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# Review of Age-Related Trends of Infection Among People Hospitalized Hospitalized for Infection with Concurrent Substance Use

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**Review of Age-Related Trends of Infection Among People Hospitalized  
for Infection with Concurrent Substance Use**

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Honors-in-Major Thesis

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### Abstract

**Background:** Opioids and related injection are the most common drug associated with infection (Capizzi et al., 2020). Overall, data overwhelmingly shows infection and overdose rates on the rise in recent years (Kaiser Family Foundation, 2019).

**Methods:** The aim of this study was to identify trends between age and concurrent infection rates related to substance use from 2012 to 2019. This quantitative study utilized data from the NH Hospital Discharge Summaries (Office of Health Statistics, 2021). Specifically, trends among three age groups (young adults (18-34), middle-aged (35-54), and older adults (55+)) who were admitted to an inpatient unit or the emergency department (ED) for both an infection and substance use were analyzed.

**Results:** All age groups (inpatient and ED) saw an overall increase in rates of infection from 2012 to 2019. Inpatient and emergency department findings were similar. Young adults consistently have the highest rates of infection, middle-aged adults had the highest increase in infection rates over the years, and older adults had the lowest rates.

**Discussion:** The findings presented are extremely concerning for all age groups. Age specific interventions should be put in place for all age groups to help decrease substance use and provide help to those suffering from addiction (US Department of Health and Human Services, 2016).

**Conclusion:** There has been a significant increase in infection rates related to substance use among all age groups (Office of Health Statistics, 2021). The findings presented are concerning for the state of NH as hospital admissions for infection rise. Continued monitoring of substance use and infection rates should be recorded, as this data has not been used in monitoring the

opioid epidemic. Noting patterns in this data may allow for improved interventions to lower substance misuse and overdose. NH should focus on offering age-specific interventions and resources to help decrease opioid use which would lead to fewer infections and fewer deaths (US Department of Health and Human Services, 2016).

## **Review of Age-Related Trends of Infection Among People Hospitalized Hospitalized for Infection with Concurrent Substance Use**

### **Introduction**

The United States has been devastated by an overwhelming opioid crisis throughout the last decades that has impacted all states, especially New Hampshire. New Hampshire currently ranks number two for opioid-related deaths relative to its population (Recovery Worldwide, 2021). People with substance use disorder are increasingly at risk for death as overdose rates are increasing throughout the COVID-19 pandemic, with synthetic opioids being the leading drug of overdose (Centers for Disease Control, 2021). Research shows rates of bacterial infections are increasing steadily as well. The increase in drug use is taking a heavy toll on the nation and has even caused an overall decrease in the United States' overall life expectancy (Glei & Preston, 2020).

Since 2015, there has been a sharp increase in opioid use across New Hampshire. In 2015, over 400 people in New Hampshire died of a drug overdose. That number was 2.5 times the number of overdose deaths in 2011 (New Hampshire Department of Health and Human Services, 2016). The repercussions of this epidemic are detrimental, leading not only to deaths, but increased rates of infection, abuse, unemployment, liver disease, and heart disease (NH Department of Health and Human Services, 2016). More data must be collected to help address this issue that affects so many across the state.

Opioids and related injections are the most common drug associated with infection (Capizzi et al., 2020). Overall, data overwhelmingly shows infection and overdose rates on the rise in recent years (Kaiser Family Foundation, 2019). A study published by Oxford University

Press examined the number of bacterial infections associated with substance use disorders from the years 2012 to 2017. This study found that for opioid users aged 18-44 years old, infective endocarditis hospitalizations more than doubled from 2012 to 2017 (McCarthy et al., 2020). A similar study found that from 2000 to 2013 young adults (age 15-34) hospitalizations for endocarditis increased from 27.7% to 42% (Wurcel et al., 2016). Another study surveyed incidences of sepsis in those hospitalized with opioid use disorder. Using data from United States hospitalizations from 2009 to 2013, The Society of Critical Care Medicine found that one in three patients who were coded for opioid use disorder died from sepsis (Martin, 2020). These findings are extremely concerning for this vulnerable population. A deeper dive into the correlation between substance use and concurrent infection in relation to age is needed as the adverse effects of substance use increase.

### **The Cost of Substance Misuse**

As rates of substance use and infection rise, so does the cost of care. Treating opioid use-related infection is costly and places a financial strain on patients and the healthcare system. One study found that charges for inpatient hospitalizations related to opioid misuse quadrupled from 2002 to 2012 with costs rising to 15 billion dollars in 2012 (Ronan & Herzig, 2016). Common infections related to intravenous drug use that require intensive treatment include endocarditis and sepsis. The cost of care for one patient with endocarditis is roughly \$50,000. According to the Centers for Disease Control, the total cost of treatment of endocarditis associated with drug use increased eighteen-fold from 2010 to 2015 (Fleischhauer et al., 2017). Sepsis also comes with a great cost and the United States spent 27 billion dollars on treating sepsis in a single year (Kuklick et al., 2020). Treating these drug-related infections places great strain on the patient and family, the hospital, and the country. A study done in Florida found that a single hospital in the

United States spent 11.4 million dollars for the treatment of bacterial infections (endocarditis, bacteremia or sepsis, osteomyelitis, and skin and soft tissue infections) directly related to drug injection (Tookes et al., 2015). As younger people are hospitalized earlier and develop health issues sooner in life, chronic care is needed for longer periods of time and leads to increased costs. Decreasing rates of intravenous opioid use and infection would save individuals and the country large quantities of money annually.

### **Trends in Opioid Misuse by Age**

*Young Adult Population & Opioid Misuse.* The United States Healthcare system is lacking prevention and supportive measures for young adult substance users. Gaps in care are prevalent for youths in transitional periods as they age (NIDA, 2020). There is a glaring lack of support young adults receive and many barriers to care they face when dealing with intravenous opioid use (Uchitel et al., 2019). Research shows adolescents (12-17 years old) and young adults (18-25 years old) are at the highest risk for opioid use (Strain, 2021). Brain development in adolescence and young adult years prevents them from making fully informed decisions regarding substance use (Jiloha, 2017). One retrospective study done by the National Survey on Drug Use and Health found that adolescents and young adults are more likely to misuse opioids when compared to older age groups. The study found that the prevalence of opioid misuse was 3.8% among adolescents and 7.8% among young adults (Hudgins, 2019). Opioid misuse leaves this population at high risk of infection and overdose (Hudgins, 2019). JEMA Network Open found that opioid overdose is up 320% in young people in Toronto. Understanding substance use in young adults and implementing tailored interventions can support a healthy transition into adulthood and prevent drug misuse and overdose (OPI, 2020).

***Middle-aged Population & Opioid Misuse.*** Studies show that middle-aged Americans are falling victim to the opioid crisis as well. In 2019, there were 22,440 opioid-related deaths in the United States for people aged 35-54. This is a stark rise since 2015 when 16,052 opioid-related deaths occurred (Kaiser Family Foundation, 2019). The tragedies of this disease are leaving middle-aged adults with physical health issues, mental health changes, and suicidal thoughts. Middle-aged adults who misuse opioids are ten times more likely to have suicidal thoughts than those who do not use (Perlman, 2019). The rise in substance misuse and addiction in this population has also been linked to an increased diagnosis of depression (Perlman, 2019). Upon researching health databases, little research was available for this age group. Targeting interventions to address the dilemmas of overprescribing to this age group and increasing mental health support could greatly benefit middle-aged adults from substance use and its adverse effects (SAMHSA, 2020).

***Older Adults & Opioid Misuse.*** Older adults are a vulnerable population through economic, social, and cognitive factors (Senior First, 2022). The population of older adults in the United States is expected to grow to 77 million by 2035 and will outnumber children, young adults, and middle-aged adults (Vespa, 2018). Unfortunately, a large portion of this population suffers from substance misuse. One million older adults were reported to have a substance use disorder in the year 2018 (NIDA, 2020). This concerning number is only projected to continue rising. From the years 2012 to 2017, the percentage of opioid use rose by 143.5% (Kaiser Family Foundation, 2019). In 2019, people aged 55 and over accounted for 19% of opioid-related deaths with 9,290 deaths. Retirement, increased opioid prescriptions, grieving of loved ones, feeling a loss of independence and purpose, and increased solitude place this age group at heavy risk for addiction (NIDA, 2020). Regardless of the high rates of substance misuse, the state of New



Hampshire reports only 24% of those with substance misuse sought treatment in 2018.

Nationally, older adults have a lower rate of substance misuse than their younger counterparts, but proportionally they have the lowest rate of treatment (NIDA, 2020).

### **Aims**

Knowing which New Hampshire age groups are most vulnerable to substance misuse and consequently at increased risk for infection is crucial so age-specific interventions can be introduced appropriately. The Substance Abuse and Mental Health Services administration has acknowledged that creating targeted interventions based on the characteristics of the population can increase the effectiveness of the interventions applied (SAMHSA, 2021). For this reason, collecting data and analyzing trends regarding specific characteristics of the population will assist in the creation of evidence-based interventions to best assist these vulnerable populations. To address this gap, this study was aimed at identifying trends between age and concurrent infection rates related to substance use from 2012 to 2019.

### **Methodology**

The study was conducted using a hospital discharge data set collected from hospitals in New Hampshire regarding substance use, concurrent infection rates, and age. The sample included people who visited a hospital in New Hampshire and had a code for infection and opioid use throughout their hospital stay. The age range in years was 18 to 85 plus. The goal was to obtain data regarding the trends of concurrent opioid-associated infections with age. Through quantitative analysis, the numbers of infections with age were trended so relationships could be visualized.

Data was requested from the Hospital Discharge Database for concurrent opioid and infection related encounters. These data included information from 2012 to 2019 regarding injecting related bacterial infections, age, and inpatient and emergency department admissions for every patient admitted with ICD-9/ 10 diagnosis codes for both an infection and substance use. To analyze this database, the numbers of opioid use/abuse and concurrent infections were compared from the years 2012 to 2019. The sample includes drug users in New Hampshire aged 18 to 85 plus who were either seen in the emergency department or admitted to the hospital for infection related to opioid use. The study aimed to identify how the population of substance users in New Hampshire were being affected by rates of infection by age group. By identifying which age group is increasingly at risk for opioid-related infections including skin infection, cellulitis abscess, endocarditis, septic bacteremia, septic arthritis, osteomyelitis, and other infections over the recent years.

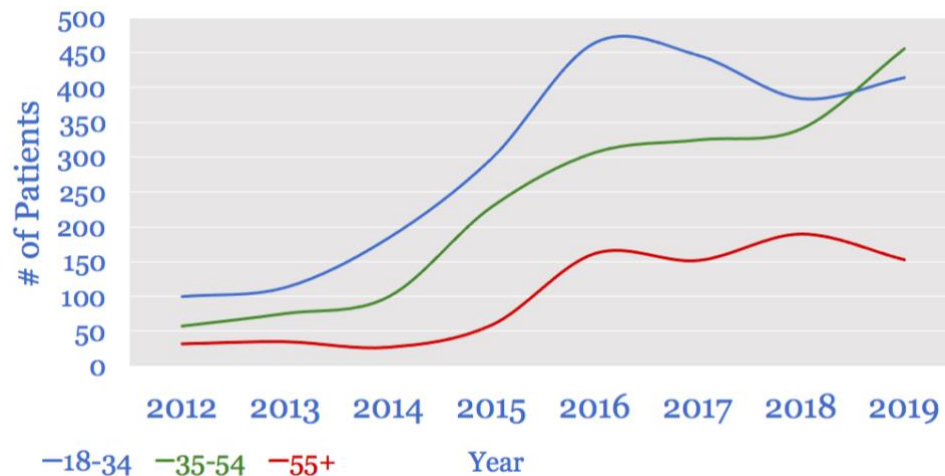
### **Analysis**

Data from the Hospital Discharge Summaries for concurrent substance use and infection was organized into age-appropriate categories. For the years 2012 to 2019 summaries of cases of admissions for opioid related codes (opioid abuse/use/dependence/poisoning and adverse effects of opioid) with concurrent infection by the following age groups 18-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, 85+ were individually coded for opioid abuse/use/dependence and opioid poisoning with concurrent infection. Totals were calculated for each year and age group. For years and age groups that had less than five people code for infection and opioid use, the datasheet reported 1-4 to maintain the anonymity of the people included in the data set. We recoded reported incidence of 1-4 as one when performing these calculations. After creating the totals for each individual age group, totals for each age

group were combined into three groups. The groups included: 18-34, 35-54, and 55+. Three groups were created in an effort to distribute the populations appropriately into defined categories of young adults, middle-aged, and older adults. This was done for both the inpatient discharge data as well as emergency department discharge data. These numbers were then used to plot graphs comparing inpatient and emergency admissions for concurrent infection and opioid use by year and age group. This data was used for quantitative analysis. From this data, observations were made regarding which age group is at the highest risk for opioid use and related adverse effects. This study posed no risks to human subjects as this was a secondary analysis of a pre-existing database and all information used is untraceable to any of those from whom data was collected.

## **Results**

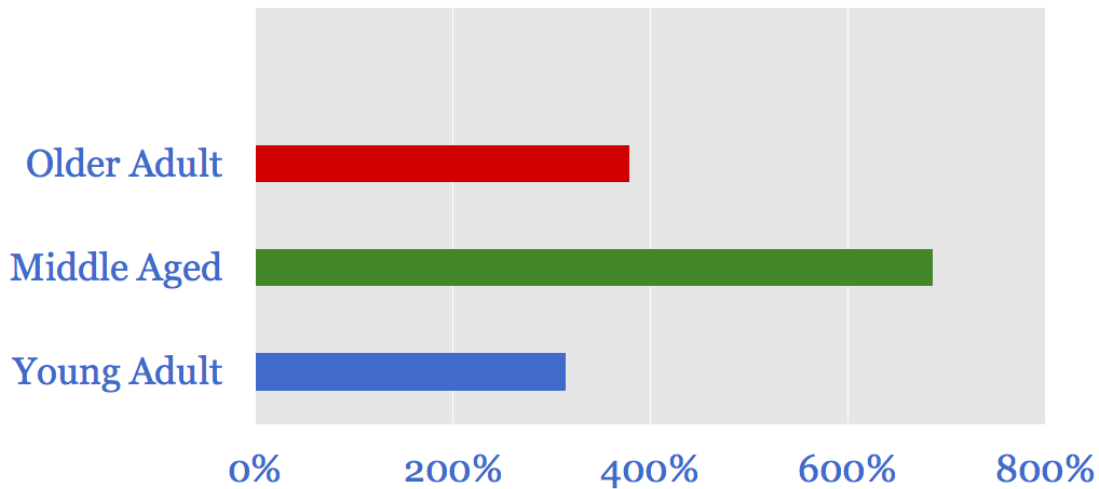
Numerical data was retrieved from the hospital data discharge set and analyzed. Figures were created to allow for better visualization of obtained information. Figure 1 depicts rates of infection inpatient admissions in New Hampshire hospitals of patients in three separate age groups (young adult, middle-aged, and older adults) who were coded for a substance use disorder from the years 2012 to 2019. Figure 1 shows young adults aged 18-34 consistently have the highest rates of infection (besides the year 2019) with a steady increase from 2012 to 2016. In 2012, there were 100 patients admitted with concurrent infection and substance use codes, but by 2016, rates increased by 364% and 464 patients were patients admitted with infection and substance misuse codes. After this peak in 2016, the number of people admitted for infection and substance use decreased to a total of 419 in 2019.



**Figure 1. Inpatient Admissions for Concurrent Infection and Substance Cases by Age Group in New Hampshire (2012-2019)**

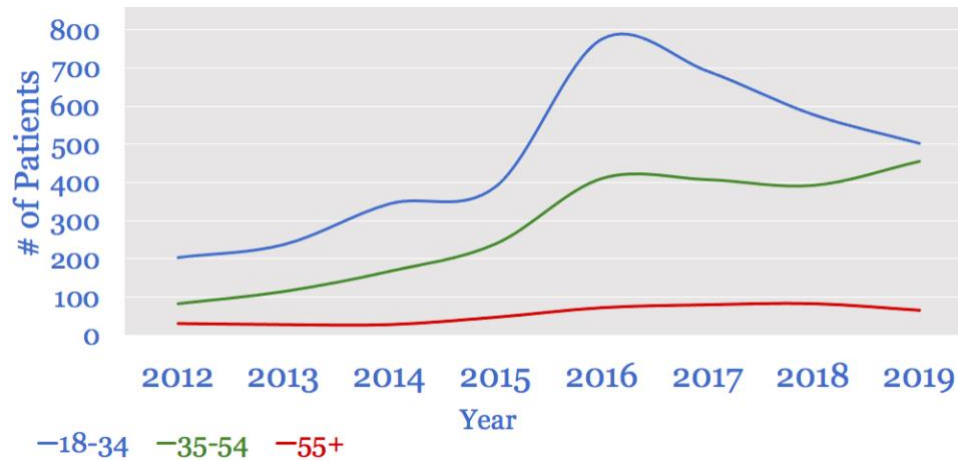
Despite this decrease since 2016, the overall increase since 2012 is stark with a net increase of 319% which is shown in Figure 2. Young adults hold the most overall inpatient admissions for all years combined with 2,403 total admissions. The average number of inpatient admissions for young adults coding for opioid use and related infection was 300.4 admissions per year. The middle-aged group, 34-54, has undergone the greatest increase in the number of patients admitted for infection and substance use. The group started with 58 admissions in 2012 and the numbers shot up to 456 by 2019, leaving this age group with the most overall infections in 2019. The number of people admitted with infection and substance use codes had a net increase of 686.2% over the eight-year span as displayed in Figure 2. The average number of inpatient admissions from 2012 to 2019 for middle age opioid use and related infection was 236.5 per year. Older adults also saw an increase in people admitted with infection and substance misuse codes. In 2012, the older adult population started with 32 admissions, and by 2019, it had increased to 153 admissions related to infection and substance misuse. Overall, they had a net increase of 378.1%. The average number of admissions for older adults admitted for substance

misuse and infection was 101.3 older adults. Figure 2 shows the percentage increase in inpatient cases.



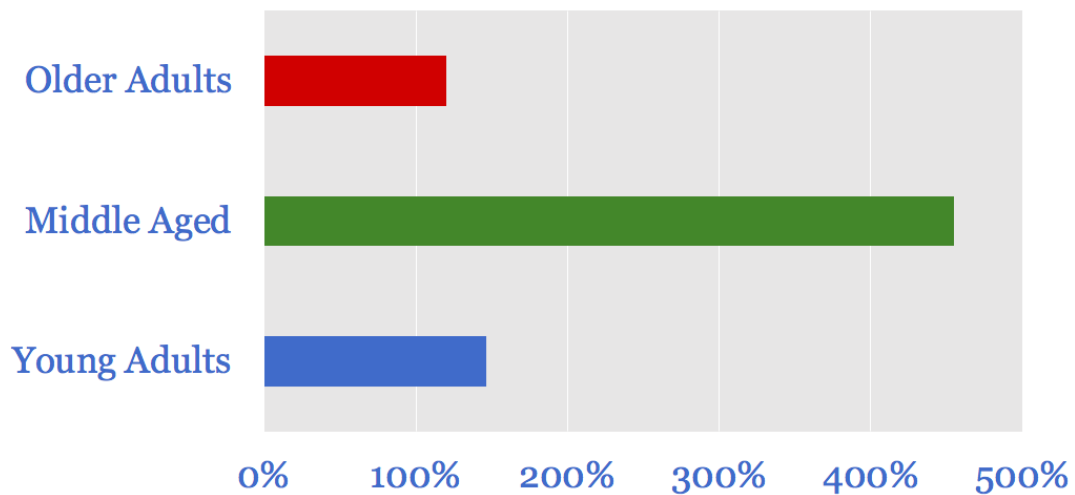
**Figure 2. Net percentage increase in inpatient admissions (2012-2019)**

Emergency department visits of patients with concurrent infection and substance use can be visualized in Figure 3. The graph of emergency department admissions for patients who coded for infection and substance misuse looks generally similar to Figure 1 which depicts inpatient admissions as infection has been trending up among all ages. Young adults consistently have the highest rates of infection. In 2012, 204 young adults were admitted to the emergency department for concurrent infection and substance use, whereas in 2019 increased to 504 young adults. Once again, a peak was noted in the year 2016 with 776 visits. From 2016 to 2017, there was a 98.9% increase in young adults seen in the emergency department with concurrent substance use and infection.



**Figure 3. Emergency Department Admissions for Concurrent Infection and Substance Cases by Age Group in New Hampshire (2012-2019)**

Since 2016, this number has been decreasing, but the overall net increase in young adults seen was 146.5% as seen in Figure 4. The average number of young adults visiting the emergency department coding for both infection and substance use from 2012 to 2019 was 465.8 people. Middle-aged adults also had a steady increase from 2012 to 2016 which then plateaued until 2018, but the numbers are back on the rise as of 2018. The year 2012 saw 82 patients and that number reached as high as 410 in 2016 before a 2-year decline. The emergency department visits then increased from 2018 to 2019. There were 283.3 average visits per year for middle-aged adults. This age group had the largest net percent increase for the emergency department from 2012 to 2019 with a 454.9% increase. Older adults experienced the lowest number of visits to the emergency department for infection and substance misuse by far. The highest year was 2018 with 84 total admissions. Generally, their numbers have increased since 2012 starting at 30 and ending with 66 in 2019, resulting in a 120% net increase. Figure 4 shows the increase in emergency department increases.



**Figure 4. Net Percentage Increase in Emergency Department Admissions (2012-2019)**

In both the inpatient and emergency department visits, middle-aged adults have the greatest overall jump in patients being seen for substance misuse and infection. On average, young adults have the highest rate of infection overall. Older adults stayed consistent with the lowest levels of substance misuse and related infection despite the recent rise they have been seeing. As of 2019, the middle age group is the only group still experiencing a rise while young adults and older adults have seen a slight decrease.

When comparing inpatient data to emergency department data, the emergency department consistently saw higher rates of patients visiting for substance misuse and concurrent infection rates. However, each age group followed a similar pattern in rises and falls of rates of substance use and concurrent infection each year in both inpatient admissions and emergency department visits. Young adults followed a similar pattern in the inpatient and emergency departments with a steep increase from 2012 onward until a peak was reached in 2016. From there both areas saw a decrease in rates in the years 2017 to 2018. As of 2019, inpatient units saw a rise, while emergency department rates are continuing to decrease. Both the emergency

department and inpatient graphs display a consistent rise in rates from 2012 to 2016 then a plateau followed by an increase from 2016 to 2019 in the middle-aged group. Rates of substance use and concurrent infection for older adults in the emergency department compared to inpatient units has the greatest variability. Rates were consistently higher in inpatient units as compared to the emergency department.

### **Discussion**

The findings presented are extremely concerning for the people of New Hampshire. Overall, this data is showing sharp increases in the number of people requiring treatment for substance misuse and related infections at hospitals. Since 2012, all age groups have climbed to reach record high numbers. Although there has been a minute decrease in these numbers in recent years for some age groups, the general consensus is alarming. As this opioid epidemic continues, the victims continue to suffer. Studies show that the effects of the opioid crisis are leading to lower quality of life and lower life expectancy (Tran et al., 2020). According to the surgeon general, interventions need to be put in place to help prevent substance misuse from occurring and to aid those already suffering from this disease (US Department of Health and Human Services, 2016).

#### **Age-Specific Interventions**

*Young Adults.* Age-specific interventions should also be implemented to best help this vulnerable population. The Surgeon General recommends that efforts be heavily focused on prevention methods starting with young adults (US Department of Health and Human Services, 2016). Using drugs at a younger age greatly increases the risk of addiction. Young adults lack a fully developed frontal lobe and tend to make more decisions that could be considered



reckless. The use of drugs and alcohol only perpetuates this issue, as using substances at a young age can hinder neurodevelopment (Winters & Arria, 2011). For this reason, extra education methods are needed to stop substance use before it starts in young adults. Research also suggests increased access and implementation of screening, brief intervention, and referral to treatment (SBIRT) (Uchitel et al., 2019). Methods to increase SBIRT include increasing insurance coverage of substance use services and increased funding for the treatment of substance use disorders. Another intervention includes increased pediatric access to methadone, buprenorphine, and naltrexone by allotting more educational resources to pediatricians so they can act as prepared prescribers. Targeting at-risk populations in youth settings such as in the foster care system or juvenile corrections system could also be beneficial. Addressing substance use at a younger age will help to prevent the perpetuation of the substance abuse and lower associated complications (Uchitel et al., 2019).

*Middle Aged.* Young adults are not the only ones that are a cause for concern. The most unexpected reveal was the increase in infection related to opioid use for middle-aged adults. In 2020, people aged 35-44 in the United States had the highest rate of overdose deaths (United States Department of Agriculture, 2020). Certain factors may play a role in a noted rise such as increased opioid prescriptions and increased mental health issues becoming apparent at this period in life (SAMHSA, 2020). This group tends to be overlooked and there is insufficient data outlining how to best target prevention efforts to this group. They face many risk factors for substance abuse such as the stressors of marriage, work, and parenthood. This age group should be screened for risk factors such as smoking, having friends or family who misuse substances, and self-employment (Kheirandish et al., 2021). Substance misuse screening should be standard among this age group at primary care provider check-ups and doctors' appointments. Providers

also need to be cautious when prescribing opioids and provide ample educational resources regarding the risks involved with taking these medications (Perlman, 2019).

*Older Adults.* Despite the fact that older adults have the lowest rates of substance misuse and related infection they cannot be forgotten. Some proposed interventions to increase the amount of those who receive treatment include offering treatment facilities that are designed with this age group in mind. Increasing the use of telehealth may be an option to aid in increasing access to care (Han & Moore, 2018). There is stigma around older adults and ageism in today's society. Many people, including healthcare providers, hold misconceptions that those of older age do not face issues regarding substance misuse. Perpetuation of these stereotypes in society is damaging and can lead to increased rates of substance use. Identifying substance misuse in this population can be a challenge for healthcare workers. Older adults typically deal with many other physical and mental health conditions that can mask substance misuse signs and symptoms. Offering a standardized screening such as The Michigan Alcohol Screening Test-Geriatric Version may help identify and allow for earlier interventions to help this population (Han & Moore, 2018).

### **Infection & Overdose Prevention**

Infection prevention methods are effective for all people regardless of age. Research has shown that interventions such as education regarding infections, needle exchange programs, and supervised injection facilities are supportive in preventing complications such as infection and overdose in intravenous drug users (Bouzanis et al., 2021). Increasing naloxone administration education outreach as well as increasing the availability can be essential in saving the lives of those experiencing an overdose. Statistics show that high rates of naloxone distribution could

decrease the mortality of drug overdoses by 21% (NIDA, 2021). Overall, increased education and infection prevention services are essential to protecting substance misuse.

Data outlining rates of infection in those who use substances need to be reviewed more consistently. Thoroughly examining data regarding those who are presenting to the hospital with infection and substance misuse will help identify where interventions can be placed to help these individuals. Those who are presenting to the hospital are coming for help, yet they often are not provided adequate resources to maintain their health and safety. Hospitals should introduce education methods and a detailed list of resources to patients upon discharge. Public health interventions also need to be introduced to help aid this population. Interventions such as encouraging single use needles, using sterile water (if mixing drugs), not sharing needles, and hand washing should be encouraged among those who use substances (Harvey et al., 2022).

### **Emergency Department Versus Inpatient Admissions**

When comparing New Hampshire's numbers of admissions for the emergency department and inpatient units to national trends the findings are quite similar. The results of this study found that the emergency department had a higher number of visits for substance misuse and related infection as compared to the inpatient units. Young adults were consistently visiting the emergency department more than any other age groups. This finding is aligned with national statistics that show 18-34-year old's as the most likely to visit the emergency department for substance use and related issues (CDC, 2019). As people age, the body becomes more immunocompromised, or co-morbid conditions are more likely to be present, which leaves older adults who misuse intravenous opioids at great risk for infection. However, the data overwhelmingly showed lower admission rates to the emergency department and inpatient units

for older adults. While it is known older adults typically use substances less than young adults it was still questionable why so few older adults visited the hospital. Some potential barriers to care include a lack of insurance or transportation (Van Gaans & Dent, 2018).

### **Limitations**

Limitations of this study include that the sample included codes only for opioid use generated case reports. Although codes for methamphetamine and cocaine use were included in the request, there were very few cases of these code applications. This may indicate that the findings do not include all cases of concurrent infection and substance use in the state of New Hampshire. This study is also limited by the fact that the age groups did not include anyone below age 18.

### **Conclusion**

In conclusion, there has been a significant increase in infection rates related to substance use among all age groups (Office of Health Statistics, 2021). The findings presented are concerning for the state of New Hampshire as hospital admissions for drug related infection rise. An increase in substance misuse, infection, and overdose will continue to lead to adverse effects for the state and its population. Continued monitoring of substance use and infection rates should be initiated, as this data has not been used in monitoring the opioid epidemic. Identifying trending data regarding these variables may allow for improved interventions to lower substance misuse and overdose. New Hampshire should focus on offering age-specific interventions and resources to decrease opioid use which would lead to fewer infections and fewer deaths (US Department of Health and Human Services, 2016). More research needs to be collected on the topic of interventions targeted toward the middle-aged group to aid this population specifically

as they have had the highest net increase in substance use and infection. Prevention efforts should be targeted towards young adults as well, who quite consistently suffer from the highest rates of substance use and related adverse effects. Overall, the study concludes that substance use and related infection is increasing for all age groups. New Hampshire should increase interventions accordingly to help this vulnerable population.

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