen since 2010 (Overdose Death Rates, 2017). With heroin use in young adults more than doubling in the past decade, the magnitude of the loss of life is expected to continue to grow. Maryland has been one of the hardest hit states by the epidemic, experiencing a more than 60% increase in heroin-related overdoses in 2016 alone (Drug-and Alcohol-Related Intoxication Deaths in Maryland, 2016, 2017).

In a number of ways, substance use disorders go hand-in-hand with societal changes, as well as the availability of particular drugs and other illicit substances (Durrant & Thakker, 2003). Much of the current epidemic was likely borne out of the abundance of opioid painkillers in the early 2000s and the popularity of their recreational use with the Millennial generation (Drug Use Across the Generations, 2014). However, the over-prescription of opioids for chronic pain management in middle-aged adults and seniors may also have fueled the current crisis. In fact, one-in-four patients receiving these medications eventually struggle with opioid use disorder (Boscarino et al., 2010). Middle-aged adults and seniors of the Gen X and Baby Boomer generations, respectively (see section 2.3 for our definitions of generational cohorts), have also experienced the largest increase in rates of opioid-related overdose in recent years (Drug Overdose Deaths in the United States, 1999-2015, 2017). In all three of these generations, high-intensity opioid painkiller use appears to be associated with high rates of heroin use (Mack, Jones, & Paulozzi, 2013; Wall et al., 2018). While it is evident that there are diverse pathways leading to heroin use that span multiple generations (Wall et al., 2018), the extent and nature of heroin use disorder within these generational groups and how these groups utilize treatment remains unclear.

Social scientists often address differences in generational groups by age, period, and cohort (APC) effects (Mason & Wolfinger, 2002). Age effects arise from the biological and behavioral differences that exist between generational groups based on their respective positions in the life cycle. As a case in point, 60% of all cancers occur after age 65 and therefore immediately affect Baby Boomers more heavily than other generational groups (Berger et al., 2006). Consequently, Baby Boomers will need to pay more attention to and take a more active role in cancer prevention activities, as a result of their reaching an age when cancer is prevalent rather than their being Baby Boomers in particular (LeRouge et al., 2014). Period effects emerge when significant events and broader social movements simultaneously impact all generations. For instance, the abundance of opioid painkillers in the early 2000s made these drugs widely available to all generations (Drug Use Across the Generations, 2014). Cohort effects can be described as the byproduct of the unique historical circumstances that members of a particular generational group experienced that may impact how they form their opinions and attitudes during key moments in their development and even later in life (Yang & Land, 2013). For example, Baby Boomers are known to have led the social upheavals of the 1960s and 1970s, which included a dramatic increase in experimentation with illicit drugs (Cross & Kleinhesselink, 1985; Patterson & Jeste, 1999).

It is for this reason that Baby Boomers may also have higher rates of substance use disorders relative to other generations (Chhatre, Cook, Mallik, & Jayadevappa, 2017; Nogueira et al., 2013; Patterson & Jeste, 1999). On the other hand, illicit drug use in Millennials is down from previous generations according to NIDA's Monitoring the Future survey (Drug Use Trends Remain Stable or Deline Among Teens, 2015). Millennials are also experiencing higher levels of mental health issues, including anxiety and depression, than generations past (Curran & Hill, 2017; Merikangas et al., 2010). It may be for these reasons that Millennials have seemingly turned to prescription medications, including Adderall and opioid painkillers, as an outlet for experimentation or a source of relief. While it may be difficult or even impossible to definitively distinguish cohort effects from age and period effects, it is well accepted that the concerted influence of these factors gives rise to generational trends (Yang & Land, 2013). Moreover, understanding APC effects in general may be essential to designing treatment strategies and bringing about behavioral health-related change.

Large scale, multi-year studies of those receiving substance use disorder treatment are rare, but when such data are available they can help to inform researchers and practitioners about which populations bear a disproportionate burden of disease, which treatment approaches are most effective, and how diverse groups within a population respond to different types of treatments. Administrative data has proven useful for this purpose (for review (Evans, Grella, Murphy, & Hser, 2010)). Luchansky et al. (2000a) used administrative data to analyze factors related to readmission in the state of Washington and Nosyk et al. (2014) used administrative data to examine heroin use disorder treatment utilization and outcomes in the state of California. These authors were not only able to document the continuum of care and its impact on patterns of readmission over time, but were also able to make policy suggestions for improving statewide systems of care and breaking the cycle of substance use disorder (Luchansky, Brown, Longhi, Stark, & Krupski, 2000; Nosyk et al., 2014). Opioid maintenance therapy (OMT) remains the "gold standard" for heroin use disorder treatment. A wealth of literature has demonstrated that it is a practical, effective, and cost-effective approach, but its use continues to generate controversy (for review (Bart, 2012; Connery, 2015)). In fact, in some criminal justice settings OMT is even prohibited as a treatment modality (Friedmann et al., 2012). If and how OMT disparities exist across various populations remains to be fully addressed.

In this study we expand the understanding of heroin use disorder treatment utilization and treatment readmission patterns using data from clients in the state of Maryland. By examining an administrative data set that captures an array of client variables longitudinally, we are able to compare patterns of readmission across generational groups and evaluate how other factors that have been found to be associated with readmission, such as gender, race/ethnicity, and employment status affect these patterns (Li, Sun, Marsh, & Anis, 2008; Luchansky et al., 2000; Mark, Vandivort-Warren, & Montejano, 2006). Together, these descriptive results may be used to begin to inform how treatment protocols and statewide models for care can be tailored to meet the needs of generational groups and populations at large.

## 2. Methods

### 2.1 Data

Data was obtained from the Statewide Maryland Automated Record Tracking (SMART) system, a case management database for individuals receiving substance use disorder treatment within the state of Maryland. The SMART system captures statewide administrative client data from both publically-funded and private treatment providers throughout treatment, from admission until discharge. The information captured is similar to that of the Treatment Episode Data Set (TEDS) public use files; however, SMART links individual-level treatment admission records within and across years via a unique client ID. By doing so, an individual client's multiple admissions and readmissions can be tracked longitudinally. A total of 13,009 treatment admission records from 2007 through 2013 were collected from 5,390 treatment-naïve clients indicating heroin as a primary drug of abuse at their time of initial enrollment. Treatment-naïve clients were defined as those with a first treatment record in the SMART system between 2007 and 2010, who also self-reported no prior treatment for opioid or heroin use disorder. Clients who had heroin use disorder treatment records before 2007, were excluded from the study population. Clients who resided outside of Maryland and who had incarceration or death as their first discharge reason were excluded from the study population. A small number of clients who had missing race/ethnicity data were also excluded from the study population. Data from each client in the study population was collected over four years after first treatment admission. If a new client record appeared in the SMART system after their initial treatment episode (which may have consisted of multiple contiguous treatment enrollments, no greater than a week in between), a treatment readmission was recorded for that client.

### 2.2 Measures

The principal outcome measure in this study was readmission to treatment. For baseline demographic measures, we included gender, race/ethnicity, age at time of initial treatment enrollment, generation, employment status, and geographical region. Some measures, like employment status, varied over time or changed through readmission. In addition, individuals identifying as having some employment were grouped into the employed category. For the purposes of this study, we coded variables as their values at initial treatment enrollment. We also included measures of treatment completion and initial treatment types and intensities, which correspond to the American Society of Use Disorder Medicine (ASAM) levels of care. If a client was discharged from their initial treatment and did not require additional treatment or completed their initial treatment plan and were referred to enroll in additional treatment services, a treatment completion was recorded for that client.

### 2.3 Analyses

For baseline demographic tables, we calculated Pearson chi-square statistics and corresponding p-values for each measure. All analyses employed were two-tailed with a 0.05 threshold for statistical significance. For readmission covariate comparisons, adjusted odds ratios were obtained from logistic regression models. For generational cohort comparisons, we divided all 5,390 clients into three cohorts based on their age at time of

first admission. The Millennial cohort contained 2,769 clients (~born in 1982 to 2000s), the Gen X cohort contained 2,380 clients (~born in 1961 to 1981), and the Baby Boomer cohort contained 241 clients (~born in 1940s to 1960). In addition to the basic multivariate logistic regression, we also ran models with interaction terms between generational cohorts and several control variables. Predicted probabilities were then calculated by converting the log odds scale produced by the regression procedure to a probability scale, along with 95% confidence intervals to test for pairwise significant differences. Plus, the significance of interaction terms was tested by using a Wald Chi-square test, controlling for other covariates. These probabilities were plotted for gender, race, employment and region. All statistical analyses were performed using SAS 9.4 (SAS Institute, Cary, North Carolina).

### 3. Results

#### 3.1 Sociodemographic trends in treatment readmission

A total of 5,390 clients comprised the study population (Table 1). The majority of clients were male (68%,  $n=3,660$ ), most were white (57%,  $n=3,054$ ), more than 50% of clients were Millennials. A large percentage were unemployed (77%,  $n=4,156$ ) and the majority resided in an urban-setting (77%,  $n=4,150$ ). Comparing demographic characteristics by readmission revealed some key differences. 47% of male clients had a readmission within four years, while over 55% of female clients had a readmission in the same time period. Accordingly, readmission frequencies differed significantly based on gender ( $p<0.01$ ). With respect to race, white clients were significantly more likely to have a readmission than their African-American counterparts ( $p<0.01$ ): approximately 55% of white clients had a readmission, while 42% of African-American clients had a readmission.

Notably, generational cohort and age had the most significant effects on readmission ( $p<0.01$ ): Baby Boomers had the lowest levels of readmissions at approximately 29%, and the likelihood of readmission increased stepwise from Gen X (42%) to Millennial (58%) cohorts. Clients that had a readmission also had median and mean ages roughly 8 and 5 years younger than clients who did not, respectively, which further underscored the age and generational cohort effects. Differences in frequencies of readmission based on employment status were also evident. 46% of clients with some employment had a readmission within four years compared to 51% of clients who were unemployed.

#### 3.2. Sociodemographic trends in treatment readmission by generational cohort

To obtain a better understanding of how generational differences may be influencing readmission frequencies, we stratified client characteristics by generational cohort (Table 2). We found that the Millennial cohort was largely driving the gender, race, and employment status effects on readmission. Female Millennial clients were more likely to be readmitted to treatment within four years than their male counterparts or even female and male Gen Xers or Baby Boomers. White Millennials were also the most likely to have a readmission compared to other races/ethnicities both within and across generational groups. Millennials had the highest rate of employment across the generations (28% versus 18% and 11%, respectively) and were more likely to have readmission when unemployed than their Gen X or Baby Boomer counterparts. Interestingly, geographical region only seemed to

significantly affect Gen X clients' rates of readmission ( $p < 0.01$ ). Gen Xers living in an urban setting were significantly more likely to have a readmission than their suburban or rural counterparts. Also of note, Millennials had the largest amount of clients living outside of an urban setting across the generations (32% versus 14% and 8%, respectively). To confirm the moderating effects of gender, race, employment, and region on the likelihood of readmission to treatment in relation to generational cohort we performed multiple logistic regressions, tested interaction terms, calculated and plotted predicted probabilities. While point by point comparisons were similar relative to the findings in Table 2, **only the gender, race, and region x generation interaction terms were found to significantly affect an individual's odds of returning to treatment** (Figure 1).

### 3.3. Initial treatment completion and readmission by treatment type intensity

To determine how the first treatment that clients receive may affect their likelihood of readmission, we tabulated the total initial treatment enrollments, completions, and readmissions of clients across four years by treatment type/intensity (Table 3). **Treatment completion may provide additional insight into readmission as it regarded as positive indicator of treatment success** (Luchansky, He, Krupski, & Stark, 2000; Zarkin, Dunlap, Bray, & Wechsburg, 2002). Out of the total 5,390 initial enrollments, OMT made up the largest portion (27%,  $n=1,468$ ). Intensive outpatient treatment (17%,  $n=911$ ) and medically monitored intensive inpatient detox services (16%,  $n=887$ ) also comprised substantial portions of the total enrollments. **Approximately half of clients who received OMT or intensive outpatient treatment had a readmission within four years. OMT treatment completion was roughly two times greater in clients who had a readmission**, suggesting that poorer retention played a role in this trend. **Outpatient treatment had percentages of client readmissions similar to that of OMT. However, treatment completion was roughly two times greater in clients who did not have a treatment readmission**, which may indicate better treatment success in drug-free treatment settings (Zarkin, Dunlap, Bray, & Wechsburg, 2002). Curiously, of the 457 enrollments in clinically managed high-intensity residential treatment (8% of the population), a striking majority (73%,  $n=334$ ) did not have a readmission within four years. In fact, **clinically managed residential treatments had the lowest percentages of clients with readmission at the aggregate level** (33%,  $n=215$ ) with only modest differences in treatment completion. **Conversely, detox services had the largest percentages** of clients with readmission at the aggregate level (58%,  $n=750$ ), again with only modest differences in treatment completion.

### 3.4. Initial treatment completion and readmission by treatment type/intensity and generational cohort

To ascertain if there were any disparities in utilization of treatment types/intensities across generational cohorts, we again tabulated the total initial treatment enrollments, completions, and readmissions of clients for four years across generations by treatment type/intensity. Tables 4A, B, and C present this data for Millennial, Gen X, and Baby Boomer cohorts, respectively. **OMT was most widely used in Millennials at approximately 33% of all initial treatment enrollments**. OMT utilization decreased stepwise from Gen X (21%) to Baby Boomer (17%) cohorts. However, the **likelihood of readmission following an initial OMT enrollment** oddly decreased when moving across generations from Millennials to Baby



Boomers (54% to 38% to 32%, respectively). OMT treatment completion in clients that did not experience a readmission was relatively static across generations at 4%, but increased across generations from Millennials to Baby Boomers in clients who had a readmission (7% to 11% to 15%, respectively). Intensive outpatient treatment was the most widely used initial treatment in Gen Xers (22%) and Baby Boomers (28%) with no noticeable differences in treatment completion between clients who did and did not experience a readmission. While relative numbers of enrollments in clinically managed high-intensity residential treatment were small, rates of readmission remained low across all generations with modest differences in treatment completion between clients who had and did not have a readmission. However, Gen X clients were over two times more likely to receive this treatment compared to their generational counterparts. At the aggregate level, detox services comprised a large portion of Millennial clients' initial enrollments (27%,  $n=743$ ), but had the highest rates of readmission (66%) relative to other generational cohorts (52% in Gen X clients and 32% in Baby Boomer clients) with modest differences in treatment completion. At the aggregate level, behavioral outpatient interventions comprised the largest portion of Gen X and Baby Boomer clients' initial enrollments (34% and 42%, respectively) and were associated with both lower rates of readmission and higher rates of completion relative to Millennial clients.

### 3.5. Logistic regression analysis of treatment readmission

To determine what client variables most significantly affected the likelihood of overall treatment readmission we constructed a logistic regression model with data from the entire study population (odds ratios on Table 1). Female clients were 17% more likely to experience readmission than were male clients (odds ratio of 1.17). Ethnicity had varying effects on readmission. African-Americans were less likely to have a readmission than white clients (odds ratio of 0.84), while Hispanics were more likely to be readmitted than non-Hispanic clients (odds ratio of 1.57). Millennials were almost two and three times more likely to experience a readmission than Gen X or Baby Boomer clients, respectively (odds ratios of 0.60 and 0.34). Unemployed clients had higher odds (1.37) of readmission compared to clients with some employment. Finally, clients residing in urban settings had a higher chance of readmission (1.23) compared to clients living in rural areas.

## 4. Discussion

The most significant and striking sociodemographic trend we observe this study is that client readmission patterns are age and generational cohort-dependent. The younger a client is at the time of their first treatment admission for heroin use disorder, the more likely they are to return to treatment. This trend is supported by a number of studies identifying age of onset of drug use as a key factor in persistent drug use later in life (Bergen-Cico & Lape, 2013; Chalana, Kundal, Gupta, & Malhari, 2016; Naji et al., 2017). It may also be supported through work investigating age of first use disorder treatment as a predictor of future patterns of use disorder (Chi et al., 2014; Evans, Li, Grella, Brecht, & Hser, 2013). However, interpretation of these findings may be confounded by the fact that portions of Gen X and Baby Boomer clients report previous use disorders with other non-opioid substances. Furthermore, it may be impossible to separate age from cohort effects in this study. Our

most significant sociodemographic trends in readmission are exhibited by both young (<35 year of age) and Millennial clients. An interesting phenomenon we do observe is a steep drop in the rate of readmission between clients aged 15-24 years and 25-34 years. One explanation may be that clients aged 15-24 years fall entirely within the Millennial cohort, whereas there are a mixture of Millennial and Gen X clients in the 25-34 age range. A deeper APC analysis with a larger longitudinal data set will be needed in future studies to establish more definitive age, period, and cohort effects with regard to heroin use disorder treatment readmission.

On the surface, this study confirms what a number of sources have reported regarding the current opioid crisis that: **the bulk of drug users comprising the opioid epidemic are young, male, and white** (Drug-and Alcohol-Related Intoxication Deaths in Maryland, 2016, 2017; Drug Overdose Deaths in the United States, 1999-2015, 2017). While our study population is largely comprised of male clients, reflecting that the opioid epidemic disproportionately affects men, it appears that Millennial female clients are most likely to return to treatment. This finding generally dovetails well with evidence from a growing number of studies investigating gender differences in opioid use disorders (Back et al., 2011; Campbell et al., 2010; Haifeng et al., 2015; Holdcraft & Iacono, 2004). Specifically, **women are more likely to be over-prescribed opioids and more rapidly progress from use to dependence than men** (Back et al., 2011). Women also **tend to underutilize treatment overall** (Back et al., 2011), which may partially explain why men outnumber women two-to-one in our study population. **Women may also face harsher external pressures to return to treatment and may be more compliant with treatment recommendations.** However, female Gen X and Baby Boomer clients do not exhibit this same pattern. Clearly, there appear to be important APC effects at play with regard to gender that merit further investigation.

Historically, in Maryland, heroin use disorder has been seen predominantly as a problem of poor, African-American men and women living in large urban areas such as Baltimore (Agar & Reisinger, 2002; Durrant & Thakker, 2003). This view is potentially borne out in the Gen X and Baby Boomer clients, who largely reside in these urban settings. However, **in recent years the racial disparity in heroin use disorder has shifted towards young white men and women who live not only in large metropolitan areas, but also suburban and rural settings.** There are 27% more white clients in our study population than African-American, which is even more marked between generational cohorts and underscores the **recent shift in racial disparity. White Millennials in treatment exceed that of their African-American counterparts by a factor of seven, whereas the number of African-American Gen Xers and Baby Boomers is three times greater than that of their white counterparts.** Furthermore, Millennial clients are the only population to be significantly more likely to be readmitted to treatment than their African-American counterparts within the same four-year period. One possibility for these racial differences may be due to the **lower rates that African-American patients are prescribed opioids for chronic pain management** (Hoffman, Trawalter, Axt, & Oliver, 2016; Singhal, Tien, & Hsia, 2016). Consequently, **African-Americans may have had, and likely still have, a more difficult path to obtaining gateway opioids.**

Another interesting sociodemographic trend exhibited only in the Millennial cohort was that clients who were **unemployed were more likely to return to treatment** than those that were



employed. It may be that clients that are unemployed face stressful financial hardship and have more unstructured free time, both of which elevate their risk of drug use (Badel & Greaney, 2013). There are also well-documented barriers to employment for unemployed drug users and should unemployment persist, then obtaining gainful employment can become more difficult as clients age (Sigurdsson, Ring, O'Reilly, & Silverman, 2012). It remains unclear why Gen X and Baby Boomer clients do not exhibit this same trend, though. Furthermore, the moderating effect of employment status on the overall likelihood of returning to treatment failed to reach significance. Future studies may need to categorize employment status in greater detail (fulltime, part-time, retired, etc.) to fully address how it influences readmission to treatment.

Despite the abundance of studies supporting the effectiveness of OMT, its use accounts for only 28% of our study population. However, it is by far the most frequently used initial treatment in our population, especially by the Millennial cohort. Roughly half of all clients who receive OMT return to treatment within four years. Ideally, a heroin use disorder client would remain on OMT for long periods of time, if not indefinitely, as many clients are unable to taper off and retain positive biological and behavioral health gains. The trends we see in OMT treatment completion would support this view as higher rates of completion go hand-in-hand with higher rates of readmission. Furthermore, the average time in treatment for clients receiving OMT in our study population is approximately 8 months, while the average time in OMT for clients who do not experience a readmission is about 20 months (data not shown). Millennials actually have the shortest retention and the largest percentage of discharged incomplete OMT treatments (roughly 72%) in our study population (data not shown). Taken together, these findings would suggest that there is a substantial avoidance to this treatment modality in Millennial clients, but to a lesser degree in Gen X and Baby Boomer clients. Millennial clients may also exhibit avoidance to detoxification services and potentially poorer outcomes, too. More than half of Millennial clients receiving an initial enrollment in detoxification services return for another round within four years and on average these clients return for approximately two rounds (data not shown). As evidenced elsewhere (Nosyk et al., 2014), the likelihood of successful treatment completion diminishes as detoxification episodes progress. Gen X and Baby Boomer clients are somewhat spared this phenomenon in our study population.

OMT is not the only treatment modality with marked generational differences. Outpatient treatment services are by far the most frequently used initial treatment in Gen X and Baby Boomer clients. The prevalence of readmission in these cohorts is also lower and treatment completion higher than that of the Millennial cohort. Clinically managed high-intensity residential treatment yields the lowest rates of readmission across all generational cohorts possibly due to the greater level of counselor-patient engagement and services that are available to clients in this modality. While medically monitored intensive inpatient treatment also offers similar, albeit greater, levels of care, clinically managed high-intensity residential treatment has the highest rates of treatment completion (over 75%) in our study population.

#### 4.1. Limitations

The advantages of our dataset (data collected from multiple sources across racial/ethnic, geographic, and generational lines), we believe, provide a great deal of insight into treatment patterns exhibited by heroin use disorder clients. However, there are some limitations. Notwithstanding the clear generational trends presented here, a very important data limitation still looms: without clinical context, it may be hard to rely too much on treatment readmission data as an indicator of client outcomes. Readmission by itself may not be a good indicator of program performance and outcome (Humphreys & Weingardt, 2000). Readmission may indicate that a client is recruiting help and support for their ongoing heroin use disorder, which would be a positive outcome as engagement and retention are favorable predictors of treatment success (for review (Stark, 1992)). Conversely, it could mean that a client has returned to previous patterns of heroin use and has been remanded to treatment. In this study, we look at initial treatment completion status to provide some context to readmission, but define treatment completion more broadly than other studies, where treatment completion may be defined by the final discharge at the end of a treatment episode. Biological and behavioral health outcomes and measures of quality of life and social functioning would add even more context. Future studies, in collaboration with clinicians working in this area, are currently underway to build on these results and address the questions surrounding treatment readmission and its relation to completion, retention, and outcome across generations.

Additionally, our data source only captures treatment provided at publically-funded treatment providers within Maryland. If a client moved out of state, was incarcerated, or died while not in treatment, our data source would not capture this information. Using Maryland data also limits the generalizability of our findings. There is also a potential for conflated drug treatment records across individuals with a common unique identifier in our study population. However, during the construction of our population, a number a data management rules were implemented to minimize client misclassification during the de-identification process. Our analysis also depends on self-reported data for client characteristics. Another potential limitation is that we only examine the influence of a client's first treatment admission. Clients are often admitted to multiple modalities in succession during a treatment episode. It is possible that a client's first treatment is brief and therefore had little impact on readmission relative to subsequent treatment admissions during a single episode. At the same time, over 50% of our study population that experience a readmission return to the same exact treatment modality and about 60% return to the same level of care. Despite these limitations, we do believe that these data are unusually detailed, and provide us with the best available information on the individual-level characteristics and treatment details, over time, of those undergoing treatment for heroin use over the course of several years.

#### 5. Conclusions

We find important generational patterns in heroin use, treatment, and readmission rates among clients undergoing treatment for heroin use disorder. Millennials bear the brunt of the current opioid epidemic and present a changing landscape of heroin use with regard to

gender, race/ethnicity, employment, and urban living. Millennials also utilize OMT as the first means of treatment to a higher degree than other generations. Concomitantly, Millennials have the poorest treatment retention and highest rates of OMT readmission in our study population. Older generations are more likely to engage in behavioral interventions as their primary treatment, but still exhibit less treatment readmission and avoidance across multiple treatment modalities than Millennials. These findings imply that **generational characteristics may predict how clients engage and respond to various treatment modalities and that treatment strategies and health policies would benefit from considering such factors.**

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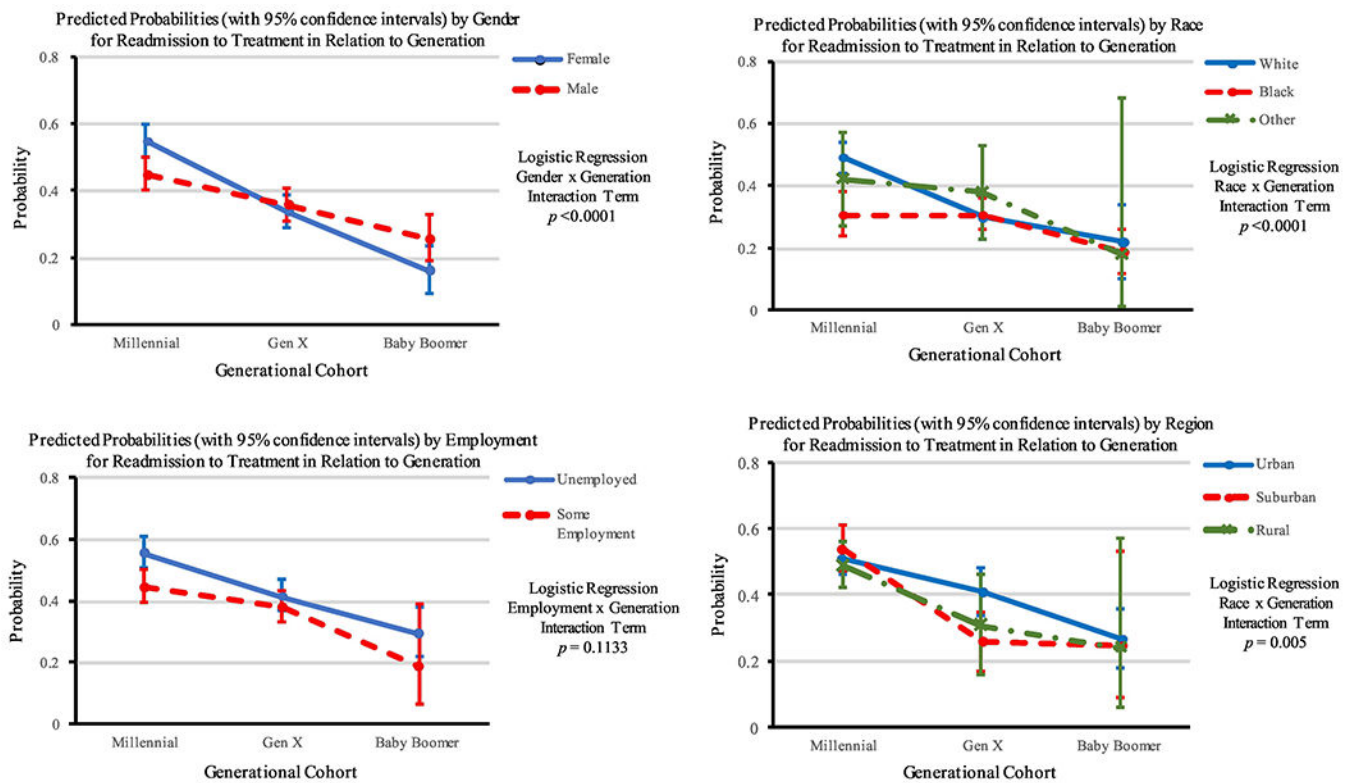
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### Highlights

- The bulk of clients receiving heroin addiction treatment in Maryland from 2007-2013 were Millennials and present a changing landscape of treatment readmission with regard to gender, race/ethnicity, employment, and urban living.
- The risk of all client treatment readmission in our client population was age and generational cohort-dependent; the younger a client was at admission, the more likely they were to return to treatment.
- Millennial clients most often received opioid maintenance therapy (OMT) as their initial treatment, but evidenced more treatment avoidance and readmission to treatment than Gen X or Baby Boomer clients.
- Gen X and Baby Boomer clients most often received behavioral interventions as their initial treatment, but still exhibited lower rates of treatment readmission across multiple modalities when compared to Millennial clients.
- Taken together, our findings suggested that generational characteristics are an important part of use patterns and treatment readmission





**Fig. 1.** Predicted probabilities of readmission by gender, race, employment, and region across generations.

**Table 1**

Client sociodemographic characteristics relative to treatment readmission.

Measure	All Clients (N=5390)	Clients without treatment readmission within 4 years (n=2793)	Clients with treatment readmission within 4 years (n=2597)	Chi- square p- value	Adjusted Odds Ratio with 95% Confidence Interval	
Gender				< 0.01		
Male	3660	1999 (54.62%)	1661 (45.38%)			
Female	1730	794 (45.90%)	936 (54.10%)		1.20 (1.07, 1.36)	*
Race				< 0.01		
White	3054	1412 (46.23%)	1642 (53.77%)			
Black or African American	2220	1326 (59.73%)	894 (40.27%)		0.77 (0.67, 0.89)	*
Asian or Pacific Islander	25	12 (48.00%)	13 (52.00%)		0.95 (0.42, 2.10)	
Native American	22	10 (45.45%)	12 (54.55%)		1.11 (0.47, 2.60)	
Other	69	33 (47.83%)	36 (52.17%)		0.88 (0.51, 1.49)	
Ethnicity				0.02		
Hispanic	111	45 (40.54%)	66 (59.46%)		1.55 (1.02, 2.38)	*
Not Hispanic	5279	2748 (52.06%)	2531 (47.94%)			
Generation				< 0.01		
Millennial	2769	1211 (43.73%)	1558 (56.27%)			
Gen X	2380	1409 (59.20%)	971 (40.80%)		0.60 (0.52, 0.69)	**
Baby Boomer	241	173 (71.78%)	68 (28.22%)		0.34 (0.25, 0.46)	**
Age (Years)				< 0.01		
15 - 24	1467	557 (37.97%)	910 (62.03%)			
25 - 34	1302	654 (50.23%)	648 (49.77%)			
35 - 44	1409	795 (56.42%)	614 (43.58%)			
45 - 54	971	614 (63.23%)	357 (36.77%)			
55 - 64	223	159 (71.30%)	64 (28.70%)			
65 - 74	18	14 (77.78%)	4 (22.22%)			
Age (Median)	34.00	37.00	29.00			
Age (Mean)	34.53	36.72	32.17			
Employment Status				< 0.01		
Some Employment	1234	686 (55.59%)	548 (44.41%)			
Unemployed	4156	2107 (50.70%)	2049 (49.30%)		1.41 (1.23, 1.61)	**
Region				0.78		
Rural	750	381 (50.80%)	369 (49.20%)			
Suburban	490	251 (51.22%)	239 (48.78%)		1.07 (0.85, 1.36)	
Urban	4150	2161 (52.07%)	1989 (47.93%)		1.24 (1.05, 1.45)	*

\* adjusted odds ratio significant with  $p < 0.05$ ,

\*\* very significant with  $p < 0.0001$

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**Table 2.** Client sociodemographic characteristics relative to treatment readmission across generations.

Measure	Millennial Cohort				Gen X Cohort				Baby Boomer Cohort			
	Total (N=2769)	Without readmission within 4 years (n=1211)	With readmission within 4 years (n=1558)	Chi- square p-value	Total (N=2380)	Without readmission within 4 years (n=1409)	With readmission within 4 years (n=971)	Chi- square p-value	Total (N=241)	Without readmission within 4 years (n=173)	With readmission within 4 years (n=68)	Chi- square p-value
Gender				< 0.01				0.50				0.17
Male	1634	786 (48.10%)	848 (51.90%)		1834	1079 (58.83%)	755 (41.17%)		192	134 (69.79%)	58 (30.21%)	
Female	1135	425 (37.44%)	710 (62.56%)		546	330 (60.44%)	216 (39.56%)		49	39 (79.59%)	10 (20.41%)	
Race				< 0.01				0.28				0.91
White	2367	985 (41.61%)	1382 (58.39%)		648	400 (61.73%)	248 (38.27%)		39	27 (69.23%)	12 (30.77%)	
Black or African American	334	195 (58.38%)	139 (41.62%)		1687	987 (58.51%)	700 (41.49%)		199	144 (72.36%)	55 (27.64%)	
Asian or Pacific Islander	19	8 (42.11%)	11 (57.89%)		6	4 (66.67%)	2 (33.33%)		0	0 (0.0%)	0 (0.0%)	
Native American	10	4 (40.00%)	6 (60.00%)		12	6 (50.00%)	6 (50.00%)		0	0 (0.0%)	0 (0.0%)	
Other	39	19 (48.72%)	20 (51.28%)		27	12 (44.44%)	15 (55.56%)		3	2 (66.67%)	1 (33.33%)	
Ethnicity				0.33				0.14				0.04
Hispanic	71	27 (38.03%)	44 (61.97%)		36	17 (47.22%)	19 (52.78%)		4	1 (25.00%)	3 (75.00%)	
Not Hispanic	2698	1184 (43.88%)	1514 (56.12%)		2344	1392 (59.39%)	952 (40.61%)		237	172 (72.57%)	65 (27.43%)	
Employment Status				< 0.01				0.30				0.28
Some Employment	770	396 (51.43%)	374 (48.57%)		438	269 (61.42%)	169 (38.58%)		26	21 (80.77%)	5 (19.23%)	
Unemployed	1999	815 (40.77%)	1184 (59.23%)		1942	1140 (58.70%)	802 (41.30%)		215	152 (70.70%)	63 (29.30%)	
Region				0.36				< 0.01				0.95

Measure	Millennial Cohort				Gen X Cohort				Baby Boomer Cohort			
	Total (N=2769)	Without readmission within 4 years (n=1211)	With readmission within 4 years (n=1558)	Chi- square p-value	Total (N=2380)	Without readmission within 4 years (n=1409)	With readmission within 4 years (n=971)	Chi- square p-value	Total (N=241)	Without readmission within 4 years (n=173)	With readmission within 4 years (n=68)	Chi- square p-value
Rural	562	256 (45.55%)	306 (54.45%)		180	119 (66.11%)	61 (33.89%)		8	6 (75.00%)	2 (25.00%)	
Suburban	332	135 (40.66%)	197 (59.34%)		146	107 (73.29%)	39 (26.71%)		12	9 (75.00%)	3 (25.00%)	
Urban	1875	820 (43.73%)	1055 (56.27%)		2054	1183 (57.59%)	871 (42.41%)		221	158 (71.49%)	63 (28.51%)	

**Table 3.**

Client treatment characteristics and outcomes relative to readmission.

Treatment Type	Total Initial Treatment Enrollment (N=5390)		No Readmission Within 4 Years (n=2793)		Readmission Within 4 Years (n=2597)	
	Count	% Completion	Count	% Completion	Count	% Completion
I OMT -Opioid maintenance therapy	1468	6.13%	783 (53.34%)	4.34%	685 (46.66%)	8.18%
II.1 - Intensive outpatient treatment	911	35.57%	489 (53.68%)	38.24%	422 (46.32%)	32.46%
III.7-D - Medically monitored intensive inpatient detoxification services	887	70.91%	363 (40.92%)	71.07%	524 (59.08%)	70.80%
I - Outpatient treatment	648	29.01%	369 (56.94%)	36.04%	279 (43.06%)	19.71%
III.5 - Clinically managed high-intensity residential treatment	457	62.14%	334 (73.09%)	64.97%	123 (26.91%)	54.47%
III.7 - Medically monitored intensive inpatient treatment	383	68.93%	156 (40.73%)	73.72%	227 (59.27%)	65.64%
I-D - Outpatient ambulatory detoxification	224	83.48%	98 (43.75%)	84.69%	126 (56.25%)	82.54%
III.1/III.3 - Clinically managed medium/low-intensity residential treatment	190	50.53%	98 (51.58%)	52.04%	92 (48.02%)	48.91%
II-D - Intensive outpatient detoxification services	142	41.55%	63 (44.37%)	36.51%	79 (55.63%)	45.57%
OMT-D - Opioid maintenance therapy-detoxification	47	6.38%	26 (55.32%)	3.85%	21 (44.68%)	9.52%



Table 4.

Client treatment characteristics and outcomes relative to readmission across generations.

A. Millennial Cohort						
Treatment Type	Total Initial Treatment Enrollment (N=2769)		No Readmission Within 4 Years (n=1211)		Readmission Within 4 Years (n=1558)	
	Count	% Completion	Count	% Completion	Count	% Completion
I OMT -Opioid maintenance therapy	922	5.64%	439 (47.61%)	4.33%	483 (52.39%)	6.83%
II.1 - Intensive outpatient treatment	331	30.82%	155 (46.83%)	35.48%	176 (53.17%)	26.70%
III.7-D - Medically monitored intensive inpatient detoxification services	528	67.80%	178 (33.71%)	69.10%	350 (66.29%)	67.14%
I - Outpatient treatment	310	25.81%	146 (47.10%)	34.25%	164 (52.90%)	18.29%
III.5 - Clinically managed high-intensity residential treatment	145	54.48%	110 (75.86%)	57.27%	35 (24.14%)	45.71%
III.7 - Medically monitored intensive inpatient treatment	202	66.34%	55 (27.23%)	74.55%	147 (72.77%)	63.27%
I-D - Outpatient ambulatory detoxification	90	84.44%	26 (28.89%)	88.46%	64 (71.11%)	82.81%
III.1/III.3 - Clinically managed medium/low-intensity residential treatment	87	47.13%	37 (42.53%)	45.95%	50 (57.47%)	48.00%
II-D - Intensive outpatient detoxification services	88	35.23%	36 (40.91%)	30.56%	52 (59.09%)	38.46%
OMT-D - Opioid maintenance therapy-detoxification	37	5.41%	17 (45.95%)	5.88%	20 (54.05%)	5.00%
B. Gen X Cohort						
Treatment Type	Total Initial Treatment Enrollment (N=2380)		No Readmission Within 4 Years (n=1409)		Readmission Within 4 Years (n=971)	
	Count	% Completion	Count	% Completion	Count	% Completion
I OMT -Opioid maintenance therapy	506	6.92%	317 (62.65%)	4.42%	189 (37.35%)	11.11%
II.1 - Intensive outpatient treatment	513	37.04%	284 (55.36%)	38.03%	229 (44.64%)	35.81%
III.7-D - Medically monitored intensive inpatient detoxification services	327	75.23%	160 (48.93%)	72.50%	167 (51.07%)	77.84%
I - Outpatient treatment	303	30.36%	194 (64.03%)	35.57%	109 (35.97%)	21.10%
III.5 - Clinically managed high-intensity residential treatment	300	65.33%	215 (71.67%)	68.37%	85 (28.33%)	57.65%
III.7 - Medically monitored intensive inpatient treatment	172	72.09%	96 (55.81%)	72.92%	76 (44.19%)	71.05%
I-D - Outpatient ambulatory detoxification	110	82.73%	56 (50.91%)	83.93%	54 (49.09%)	81.48%

<b>A. Millennial Cohort</b>						
<b>Treatment Type</b>	<b>Total Initial Treatment Enrollment (N=2769)</b>		<b>No Readmission Within 4 Years (n=1211)</b>		<b>Readmission Within 4 Years (n=1558)</b>	
	<b>Count</b>	<b>% Completion</b>	<b>Count</b>	<b>% Completion</b>	<b>Count</b>	<b>% Completion</b>
III.1/III.3 - Clinically managed medium/low-intensity residential treatment	89	56.18%	55 (61.80%)	58.18%	34 (38.20%)	52.94%
II-D - Intensive outpatient detoxification services	46	52.17%	21 (45.65%)	42.86%	25 (54.35%)	60.00%
OMT-D - Opioid maintenance therapy-detoxification	10	10.00%	9 (90.00%)	0.00%	1 (10.00%)	100.00%
<b>C. Baby Boomer Cohort</b>						
<b>Treatment Type</b>	<b>Total Initial Treatment Enrollment (N=241)</b>		<b>No Readmission Within 4 Years (n=173)</b>		<b>Readmission Within 4 Years (n=68)</b>	
	<b>Count</b>	<b>% Completion</b>	<b>Count</b>	<b>% Completion</b>	<b>Count</b>	<b>% Completion</b>
I OMT -Opioid maintenance therapy	40	7.50%	27 (67.50%)	3.70%	13 (32.50%)	15.38%
II.1 - Intensive outpatient treatment	67	47.76%	50 (74.63%)	48.00%	17 (25.37%)	47.06%
III.7-D - Medically monitored intensive inpatient detoxification services	32	78.13%	25 (78.13%)	76.00%	7 (21.87%)	85.71%
I - Outpatient treatment	35	45.71%	29 (82.86%)	48.28%	6 (17.14%)	33.33%
III.5 - Clinically managed high-intensity residential treatment	12	75.00%	9 (75.00%)	77.78%	3 (25.00%)	66.67%
III.7 - Medically monitored intensive inpatient treatment	9	66.67%	5 (55.56%)	80.00%	4 (44.44%)	50.00%
I-D - Outpatient ambulatory detoxification	24	83.33%	16 (66.67%)	81.25%	8 (33.33%)	87.50%
III.1/III.3 - Clinically managed medium/low-intensity residential treatment	14	35.71%	6 (42.86%)	33.33%	8 (57.14%)	37.50%
II-D - Intensive outpatient detoxification services	8	50.00%	6 (75.00%)	50.00%	2 (25.00%)	50.00%