

Invasive Bacterial Infection Hospitalizations Associated with Injection Drug Use in Allegheny County, PA, 2016-2020

by

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Abstract

Introduction: In Allegheny County, the frequency of invasive bacterial infections associated with injection drug use is not known.

Methods: Pennsylvania Healthcare Cost Containment Council in-patient hospitalization data from 2016 through 2020 were analyzed. These records were limited to Allegheny County residents hospitalized at acute care facilities. The frequency and percentage of endocarditis, osteomyelitis, skin and soft tissue infection (SSTI), and *Staphylococcus aureus* (*S. aureus*) sepsis hospitalizations containing IDU-related diagnoses were identified across the time period. Demographic characteristics were observed to determine which populations experience the highest proportion of hospitalizations.

Results: There were 562, 506, 2418, and 282 endocarditis, osteomyelitis, SSTI, and *S. aureus* sepsis IDU-related hospitalizations from 2016 through 2020. The largest percentage of hospitalizations with the presence of an IDU diagnosis code occurred among endocarditis admissions (24.6%) while the smallest percentage occurred among osteomyelitis hospitalizations (7.1%). The percentage of invasive bacterial infections associated with IDU did not vary greatly across the 5-year period. Endocarditis, osteomyelitis, SSTI, and *S. aureus* sepsis IDU-related hospitalizations were highest among White individuals, persons with opioid use diagnoses, and

Medicaid beneficiaries. Age group and sex characteristics differed between the condition types. Length of stay and total charges were highest per *S. aureus* sepsis IDU-related hospitalizations.

Conclusion: Bacterial infections associated with injection drug use are present in small, but important numbers. These findings are relevant in the field of public health due to the substantial percentage of osteomyelitis, SSTI, *S. aureus* sepsis, and endocarditis hospitalizations associated with injection drug use ranging from 7.1% to 24.6%. Prevention efforts addressing risky injection behaviors, such as the expansion of syringe service programs, hold the potential to reduce the number of invasive bacterial infections associated with injection drug use.

Table of Contents

Preface.....	x
1.0 Introduction.....	1
1.1 Overdose Epidemic in Allegheny County, Pennsylvania.....	1
1.2 Infectious Diseases and Injection Drug Use.....	3
1.3 Risk Factors for Bacterial Infections.....	4
1.4 Characteristics of IDU-related Hospitalizations in the United States.....	5
1.5 Invasive <i>Staphylococcus aureus</i> in Persons who Inject Drugs.....	6
1.6 Sepsis.....	6
1.7 Skin and Soft Tissue Infections.....	6
1.8 Endocarditis.....	7
1.9 Osteomyelitis.....	9
1.10 Prevention of Bacterial Infections among Persons Who Inject Drugs.....	10
1.11 Defining the Population of Persons Who Inject Drugs.....	11
1.12 Gaps in Knowledge.....	12
1.13 Public Health Significance.....	13
2.0 Objective.....	14
3.0 Methods.....	15
4.0 Results.....	18
4.1 Endocarditis IDU-related Hospitalizations.....	20
4.2 Osteomyelitis IDU-related Hospitalizations.....	22
4.3 Skin and Soft Tissue Infection IDU-related Hospitalizations.....	24

4.4 <i>Staphylococcus aureus</i> Sepsis IDU-related Hospitalizations.....	26
5.0 Discussion.....	29
Appendix A Injection Drug Use Algorithm.....	34
Appendix B Injection Drug Use Algorithm Exclusions.....	41
Appendix C ICD-10 Codes for Endocarditis, Osteomyelitis, Skin and Soft Tissue Infections, and <i>S. aureus</i> Sepsis	42
Bibliography	43

List of Tables

Table 1 Endocarditis IDU-Related Hospitalizations among Allegheny County Residents by Drug Use Diagnosis and Demographic Characteristics, 2016-2020..... 21

Table 2 Hospital Outcomes for IDU-related Endocarditis Hospitalizations..... 21

Table 3 Osteomyelitis IDU-Related Hospitalizations among Allegheny County Residents by Drug Use Diagnosis and Demographic Characteristics, 2016-2020..... 23

Table 4 Hospital Outcomes for IDU-related Osteomyelitis Hospitalizations..... 23

Table 5 SSTI IDU-Related Hospitalizations among Allegheny County Residents by Drug Use Diagnosis and Demographic Characteristics, 2016-2020 25

Table 6 Hospital Outcomes for SSTI IDU-related Hospitalizations 26

Table 7 *S. aureus* Sepsis IDU-Related Hospitalizations among Allegheny County Residents by Drug Use Diagnosis and Demographic Characteristics, 2016-2020..... 27

Table 8 Hospital Outcomes for *S. aureus* Sepsis IDU-related Hospitalizations..... 28

Appendix Table 1 Injection Drug Use Algorithm ICD-10 Codes..... 34

Appendix Table 2 Important Exclusions from IDU Algorithm..... 41

Appendix Table 3 ICD-10 Codes for Endocarditis, Osteomyelitis, SSTIs, and *S. aureus* Sepsis 42

List of Figures

Figure 1 Frequency of endocarditis, osteomyelitis, SSTI, and <i>S. aureus</i> sepsis hospitalizations among Allegheny County residents, 2016-2020.....	18
Figure 2 Frequency of endocarditis, osteomyelitis, SSTI, and <i>S. aureus</i> sepsis hospitalizations among Allegheny County residents that countain at least one IDU-related diagnosis code, 2016-2020	19
Figure 3 Percentage of endocarditis, osteomyelitis, SSTI, and <i>S. aureus</i> sepsis hospitalizations among Allegheny County residents that contain at least one IDU-related diagnosis code by year, 2016-2020.....	19

Preface

I would like to thank everyone who has advised, mentored, and guided me throughout my graduate school experience. I would like to thank my essay advisor, Dr. Thomas Songer, for taking the time to answer my countless questions and provide guidance on the content and organization of my essay. Your knowledge on the overdose crisis has been instrumental in the completion of this essay and our conversations have improved my critical thinking skills. I would also like to thank Dr. Nancy Glynn for supporting me in the challenges I faced as an MPH student and providing insight into how to face these problems. Dr. Glynn, your dedication to your students is unmatched, and I would not be the epidemiologist I am today without your direction and support. Thank you to Dr. Jeanine Buchanich for your insightful feedback. I also want to thank Dr. Kristen Mertz for your assistance in developing this essay topic and outlining the content of this essay. I appreciate the time you and all my committee members took in reading and advancing forward the many versions of this essay. Thank you to Earl Hord for your outstanding mentorship. I appreciate your constant support in my work at the Allegheny County Health Department where you continue to provide me with challenging opportunities. I have been fortunate to learn from you and develop skills and knowledge that will play an important role in my future as a public health professional. I would also like to thank Hiba Anwer, who has also mentored me during my time at the Allegheny County Health Department. Finally, thank you to all my friends, especially Mya Brady and Rosie Benford Miller, at Pitt Public Health who have been the most amazing support system to have as a graduate student during a pandemic. I cannot thank you enough for your infinite moral support. Thank you for always celebrating the small wins and big successes with me.

1.0 Introduction

The burden of drug misuse in the United States is a public health issue that has increased significantly in the last three decades. The age-adjusted rate of unintentional drug overdose deaths in the United States has increased every year from 1999 to 2017. The rate was lower in 2018 compared to 2017, but increased again in 2019.¹ Opioid use disorder (OUD) contributes to high unintentional drug overdose mortality rates in the United States.² Over 70% of all unintentional drug overdose deaths involved opioids in 2019 and between 1999 and 2019, an estimated 500,000 individuals died from an unintentional opioid overdose.³

According to the Centers for Disease Control and Prevention (CDC), within the last 30 years, there have been three distinct waves of unintentional opioid overdose deaths. The first wave of increased unintentional overdoses in the 1990s was initiated by the widespread prescribing of opioids.³ Opioid prescriptions put individuals at an increased risk for opioid use disorder (OUD), characterized by opioid dependence, abuse, and misuse.² In 2010, the U.S. saw a surge in deaths involving heroin, and beginning in 2013, higher percentages of synthetic opioids were involved in opioid overdose deaths.³

1.1 Overdose Epidemic in Allegheny County, Pennsylvania

Following national trends, Pennsylvania and Allegheny County have seen a continuous increase in overall unintentional drug overdoses. The drug-related unintentional overdose mortality rate increased by 36% between 2015 and 2018.⁴ In Pennsylvania, the age adjusted

unintentional drug overdose death rate was similar, but slightly higher in 2019 compared to 2018. The death rate was 3.61 per 10,000 persons and 3.56 per 10,000 persons, in 2018 and 2019, respectively.⁵ Of the 67 counties in Pennsylvania, Allegheny County had the third highest unintentional overdose death rate per 10,000 persons in both 2017 and 2018.⁴

Fatal unintentional overdoses in Allegheny County peaked in 2017 at 6.83 deaths per 10,000 residents, and have increased between 2018 and 2020 from 4.02 per 10,000 residents to 5.63 per 10,000 residents.⁶ Males and White residents accounted for a larger percentage of unintentional overdoses than females from 2016 through 2020.⁷ Opioid use and misuse are more common among males as a result of a combination of factors, including masculinity social norms that promote risk-taking.⁸ Although White residents account for a greater proportion of deaths, the death rate of Black individuals has been higher than that of White individuals since 2018 with a disproportionately high rate seen specifically among Black males. These racial disparities have been proposed to be the result of barriers to SUD treatment and anti-drug laws that historically target Black communities.⁹

Opioids frequently contribute to overdose deaths in Allegheny County. Each year from 2016 through 2020, opioids were involved in over 80% of deaths. Additionally, most deaths in Allegheny County involve multiple substances. In 2019, polysubstance use contributed to 88% of overdose fatalities. Overdoses in Allegheny County also tend to impact younger and middle-aged individuals. From 2014 through 2017 and from 2018 through 2020, 24 to 35-year-olds and 35 to 44-year-olds accounted for the largest percent of fatal overdoses compared to all other age groups, respectively. ED admissions due to unintentional overdoses follow similar age trends. From 2016 through 2020, unintentional overdose ED admissions were highest among males, White residents, and 35 to 44-year-olds compared to females, Black residents, and all other age groups. Trends of

demographic characteristics of poisonings in Allegheny County are important to understand to determine who is most affected by the overdose epidemic.

1.2 Infectious Diseases and Injection Drug Use

People with substance use disorder (SUD), especially those who inject drugs, are at risk for a variety of viral and bacterial comorbid conditions. A consequence of injection drug use (IDU) is an increased incidence of infectious diseases such as viral hepatitis B (HBV), viral hepatitis C (HCV), human immunodeficiency virus (HIV), bacterial bloodstream infections, infective endocarditis (IE), osteomyelitis, and skin and soft tissue infections (SSTIs). These concomitant conditions can be transmitted among persons who inject drugs (PWID) due to the use of non-sterile injection equipment, contaminated injection equipment, repeated injections, and improper injection technique.¹⁰

Bloodborne viruses such as HIV and hepatitis B and C have been well-studied among PWID. The CDC estimates that for every 10 new HIV infection in the U.S., one is among PWID.¹¹ There are also significant associations between PWID and hepatitis B and C infections. Between 3.5-20% of PWID are currently living with a chronic hepatitis B infection, and an estimated 22.6% of PWID have been infected with hepatitis B at some point in their lives.¹² Hepatitis C infections increased by 249% between 2010 and 2016.¹¹ A study estimated that the 2011 incident rates of HIV and HCV were 55 and 43,126 per 100,000 PWID, respectively.¹³ IDU is the predominant risk factor for HCV infection in the U.S.¹⁴ In 2013, a global burden of disease study found that IDU contributed to 39.1% of the Disability Adjusted Life-Years (DALYs) due to HCV.¹⁵

While HIV, HBV, and HCV are common illnesses among people with SUD and particularly those who inject drugs, bacterial infections are also associated with severe morbidity and mortality. An increase of opioid misuse and abuse is associated with an increase in bacterial infections.¹⁶⁻¹⁸ A retrospective cohort study of U.S. inpatient discharges found that among people with osteomyelitis, infective endocarditis (IE), central nervous system abscesses, and SSTIs, the percentage with SUD diagnoses increased from 2012 to 2017. The rates of bacterial infections increased primarily among younger age groups. In 2017, the proportion of IE, osteomyelitis, and SSTI hospitalizations with a diagnosis of SUD was 39.4%, 16.6%, and 9.4%, respectively.¹⁹

1.3 Risk Factors for Bacterial Infections

Certain behaviors in PWID can put individuals at an increased risk for developing an invasive infection. Bacterial infections can result from non-disinfected injection sites, poor hand hygiene, and reused syringes. These practices allow for the spread of opportunistic bacteria such as *Staphylococcus aureus* (*S. aureus*), a microorganism typically present on skin, into the bloodstream. Multiple skin wounds and high levels of *S. aureus* colonization are thought to be the reason for increased bacterial infection rates among PWID.²⁰ Injection equipment can be contaminated by exposure to the environment if proper care is not taken to ensure the equipment is sterile.²¹ Also, injecting into uncleaned skin has been linked with greater susceptibility to skin abscesses and severe sepsis.^{21,22}

People who use drugs and inject into subcutaneous tissue experience increased rates of infection.²³ Risky injection habits among PWID are associated with several factors. People with unstable housing situations are more likely to share injection equipment and develop unsafe

injection habits.²⁴ Non-fatal overdoses are common among PWID, which are correlated with heroin injection, cocaine injection, and recent incarceration.²⁵ People who are hospitalized as a result of a bacterial infection from IDU are typically unemployed and rely on government funded insurance programs such as Medicaid and Medicare.²⁶ It's important to understand what factors specific to health inequities and risky behaviors lead to the development of invasive infections among PWID. This knowledge will aid the development of education and prevention programs in this vulnerable population.

1.4 Characteristics of IDU-related Hospitalizations in the United States

A study of IDU-related bacterial infection hospitalizations in Oregon found that bacteremia sepsis made up the largest proportion of bacterial infection IDU-related hospitalizations in 2018.¹⁶ IDU-related hospitalizations for SSTI, osteomyelitis, endocarditis, and bacteremia sepsis, were highest among White individuals. SSTI and osteomyelitis IDU-related hospitalizations were higher among males than females while endocarditis IDU-related hospitalizations were higher among females. Bacteremia sepsis IDU-related hospitalizations were evenly split among males and females. IDU-related osteomyelitis, bacteremia sepsis, and endocarditis hospitalizations were highest among 50 to 59-year-olds while SSTI IDU-related hospitalizations were highest among 40 to 49-year-olds. Bacterial infection hospitalizations were highest among persons with opioid use diagnoses compared to cocaine, stimulant, sedative and other psychoactive drug diagnoses. This study also found that SSTI, osteomyelitis, bacteremia sepsis, and endocarditis IDU-related hospitalizations have increased between 2008 and 2018.¹⁶ Heroin, cocaine, and a combination of both, are the most common substances used by PWID in these hospitalizations.^{22,27,28}

1.5 Invasive *Staphylococcus aureus* in Persons who Inject Drugs

Invasive methicillin-resistant *Staphylococcus aureus* (MRSA) infection has increased among PWID in the United States. Jackson et al. found that across multiple states, invasive MRSA infections among PWID increased from 4.1% of invasive MRSA cases in 2011 to 9.2% in 2016. Compared to persons who do not inject drugs, PWID are 16.3 times more likely to contract invasive MRSA infections.²⁹ The prevalence of IDU-related endocarditis, osteomyelitis, Hepatitis C, and SSTI diagnoses among patients with MRSA bloodstream infections is higher in those who inject drugs than those who do not inject drugs.³⁰

1.6 Sepsis

Sepsis, or septicemia, is a life-threatening condition that results from invasion of bacteria in the bloodstream. The body's reaction to this infection is to damage its own tissues which can lead to organ failure and death.³¹ SSTIs and endocarditis may result if sepsis is left untreated.³² Sepsis is treated using antibiotics, intravenous fluids, and medications that lower blood pressure. Patients experiencing kidney failure may be put on dialysis.³³ In a Colorado cohort of PWID, lifetime prevalence of sepsis was 9.8%, which was second only to prevalence of endocarditis.²⁸

1.7 Skin and Soft Tissue Infections

SSTIs are a major bacterial infection that can result from injection drug use. SSTIs are a

result of microbes infecting skin and subcutaneous tissue, fascia, or muscle. They involve a variety of conditions that range in severity from superficial abscesses to necrotizing fasciitis. Severe SSTIs can be life-threatening and may require surgical drainage and antibiotic treatment.³⁴

SSTI rates among PWID vary across the United States. A cohort of PWID in Denver, Colorado, found that about 30% experienced a skin infection in the year preceding the study. Rates of skin infections over time amounted to over 50%.²⁸ In California, 37% of a cohort of PWID reported skin abscesses in the 6 months prior to study enrollment.²⁷ The prevalence of chronic wounds and abscesses was 34.9% in a cohort of PWID in Baltimore, Maryland.²²

SSTIs are particularly concerning because of the social and economic costs of SSTI treatment and hospitalizations. SSTIs have a higher rate of in-patient hospitalization and ED visit rates compared to other bacterial infections affecting PWID. Between 1998 and 2001, SSTI hospitalizations among PWID amounted to a healthcare cost of over 190 million U.S. dollars.³⁵ SSTIs are the most prevalent bacterial infection among PWID.³⁶ Abscesses and cellulitis are the primary SSTIs responsible for hospitalizations involving PWID, and the primary risk factor for SSTIs among PWID is frequent injections.³⁷⁻³⁹

1.8 Endocarditis

Endocarditis is another concerning bacterial infection among PWID. Endocarditis is an inflammation of the heart tissue, which like SSTIs, results from spread of fungi or bacteria through the bloodstream. Bacteria that enter the bloodstream attach to damaged heart vessels or structures which can in turn destroy heart valves. Surgery may be required to replace damaged valves.^{40,41} Intravenous antibiotics are typically administered to patients with endocarditis, which usually

requires a one week stay in a hospital.⁴¹

It is important to determine the prevalence of infective endocarditis (IE) among PWID to fully understand the extent to which this population is impacted by invasive infections. However, there is limited research on the prevalence of endocarditis among known cohorts of PWID in the U.S. One study found that lifetime prevalence of IE was 11.8% in a cohort of PWID in Colorado.²⁸

IE can be a severe disease associated with relatively high mortality rates. Approximately 11% to 26% of in-patient hospitalizations for IE results in death while 5-year mortality ranges from 12% to 50%.⁴² Repeat endocarditis infection is associated with IDU, higher one-year mortality, and frequent injections.⁴³ IDU-related IE hospitalizations in the U.S. have been increasing.^{42,44-46} In 2013, approximately 12.1% of IE hospital admissions in the U.S. were IDU-related, an increase from 7% in 2000. IDU-IE hospitalizations are increasing among 15 to 34-year-olds, females, and Whites. *S. aureus* is responsible for a majority of IE hospitalizations in PWID.⁴² IE is more likely to occur in PWID who are HIV-positive due to the compromised immune system.⁴⁷ Readmission in patients initially admitted for IDU-IE is high. One study found that 50% of patients hospitalized for IDU-IE were readmitted.⁴⁸

Research on the intersection of bacterial infections and IDU in Pennsylvania and Allegheny County is limited. However, one study found an increase in drug-use related to IE hospitalizations.¹⁷ This retrospective cohort study of all Pennsylvania resident acute-care facility hospitalizations found that drug-use associated IE hospitalizations increased by 238%, from 56 to 189, between 2013 and 2017. In Allegheny County, the hospitalization rate for drug-use associated IE was found to be higher than in Pennsylvania. There was a 443% increase in drug-use associated IE hospitalizations during this time period with an overall rate of 13.8 per 100,000 persons in

Allegheny County.¹⁷ IE undoubtedly contributes to increasing healthcare costs and research indicates poor health outcomes among PWID who are hospitalized for endocarditis.

1.9 Osteomyelitis

Osteomyelitis is another bacterial infection associated with intravenous drug use. Osteomyelitis is an infection of the bone and joints. It results from an initial infection that spreads to the bone and is usually a result of trauma to a contiguous contaminated source like blood and skin. *S. aureus* is the microorganism responsible for most osteomyelitis infections.⁴⁹ For PWID, it is possible to develop osteomyelitis via *S. aureus* entering the bloodstream through a similar mechanism that causes endocarditis and SSTIs. While osteomyelitis is associated with many complications that require hospitalization, osteomyelitis may be less prevalent among PWID than other bacterial infections.²⁸

Treatment of osteomyelitis is more intensive than for other invasive infections associated with IDU. Treatment may involve surgery or medication. Surgery for osteomyelitis may involve draining the area around the infected bone, removing infected bone, or even amputating a limb to stop the infection from spreading. Intravenous antibiotics are typically administered for 6 weeks, depending on the type of bacteria that caused the infection.⁵⁰

Osteomyelitis is also associated with high rates of morbidity, mortality, and economic costs. Yuschak et al. found that in West Florida, the length of hospital stay of opioid-use related osteomyelitis patients was significantly longer by about 5 days than that of diabetic patients admitted for osteomyelitis. The mean age of persons with opioid-use associated osteomyelitis hospitalizations was approximately 45 years of age, 11 years lower than the diabetic population.⁵¹

Longer hospital stays compared to other groups indicates that PWID may experience complications and worse health outcomes than others when diagnosed with osteomyelitis. Longer lengths of hospital stay also translates to high healthcare costs.

Sredl et al. found that in North Carolina, the rate of osteomyelitis hospitalizations in persons using opioids or amphetamines increased between 2010 and 2018. Osteomyelitis accounted for the second highest rate of bacterial infection hospitalizations in this population, after endocarditis.¹⁸ Osteomyelitis is associated with lower rates of mortality than endocarditis in PWID.⁴⁵ Osteomyelitis is a further complication of injection drug use that may require hospitalization, but the prevalence of osteomyelitis among PWID is unclear.

1.10 Prevention of Bacterial Infections among Persons Who Inject Drugs

Given the morbidity, mortality, and economic burden associated with bacterial infections in PWID, harm reduction methods focused on these communities may be able to reduce the occurrence of these infections. Prevention efforts should address common risk factors for fungal and bacterial infections in PWID, including education on hand and injection site hygiene. It is also important to inform PWID that they should not use equipment that may have been contaminated by reuse, water, soil, or saliva.

Implementation of syringe service programs (SSPs) would provide people who use drugs with sterile injection equipment and assist with proper disposal of equipment. SSPs have reduced new HIV and HCV infection occurrence by 50%,⁵² suggesting that SSPs would also reduce incidence of bacterial infections in PWID. These programs also educate PWID on safer injection practices. Because infections are more likely to occur from frequent injections, medication for

opioid use disorder (MOUD) could contribute to a reduction in invasive infection prevalence in PWID. It is important to link PWID and people with SUD to care in order to effectively treat invasive infections associated with IDU.

1.11 Defining the Population of Persons Who Inject Drugs

Analyzing data among PWID is difficult due to a lack of consensus on how to define this population using hospitalization data. There is no ICD-10 code or gold standard to define PWID. It is difficult to compare frequency distributions among different populations because existing studies use a variety of ICD-9 and ICD-10 codes to define bacterial infections, SUD, and IDU. The lack of universal case definitions limits the comparability of data between states and local health departments. The development of a standard definition for use by these agencies would permit analyses using selected ICD-9 and ICD-10 codes to better understand the intersection of bacterial infections and IDU in and between their communities.

In order to select codes that best represent IDU, it's important to understand which substances can be intravenously injected by people who use drugs. Opioids, including heroin, as well as methamphetamine, cocaine, and sedative-hypnotics like benzodiazepines and barbiturates, are substances that may be injected. Any drug that can be dissolved in water could be injected.⁵³

Previous literature defines IDU using a variety of combinations of ICD-9 and ICD-10 codes. IDU hospitalizations were defined as hospital discharges including drug use, abuse, and dependence codes for drugs typically involved with IDU including opioids, cocaine, sedatives, stimulants, and other psychoactive drugs.¹⁶ They specifically excluded codes specifying that an individual was in remission which indicates they were not actively injecting drugs. They also

chose not to use poisoning codes such as “Accidental poisoning by other opiates” because these are more likely to indicate drugs have been smoked or ingested orally. This algorithm of codes was developed through consultation of the CDC, wound clinic and emergency room physicians, and a medical information specialist. The algorithm used in Oregon was modified from an algorithm utilized in a study in Miami, Florida. This study included codes of poisonings and accidental poisonings in addition to substance abuse and dependence codes for opiates, cocaine, sedatives, amphetamines, and other drugs.

In another study, McGrew et al. conducted a sensitivity analysis on substance use, abuse, and dependence codes for opioids, cocaine, sedatives, stimulants, and other psychoactive drugs among endocarditis hospitalizations and found the ICD-10 code algorithm to be highly specific compared to an algorithm that identified IDU hospitalizations using HCV diagnosis codes.⁵⁴ This algorithm was very similar to the algorithm used by Capizzi et al.¹⁶ However, McGrew et al. included remission codes and two cocaine abuse codes that Oregon did not include in their analysis.^{16,54}

1.12 Gaps in Knowledge

In Allegheny County, frequency of bacterial infections associated with PWID and percentages of bacterial infection admissions among IDU-related hospitalizations are not fully known. There has only been one study examining prevalence of infective endocarditis in Pennsylvania and Allegheny County. However, this study examined IE with co-diagnoses of drug use rather than co-diagnoses of IDU. Other urban areas across the United States have seen increases in bacterial infections among PWID. It is important to collect up-to-date information on

bacterial infections to help the Allegheny County Health Department proactively serve its residents.

1.13 Public Health Significance

The intersection of the overdose crisis and consequences that result from injecting drugs is of great public health significance. Pennsylvania ranks 3rd in terms of overdose death rates in the United States. It is important to understand the prevalence of concomitant conditions among PWID given that a viral or bacterial illness may contribute to a decreased quality of life. Understanding how the number of hospitalizations for concomitant conditions has changed over time will help Allegheny County be more informed on health issues that impact PWID. This knowledge can improve and better direct harm reduction prevention efforts.

2.0 Objective

The objective of this study was to identify the frequency of bacterial infections associated with injection drug use, measured using in-patient hospitalization data, among Allegheny County residents from 2016 through 2020. The study seeks to understand what percentage of invasive bacterial infection hospitalizations are associated with injection drug use, and if these percentages have changed over the time period.

3.0 Methods

The Pennsylvania Health-care Cost Containment Council (PHC4) is an independent state agency that collects about 5.2 million inpatient and outpatient medical records each year from healthcare facilities in Pennsylvania.⁵⁵ Hospitals and freestanding ambulatory surgery centers are required by law to report accurate records on a quarterly basis.^{56,57} Staff at PHC4 de-identifies data from all facilities and assigns each unique patient a pseudo-ID. Further, PHC4 staff collects variables for each in-patient hospitalization and outpatient surgery including patient age, patient zip code, race, legal sex, procedural codes, and diagnosis codes. A primary diagnosis code and up to 17 secondary diagnosis codes are included in PHC4 data. The year assigned to each hospitalization represents the year of discharge; it is based on the date in which the hospital submitted data to the PHC4, and not the actual patient discharge date.

The Allegheny County Health Department (ACHD) purchases in-patient PHC4 records each year. Inpatient hospitalization data are collected from specialty general acute care, long-term acute care, psychiatric, rehabilitation, specialty, and general acute care hospitals as well as ambulatory surgery centers. For this study, PHC4 inpatient hospital discharge records from 2016 to 2020 were analyzed. Only Allegheny County residents hospitalized at ‘Specialty general acute care hospitals’ and ‘General acute care hospitals’ were included. Our dataset included 735,258 total hospitalizations of Allegheny County residents at acute care hospitals with discharge dates from January 1, 2016 through December 31, 2020.

Our study was focused on invasive bacterial infections associated with IDU. However, there is no diagnosis code in the 10th edition of International Classification of Diseases (ICD-10) for IDU. For our analysis, we identified an algorithm of ICD-10 discharge codes to represent

hospitalizations that are related to IDU which we refer to as IDU-related hospitalizations. The algorithm was a combination of ICD-10 codes previously utilized in the literature as shown in Appendix A.^{16,54} IDU-related hospitalizations were defined as those with any primary or secondary discharge diagnosis containing at least one opioid, cocaine, sedative, stimulant, or psychoactive substance use, abuse, or dependence code (all F11, F13, F14, F15, and F19 excluding codes that diagnose an individual as ‘in remission’ (Appendix B). While these specific drug types are not always injected, these drugs were selected on the basis that these substances are commonly injected. This approach identifies individuals with substance use disorder who use drugs that can be injected.

We focused on specific bacterial infections, including endocarditis, osteomyelitis, SSTIs, and *S. aureus* sepsis. We sought to identify the percentage of endocarditis, osteomyelitis, SSTI, and *S. aureus* sepsis admissions that are likely to have involved IDU. We defined ICD-10 discharge codes using previous literature^{16,17} for endocarditis, osteomyelitis, SSTIs, and direct examination of ICD-10 codes for *S. aureus* sepsis hospitalizations (Appendix C). The *S. aureus* sepsis category combines methicillin resistant *S. aureus* (MRSA) sepsis and methicillin susceptible *S. aureus* (MSSA) sepsis to represent invasive *S. aureus* infections. An endocarditis, osteomyelitis, SSTI, or *S. aureus* sepsis hospitalization was defined as one having any primary or secondary discharge diagnosis code for the condition type. An IDU-related condition hospitalization contains at least one condition diagnosis code and one IDU-related code as a primary or secondary discharge diagnosis.

We identified the frequency and demographic characteristics of IDU-related admissions for each condition. We chose to examine sex, age, race, payor type, and drug type of IDU-related admissions. We created age categories based on patient age: under 20 years of age, 20-24, 25-34,

35-44, 45-54, 55-64, 65-74, and 75 years and older. Race categories included 'White alone', 'Black alone', and 'Other.' 'Other' race included the following race categories: 'Asian alone', 'American Indian and Alaskan Native alone', 'Native Hawaiian or Pacific Islander', 'More Race Groups', and 'Other'. Insurance type categories were selected based on primary payer identification codes and categorized as 'Medicaid', 'Medicare', 'Private', or 'Uninsured'. We also looked at hospital outcomes including total charges and length of stay. We used SAS 9.4 to complete all descriptive analyses.⁵⁸

4.0 Results

Of all 735,258 Allegheny County resident hospitalizations in 2016 through 2020, 2285 (0.3%), 7119 (1.0%), 31497 (4.3%), and 2386 (0.3%) were identified as endocarditis, osteomyelitis, SSTI, and *S. aureus* sepsis hospitalizations, respectively (Figure 1). Of the 2285 hospitalizations for endocarditis, 562 (24.6%) were IDU-related. For osteomyelitis, SSTI, and *S. aureus* sepsis, 506 (7.1%), 2418 (7.7%), and 282 (11.2%) hospitalizations were associated with IDU, respectively (Figure 2). The percent of IDU involvement among hospitalizations for each condition was generally higher in 2020 than in 2016, but percentages were variable across the time period (Figure 3).

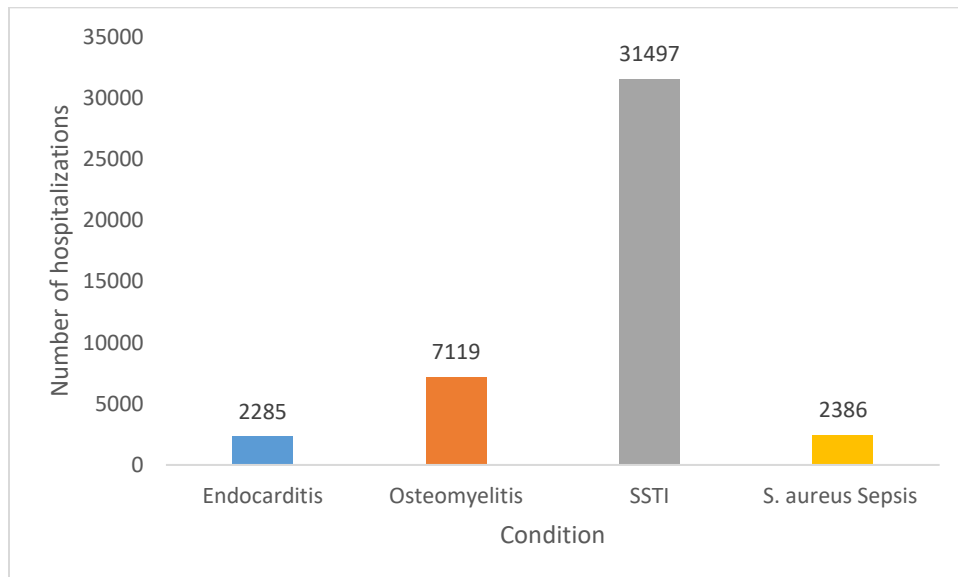


Figure 1 Frequency of endocarditis, osteomyelitis, SSTI, and *S. aureus* sepsis hospitalizations among Allegheny County residents, 2016-2020

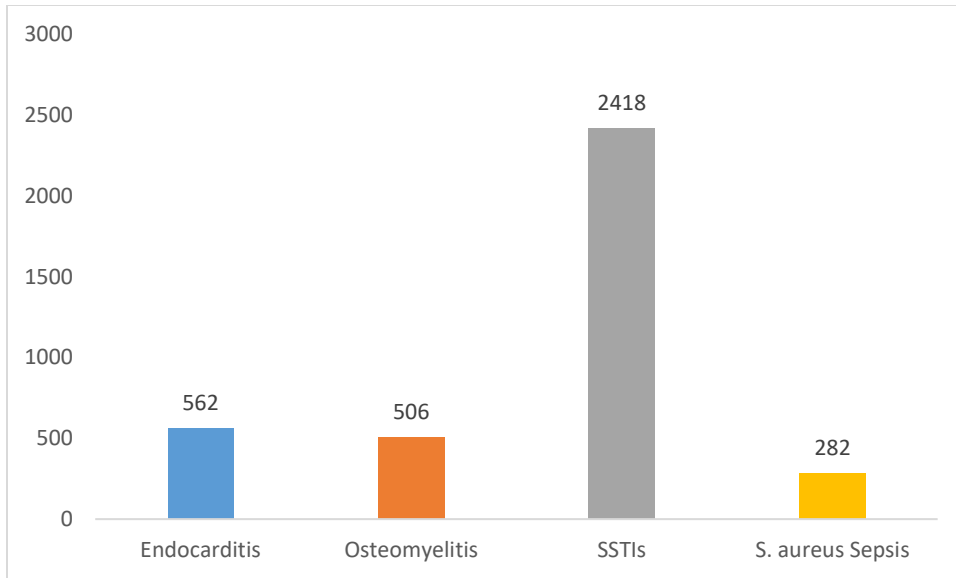


Figure 2 Frequency of endocarditis, osteomyelitis, SSTI, and *S. aureus* sepsis hospitalizations among Allegheny County residents that contain at least one IDU-related diagnosis code, 2016-2020

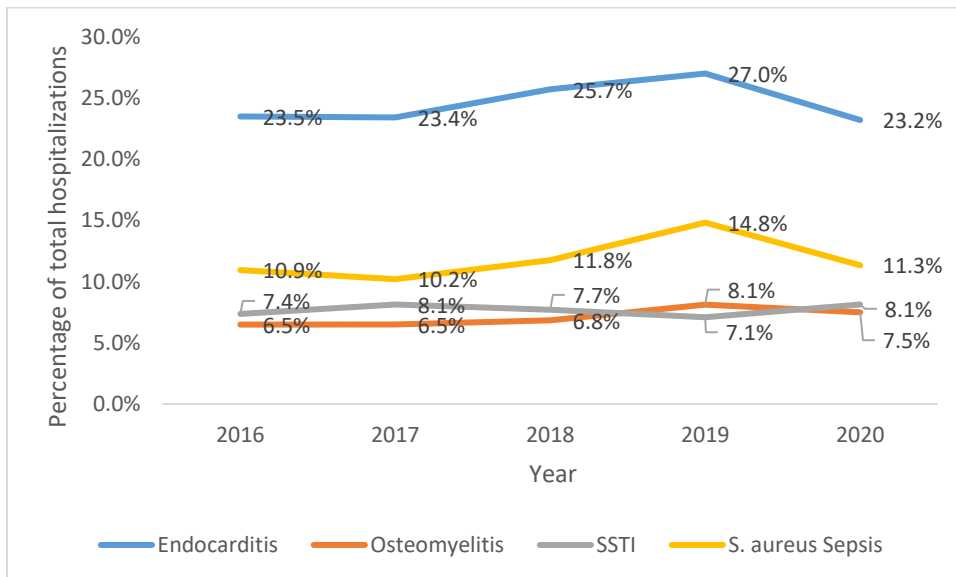


Figure 3 Percentage of endocarditis, osteomyelitis, SSTI, and *S. aureus* sepsis hospitalizations among Allegheny County residents that contain at least one IDU-related diagnosis code by year, 2016-2020

4.1 Endocarditis IDU-related Hospitalizations

The percentage of endocarditis infections with the presence of IDU-related diagnosis codes varied across the time period from 2016 to 2020 (Figure 3). IDU-related admissions markedly increased from 2017 (23.4%) to 2019 (27.0%) and noticeably decreased from 2019 to 2020 (23.2%) (Figure 3). Endocarditis hospitalizations that were associated with IDU ranged from 88 to 119 from 2016 through 2020 (Table 1). Of 562 total hospitalizations, 57.1% were among females, 86.2% were White, 42.0% were 25 to 34 years of age, and 81.3% were Medicaid beneficiaries. The large majority (60.0%) of the IDU-related hospitalizations involved a diagnosis code of opioid misuse only, 5.9% had a diagnosis of cocaine misuse only, and 30.2% were associated with simultaneous use of multiple substances (Table 1) including 29.7% with a diagnosis of opioid use and another drug.

In 2016, 58.3% of persons with IDU-related endocarditis hospitalizations were female, 85.9% were White, 38.8% were 25 to 34 years old, 61.2% were opioid-only diagnoses, and 70.9% were Medicaid beneficiaries. Each year, the number of hospitalizations remained higher among females, Whites, the 25 to 34-year-old age group, Medicaid beneficiaries, and opioid only diagnoses compared to Blacks, all other age groups, payor groups, and drug-type groups, respectively (Table 1).

The median total charge per IDU-related endocarditis admission was 94,083 U.S. dollars. The median total charge per admission was highest in 2020 (147,672 U.S. dollars). The median length of stay per IDU-related endocarditis admission was 10 days and ranged from 9 to 11 days across the time period (Table 2).

Table 1 Endocarditis IDU-Related Hospitalizations among Allegheny County Residents by Drug Use

Diagnosis and Demographic Characteristics, 2016-2020

	2016 n (%)	2017 n (%)	2018 n (%)	2019 n (%)	2020 n (%)	Total n (%)
	N = 103	N = 119	N = 129	N = 123	N = 88	N = 562
Drug Type Diagnosis						
Opioid only	63 (61.2)	69 (57.9)	70 (54.3)	73 (59.3)	62 (70.4)	337 (60.0)
Cocaine only	4 (3.9)	8 (6.7)	13 (10.1)	6 (4.9)	2 (2.3)	33 (5.9)
Sedative only	0	0	0	0	0	0
Stimulant only	1 (1.0)	0	1 (0.8)	0	0	2 (0.4)
Other psychoactive drug only	8 (7.8)	3 (2.5)	5 (3.9)	2 (1.6)	2 (2.3)	20 (3.6)
Two or more drugs	27 (26.2)	39 (32.8)	40 (31.0)	42 (34.1)	22 (25.0)	170 (30.2)
Opioid and another drug	26 (25.2)	38 (31.9)	39 (30.2)	42 (34.1)	22 (25.0)	167 (29.7)
Sex						
Female	60 (58.3)	75 (63.0)	72 (55.8)	65 (52.9)	49 (55.7)	321 (57.1)
Male	43 (42.8)	44 (37.0)	57 (44.2)	58 (47.2)	39 (44.3)	241 (42.9)
Race^a						
Black alone	13 (13.1)	16 (13.8)	13 (10.1)	13 (10.7)	15 (17.4)	70 (12.7)
White alone	85 (85.9)	100 (86.2)	115 (89.2)	107 (88.4)	68 (79.1)	475 (86.2)
Other	1 (1.0)	0	1 (0.8)	1 (0.8)	3 (3.5)	6 (1.1)
Age						
Under 20	0	0	0	0	0	0
20-24	20 (19.4)	15 (12.6)	5 (3.9)	8 (6.5)	7 (8.0)	55 (9.8)
25-34	40 (38.8)	49 (41.2)	53 (41.1)	58 (47.2)	36 (40.9)	236 (42.0)
35-44	10 (9.7)	31 (26.1)	49 (38.0)	33 (26.8)	23 (26.1)	146 (26.0)
45-54	15 (14.6)	8 (6.7)	12 (9.3)	13 (10.6)	12 (13.6)	60 (10.7)
55-64	16 (15.5)	13 (10.9)	7 (5.4)	9 (7.3)	10 (11.4)	55 (9.8)
65-74	2 (1.9)	3 (2.5)	3 (2.3)	2 (1.6)	0	10 (1.8)
75 and older	0	0	0	0	0	0
Payor^b						
Medicaid	73 (70.9)	102 (87.2)	95 (73.6)	110 (89.4)	75 (85.2)	455 (81.3)
Medicare	14 (13.6)	6 (5.1)	7 (5.4)	4 (3.3)	4 (4.6)	35 (6.3)
Private	15 (14.6)	7 (6.0)	22 (17.1)	9 (7.3)	9 (10.2)	62 (11.1)
Uninsured	1 (1.0)	2 (1.7)	5 (3.9)	0	0	8 (1.4)

a 11 hospitalizations missing race data

b 2 hospitalizations missing payor data

N = Number of hospitalizations with at least one endocarditis diagnosis code and one IDU-related code in primary or any secondary discharge diagnosis

Table 2 Hospital Outcomes for IDU-related Endocarditis Hospitalizations

	2016	2017	2018	2019	2020	Total
Total hospitalization charges, median US \$ (IQR)	83,999 (145,196)	92,424 (162,451)	97,521 (151,674)	83,271 (134,795)	147,672 (337,377)	94,083 (171,491)
Length of stay, median number of days (IQR)	10 (13)	11 (15)	11 (14)	9 (14)	11 (21)	10 (15)

4.2 Osteomyelitis IDU-related Hospitalizations

The percentage of osteomyelitis infections associated with IDU was relatively consistent from 2016 to 2020 (Figure 3). Osteomyelitis hospitalizations associated with IDU ranged from 78 to 119 during the time period (Table 3). Of 506 osteomyelitis IDU-related hospitalizations, 63.8% were among males, 74.7% were Whites, 25.1% were 55 to 64 years of age, and 73.3% were among Medicaid beneficiaries. Of these IDU-related admissions, 56.1%, 11.1%, and 24.3% involved diagnosis of opioid use only, cocaine use only, and polysubstance use, respectively (Table 3), including 22.5% with a diagnosis of opioid use and another drug. Over three quarters (78.6%) of identified osteomyelitis IDU-related hospitalizations involved opioid use.

In 2016, 59.0% of IDU-related osteomyelitis hospitalizations were among males, 66.7% were among Whites, 26.9% were among the 45 to 54-year-old age group, and 76.6% were among Medicaid beneficiaries. Over half (52.6%) involved opioid-only diagnoses. The distribution of hospitalizations among males compared to females was highest in 2019 (68.1% compared to 31.9%), and males experienced a greater proportion of hospitalizations each year compared to females. The proportion of hospitalizations among Whites and Blacks varied by year. White hospitalizations were highest in 2020 (82.4%) while Black hospitalizations were highest in 2016 (32.1%). The 25 to 34-year-old age group consistently experienced the highest proportion of hospitalizations compared to all other age groups each year from 2016 through 2020. Admissions were higher among Medicaid beneficiaries compared to admissions in all other payor groups each year (Table 3).

The median total charge per IDU-related osteomyelitis admission was 82,605 U.S. dollars. The median total charge per admission was highest in 2020 (114,146 U.S. dollars). The median length of stay ranged from 6 to 9 days each year (Table 4).

Table 3 Osteomyelitis IDU-Related Hospitalizations among Allegheny County Residents by Drug Use

Diagnosis and Demographic Characteristics, 2016-2020

	2016 n (%)	2017 n (%)	2018 n (%)	2019 n (%)	2020 n (%)	Total n (%)
	N=78	N=96	N=105	N=119	N=108	N=506
Drug Type Diagnosis						
Opioid only	41 (52.6)	52 (54.2)	58 (55.2)	67 (56.3)	66 (61.1)	284 (56.1)
Opioid and another drug	18 (23.1)	21 (21.9)	21 (20)	31 (26.1)	23 (21.3)	114 (22.5)
Cocaine only	10 (12.8)	12 (12.5)	1 (12.4)	11 (9.2)	10 (9.3)	56 (11.1)
Sedative only	0	1 (1.0)	5 (4.8)	1 (0.8)	0	7 (1.4)
Stimulant only	0	1 (1.0)	1 (1)	0	0	2 (0.4)
Other psychoactive drug only	7 (9)	8 (8.3)	5 (4.8)	5 (4.2)	9 (8.3)	34 (6.7)
Two or more drugs	20 (25.6)	22 (22.9)	23 (21.9)	35 (29.4)	23 (29.3)	123 (24.3)
Sex						
Female	32 (41)	31 (32.3)	38 (36.2)	38 (31.9)	44 (40.7)	183 (36.2)
Male	46 (59)	65 (67.7)	67 (63.8)	81 (68.1)	64 (59.3)	323 (63.8)
Race^a						
Black	25 (32.5)	29 (30.9)	21 (20.8)	26 (22.0)	19 (17.6)	120 (24.1)
White	52 (67.5)	65 (69.2)	80 (79.2)	92 (78.0)	89 (82.4)	378 (75.9)
Other ^b						0
Age						
Under 20						0
20-24	1 (1.3)	1 (1.0)	1 (1.0)	0	0	3 (0.6)
25-34	15 (19.2)	21 (21.9)	14 (13.3)	14 (11.8)	13 (12.0)	77 (15.2)
35-44	18 (23.1)	20 (20.8)	34 (32.4)	24 (20.2)	30 (27.8)	126 (24.9)
45-54	21 (26.9)	22 (22.9)	21 (20.0)	33 (27.7)	25 (23.2)	122 (24.1)
55-64	16 (20.5)	23 (24.0)	21 (20.0)	37 (31.1)	30 (27.8)	127 (25.1)
65-74	7 (9.0)	6 (6.3)	13 (12.4)	10 (8.40)	10 (9.3)	46 (9.1)
75 and older	0	3 (3.1)	1 (1.0)	1 (0.8)	0	5 (1.0)
Payor^c						
Medicaid	60 (76.9)	72 (75.0)	64 (61.0)	89 (74.8)	81 (75.0)	366 (72.3)
Medicare	10 (12.8)	6 (6.3)	17 (16.2)	18 (15.1)	11 (10.2)	62 (12.3)
Private	8 (10.3)	15 (15.6)	22 (21.0)	12 (10.1)	14 (13.0)	71 (14.0)
Uninsured	0	1 (1.0)	2 (1.9)	0	2 (1.9)	5 (1.0)

a 8 hospitalizations missing race data

c 2 hospitalizations with 'other government' insurance type not shown in table

N = Number of hospitalizations with at least one osteomyelitis diagnosis code and one IDU-related code in primary or any secondary discharge diagnosis

Table 4 Hospital Outcomes for IDU-related Osteomyelitis Hospitalizations

	2016	2017	2018	2019	2020	Total
Total hospitalization charges, median US \$ (IQR)	73,499 (105,040)	63,300 (132,162)	82,250 (114,451)	81,945 (131,387)	114,146 (155,087)	82,605 (122,359)
Length of stay, median number of days (IQR)	8 (8)	8 (11)	9 (11)	9 (12)	6 (11.5)	9 (13)

4.3 Skin and Soft Tissue Infection IDU-related Hospitalizations

The percentage of SSTIs associated with IDU was similar each year from 2016 to 2020 (Figure 3). SSTI hospitalizations associated with IDU ranged from 419 to 556 during the time period (Table 5). Of 2418 total SSTI IDU-related hospitalizations, 55.4% were among males, 81.0% were among Whites, 28.7% were 35 to 44 years of age, and 65.9% were among Medicaid beneficiaries. Of these admissions, 54.6%, 10.9%, and 26.0% involved a diagnosis of opioid use only, cocaine use only, and polysubstance use, respectively (Table 5) with 23.1% involving a diagnosis of opioid use and another drug.

In 2016, 54.8% of IDU-related SSTI hospitalizations were among males, 83.3% were among Whites, 28.8% were among the 35 to 44-year-old age group, and 68.4% were among Medicaid beneficiaries. Almost two-thirds (64.1%) involved opioid-only diagnoses. The distribution of hospitalizations among males and Whites compared to females and Blacks, respectively, was similar each year with males and whites consistently experiencing a greater proportion of hospitalizations. The proportion of hospitalizations among Whites and Blacks was slightly different in 2019 and 2020, with White hospitalizations being lower than in other years. The 35 to 44-year-old age group consistently experienced the highest proportion of hospitalizations compared to all other age groups each year from 2016 through 2020. Opioid only diagnosis codes accounted for the largest proportion of IDU-related SSTI hospitalizations and the distribution of drug type diagnoses is relatively similar each year. Admissions were higher among Medicaid beneficiaries compared to admissions in all other payor groups each year with a markedly different distribution in hospitalizations in 2018. Admissions among Medicaid beneficiaries were about 10% lower in 2018 than in other years and slightly higher among privately insured admissions (Table 5).

The median total charge per IDU-related SSTI admission was 34,133 U.S. dollars. The median total charge per admission was highest in 2020 (50,164 U.S. dollars) (Table 6). Of all 2418 hospitalizations, the median length of stay per hospitalization was 4 days. The median length of stay per IDU-related SSTI admission ranged from 4 to 5 days across the time period (Table 6).

Table 5 SSTI IDU-Related Hospitalizations among Allegheny County Residents by Drug Use Diagnosis and Demographic Characteristics, 2016-2020

	2016 n (%)	2017 n (%)	2018 n (%)	2019 n (%)	2020 n (%)	Total n (%)
	N=496	N=556	N=524	N=423	N=419	N=2418
Drug Type Diagnosis						
Opioid only	318 (64.1)	310 (55.8)	283 (54.0)	192 (45.4)	217 (51.8)	1320 (54.6)
Opioid and another drug	97 (19.6)	123 (22.1)	116 (22.1)	146 (34.5)	117 (27.9)	599 (24.8)
Cocaine only	36 (7.3)	61 (1.6)	76 (14.5)	47 (11.1)	44 (10.5)	264 (10.9)
Sedative only	6 (1.2)	9 (1.04)	11 (2.1)	3 (0.7)	8 (1.9)	37 (1.5)
Stimulant only	2 (0.4)	2 (0.4)	5 (1.0)	4 (1.0)	8 (1.9)	21 (0.9)
Other psychoactive drug only	33 (6.7)	43 (7.7)	26 (5.0)	25 (5.9)	21 (5.0)	148 (6.1)
Two or more drugs	101 (20.4)	131 (23.6)	123 (23.5)	152 (35.9)	121 (28.9)	628 (26.0)
Sex						
Female	224 (45.2)	256 (46.0)	226 (43.1)	190 (44.9)	183 (43.7)	1079 (44.6)
Male	272 (54.8)	300 (54.0)	298 (56.9)	233 (55.1)	236 (56.3)	1339 (55.4)
Race^a						
Black	68 (14.0)	88 (16.1)	83 (16.1)	83 (20.0)	67 (16.5)	389 (16.4)
White	413 (85.2)	455 (83.0)	430 (83.2)	327 (78.6)	333 (81.8)	1958 (82.5)
Other	4 (0.8)	5 (0.9)	4 (0.8)	6 (1.4)	7 (1.7)	26 (1.1)
Age						
Under 20	3 (0.6)	1 (0.2)	0	0	1(0.2)	5 (0.2)
20-24	18 (3.6)	23 (4.1)	18 (3.4)	9 (2.1)	6 (1.4)	74 (3.1)
25-34	114 (23.0)	136 (24.5)	99 (18.9)	91 (21.5)	82 (19.6)	522 (21.6)
35-44	143 (28.8)	162 (29.1)	152 (29.0)	126 (29.8)	112 (26.7)	695 (28.7)
45-54	125 (25.2)	122 (21.9)	111 (21.2)	92 (21.8)	93 (22.2)	543 (22.5)
55-64	67 (13.51)	81 (14.6)	91 (17.4)	73 (17.3)	91 (21.7)	403 (16.7)
65-74	17 (3.4)	27 (4.9)	44 (8.4)	25 (5.9)	31 (7.4)	144 (6.0)
75 and older	9 (1.8)	4 (0.7)	9 (1.7)	7 (1.7)	3 (0.7)	32 (1.3)
Payor^b						
Medicaid	337 (68.4)	372 (66.9)	294 (56.3)	297 (70.2)	290 (69.2)	1590 (65.9)
Medicare	56 (11.4)	57 (10.3)	77 (14.8)	54 (12.8)	57 (13.6)	301 (12.5)
Private	80 (16.2)	106 (19.1)	127 (24.3)	59 (14.0)	64 (15.3)	436 (18.1)
Uninsured	18 (3.7)	19 (3.4)	23 (4.4)	13 (3.1)	8 (1.9)	81 (3.4)

a 45 hospitalizations missing race data

b 5 hospitalizations with 'other government' insurance type not shown in table, 5 hospitalizations missing payor data

N = Number of hospitalizations with at least one SSTI diagnosis code and one IDU-related code in primary or any secondary discharge diagnosis

Table 6 Hospital Outcomes for SSTI IDU-related Hospitalizations

	2016	2017	2018	2019	2020	Total
Total hospitalization charges, median US \$ (IQR)	27,017 (45,743)	27,706 (38,567)	35,045 (56,453)	43,959 (63,659)	50,164 (75,063)	34,133 (58,242)
Length of stay, median number of days (IQR)	4 (5)	4 (5)	4 (5)	5 (6)	5 (7)	4 (5)

4.4 *Staphylococcus aureus* Sepsis IDU-related Hospitalizations

The percentage of *S. aureus* sepsis infections associated with IDU varied across the time period (Figure 3). Admissions markedly increased from 2018 (11.8%) to 2019 (14.8%) and noticeably decreased from 2019 to 2020 (11.3%) (Figure 3). *S. aureus* sepsis hospitalizations associated with IDU ranged from 49 to 71 across the time period (Table 7). Of 282 *S. aureus* sepsis IDU-related hospitalizations, 53.6% were among females, 86.9% were among Whites, 31.6% were 35 to 44 years of age, and 76.2% were among Medicaid beneficiaries. Of these admissions, 59.9%, 7.5%, and 26.6% involved diagnosis of opioid use only, cocaine use only, and polysubstance use, respectively (Table 7), with 26.2% of hospitalizations involving opioid use and another drug.

In 2016, 57.1% of IDU-related *S. aureus* sepsis hospitalizations were among females, 77.6% were among Whites, 30.6% were among the 45 to 54-year-old age group, and 71.4% were among Medicaid beneficiaries. Of admissions in 2016, 55.1% involved opioid-only diagnoses. The distribution of hospitalizations among females compared to males varied slightly each year. In 2018, 65.5% of admissions were among females while 34.5% were among males, which was the largest difference among female and male hospitalizations compared to all other years. Hospitalizations among Whites were consistently higher than those among Blacks. The distribution of hospitalizations among various age groups differed each year. In 2016, 30.6% of admissions were among the 45 to 54-year-old age group, but in all other years, the proportion of

admissions was highest among the 35 to 44-year-old age group. The proportion of admissions was highest in the 35 to 44-year-old age group in 2018. Opioid only diagnosis codes accounted for the largest proportion of IDU-related *S. aureus* sepsis hospitalizations each year. The distribution of hospitalizations among drug type diagnosis groups is relatively similar each year. However, the percentage of opioid-only diagnoses was markedly higher in 2020 (72.2%) than in all other years. Admissions were consistently higher among Medicaid beneficiaries compared to admissions in all other payor groups each year (Table 7).

The median total charge per IDU-related *S. aureus* sepsis admission was 126,154 U.S. dollars. The median total charge per admission was highest in 2020 (168,900 U.S. dollars). Of 282 admissions, the median length of stay per IDU-related *S. aureus* sepsis admission was 13 days. The median length of stay for *S. aureus* sepsis IDU-related hospitalizations varied slightly by year and ranged from 11 to 15 days (Table 8).

Table 7 *S. aureus* Sepsis IDU-Related Hospitalizations among Allegheny County Residents by Drug Use

	Diagnosis and Demographic Characteristics, 2016-2020					
	2016 n (%)	2017 n (%)	2018 n (%)	2019 n (%)	2020 n (%)	Total n (%)
	N=49	N=50	N=58	N=71	N=54	N=282
Drug Type Diagnosis						
Opioid only	27 (55.1)	26 (52.0)	35 (60.3)	42 (59.2)	39 (72.2)	169 (59.9)
Opioid and another drug	13 (26.5)	16 (32.0)	15 (25.9)	21 (29.6)	9 (16.7)	74 (26.2)
Cocaine only	4 (8.2)	3 (6.0)	4 (6.9)	5 (7.0)	5 (9.3)	21 (7.5)
Sedative only	1 (2.0)	2 (4.0)	0	0	0	3 (1.1)
Stimulant only	0	0	1(1.7)	0	0	1(.4)
Other psychoactive drug only	4 (8.2)	3 (6.0)	2 (3.5)	3 (4.2)	1 (1.9)	13 (4.6)
Two or more drugs	13 (26.5)	16 (32.0)	16 (27.6)	21 (29.6)	9 (29.3)	75 (26.6)
Sex						
Female	28 (57.1)	26 (52.0)	38 (65.5)	33 (46.5)	26 (48.2)	151 (53.6)
Male	21 (42.9)	24 (48.0)	20 (34.5)	38 (53.5)	28 (51.9)	131 (46.5)
Race^a						
Black	9 (19.1)	4 (8.3)	5 (8.6)	5 (7.0)	6 (11.1)	29 (10.4)
White	38 (80.9)	43 (89.6)	52 (89.7)	66 (93.0)	46 (85.2)	245 (88.1)
Other	0	1 (2.1)	1 (1.7)	0	2 (3.7)	4 (1.4)
Age						
Under 20						0

20-24	6 (12.2)	6 (12.0)	3 (5.2)	4 (5.6)	2 (3.7)	21 (7.5)
25-34	10 (20.4)	14 (28.0)	18 (31.0)	21 (29.6)	13 (24.1)	76 (27.0)
35-44	9 (18.4)	14 (28.0)	26 (44.8)	21 (29.6)	19 (35.2)	89 (31.6)
45-54	15 (30.6)	2 (4.0)	3 (5.2)	12 (16.9)	9 (16.7)	41 (14.5)
55-64	8 (16.3)	11 (22.0)	6 (10.3)	7 (9.9)	9 (16.7)	41 (14.5)
65-74	1 (2.0)	1 (2.0)	2 (3.5)	6 (8.5)	2 (3.7)	12 (4.3)
75 and Older	0	2 (4.0)	0	0	0	2 (0.7)
Payor						
Medicaid	35 (71.4)	37 (74.0)	42 (72.4)	56 (78.9)	45 (83.3)	215 (76.2)
Medicare	7 (14.3)	5 (10.0)	7 (12.1)	6 (8.5)	2 (3.7)	27 (9.6)
Private	7 (14.3)	6 (12.0)	8 (13.8)	9 (12.7)	7 (13.0)	37 (13.1)
Uninsured	0	2 (4.0)	1 (1.7)	0	0	3 (1.1)

a 4 hospitalizations missing race data

N = Number of hospitalizations with at least one *S. aureus* sepsis diagnosis code and one IDU-related code as the primary or any secondary discharge diagnosis

Table 8 Hospital Outcomes for *S. aureus* Sepsis IDU-related Hospitalizations

	2016	2017	2018	2019	2020	Total
Total hospitalization charges, median US \$ (IQR)	84,147 (82,933)	137,881 (182,996)	126,647 (304,575)	130,113 (199,274)	168,900 (345,698)	126,154 (208,010)
Length of stay, median number of days (IQR)	11 (9)	15 (14)	13 (19)	14 (13)	12 (19)	13 (15)

5.0 Discussion

The results of this analysis identified 3768 hospital admissions related to bacterial infection and the presence of IDU diagnostic codes. Of these admissions, bacterial infection involving SSTI were most frequent in occurrence by number (n=2418). However, by percentage, IDU-related involvement in admissions among endocarditis hospitalizations was quite high (almost 25% of all endocarditis admissions included an IDU diagnostic code) during the time period. At the other end of the spectrum, the percentage of IDU involvement was lowest among osteomyelitis hospitalizations (7.1%). The percentage of invasive bacterial infections associated with IDU has remained relatively stable from 2016 to 2020. The most prominent changes were the decreases in the percentage of IDU admissions among *S. aureus* sepsis and endocarditis hospitalizations from 2019 to 2020. The most prominent drug identified in the diagnostic codes throughout this assessment was the involvement of opioids.

The higher frequency of SSTIs and IDU, by number, observed among Allegheny County residents is a finding that is consistent with findings of a systematic review which found SSTIs are the most commonly reported bacterial infection associated with IDU.³⁶ Further, our results show that endocarditis admissions were the second most common condition associated with IDU, compared to the other conditions in this study. In Oregon, there were similarly more IDU-related endocarditis hospitalizations than IDU-related osteomyelitis hospitalizations but less IDU-related endocarditis hospitalizations than IDU-related SSTI hospitalizations.¹⁶ We found that there were 562 IDU-related endocarditis hospitalizations across 2016 through 2020. However, this was two times higher than a previous study that found there were 283 drug-use related infective endocarditis hospitalizations in Allegheny County from 2013 to 2017.¹⁷

The pattern of osteomyelitis IDU-related hospitalizations (low in comparison to other bacterial infections) was similar to those in Oregon. A study found that there were 371 IDU-related osteomyelitis hospitalizations in Oregon in 2018 which is an estimated rate of 9.7 per 100,000 Oregon residents.¹⁶ There were 105 IDU-related osteomyelitis hospitalizations in 2018 in Allegheny County, which can be estimated to be a rate of 8.6 per 100,000 Allegheny County residents.

These results also suggest that the majority of Allegheny County resident hospitalizations for each bacterial infection associated with IDU were among Whites and Medicaid beneficiaries. Hospitalizations were more likely to involve opioids than any other drug type. Cocaine use and polysubstance use were also involved in meaningful percentages of hospitalizations of each condition. Heroin is an opioid that has been found to be the most commonly injected drug among PWID,^{27,28} which may explain the high proportion of hospitalizations involving opioid use diagnoses. Race, insurance type, and drug use characteristics of bacterial infection IDU-related hospitalizations among Allegheny County residents are consistent with hospitalizations in Oregon where IDU-related hospitalizations for endocarditis, osteomyelitis, and SSTIs were also higher among Whites, Medicaid beneficiaries, and opioid-only diagnoses.^{16,18,26} This observation of similarities between Allegheny County and Oregon suggests that the patterns and elements related to invasive infections associated with IDU in Allegheny County are not largely different than those seen in other parts of the United States.

The percentage of bacterial infection IDU-related hospitalizations for all conditions appeared to be particularly focused among Medicaid beneficiaries. This is consistent with previous research that PWID who are hospitalized for bacterial infections are more likely to have Medicaid or Medicare.²⁶ Individuals with publicly-funded insurance may be more likely to be unemployed

or have low-paying jobs, which could further increase their risk for comorbid health issues both related and unrelated to IDU.

The percentage of endocarditis IDU-related hospitalizations was higher among females compared to males. Additionally, the percent of endocarditis IDU-related hospitalizations was prominently higher among the 25 to 34-year-old age group compared to all other age groups. Previous research in Oregon similarly shows that IDU-related endocarditis hospitalizations are higher among females.^{16,42} IDU-related endocarditis hospitalizations admissions are also increasingly impacting younger age groups.^{16,42} Total charges and length of stay per endocarditis IDU-related admission were second highest compared to all other conditions.

The percentage of osteomyelitis IDU-related hospitalizations was highest among older populations and males compared to females. Osteomyelitis IDU-related hospitalizations in Oregon were similarly highest among 50 to 59-year-olds and males.¹⁶ Osteomyelitis IDU-related hospitalizations ranked third highest for median total charge and length of stay per admission. Our results are similar to previous research that shows length of stay is high among osteomyelitis hospitalizations associated with opioid drug use.⁵¹

The percentage of IDU-related SSTI hospitalizations was higher among males compared to females and 35 to 44-year-olds compared to all other age groups. This is consistent with hospitalization data in Oregon where Capizzi et al. found that SSTI IDU-related hospitalizations were also higher among males compared to females and higher among middle aged individuals, particularly 40 to 49-year-olds.¹⁶ Total charges and length of stay were lowest per SSTI IDU-related hospitalization, which aligns with a cost analysis of bacterial infection hospitalizations in Oregon where an admission for SSTI associated with IDU was cheapest and shorter compared to an admission for osteomyelitis, endocarditis, or bacteremia sepsis.¹⁶

Total charge and length of stay per admission were highest for *S. aureus* sepsis IDU-related hospitalizations compared to all other bacterial infections indicating that invasive MRSA infections associated with IDU are contributing to high healthcare costs. A long length of stay and high total charges indicate that *S. aureus* sepsis causes the most severe illness and requires more intensive treatment than other conditions. IDU-related admissions for this condition result in a higher economic burden for individuals compared to people admitted for the other IDU-related conditions in this analysis. However, *S. aureus* sepsis IDU-related admissions were overall less costly in Allegheny County since the frequency of *S. aureus* sepsis hospitalizations was the lowest compared to all other conditions in this analysis.

There are several limitations associated with this analysis. There is no ICD-10 code for injection drug use, so we used an algorithm for IDU. The use of an algorithm suggests that we may not be capturing all hospitalizations related to IDU. Drug types identified during an in-patient hospital discharge are dependent on the person who is entering or recording ICD-10 codes. Recording of codes may be variable from person to person. Recording methods are facility and healthcare professional specific, so drug type coding may not accurately reflect all drugs a patient used prior to hospital admission. The PHC4 dataset is missing race and payor type data for some observations. However, we do not expect these missing observations to impact our findings due to the low percentage of missing data among hospitalizations.

Additionally, the analysis did not limit hospitalizations to unique patients. We are looking at total hospital admissions, not persons. Patients with endocarditis⁴⁸, especially, may come back multiple times a year. Therefore, our analysis shows incidence at the hospitalization level and not incidence at the person-level. A consequence of a hospitalization level analysis is that we cannot describe the risk of a condition among PWID. We are describing the proportion of IDU admissions

among bacterial infection hospital admissions. We looked at both primary and secondary discharge codes for each condition type. Assessing the patterns between IDU and bacterial infection where the infection is the primary reason for the admission should be a topic to address in future research. In addition, it would be important to follow a cohort of PWID to identify the frequency of hospitalization for bacterial infection.

Strengths of this study include the representativeness of our data. PHC4 collects information on all inpatient hospitalizations across all healthcare facilities in Pennsylvania. Additionally, this is one of the few widespread examinations of invasive infections associated with injection drug use in Allegheny County.

In conclusion, invasive bacterial infections associated with IDU are not infrequent in occurrence in Allegheny County. This data can provide insight on IDU concomitant condition hospitalizations as a health issue affecting the country. These data can also inform stakeholders of the demographic and direct health-care costs associated with these conditions. Identifying who may be disproportionately impacted by these conditions would allow appropriate stakeholders to direct prevention efforts to improve the health and well-being of people with SUD, particularly PWID, in Allegheny County. These data also indicate the need for harm reduction in Allegheny County, including the expansion of syringe service programs to reduce the prevalence of health issues that result from IDU.

Appendix A Injection Drug Use Algorithm

Appendix Table 1 Injection Drug Use Algorithm ICD-10 Codes

ICD-10 Code	Description
F1110	Opioid abuse, uncomplicated
F11120	Opioid abuse with intoxication, uncomplicated
F11121	Opioid abuse with intoxication delirium
F11122	Opioid abuse with intoxication with perceptual disturbance
F11129	Opioid abuse with intoxication, unspecified
F1114	Opioid abuse with opioid-induced mood disorder
F11150	Opioid abuse with opioid-induced psychotic disorder with delusions
F11151	Opioid abuse with opioid-induced psychotic disorder with hallucinations
F11159	Opioid abuse with opioid-induced psychotic disorder, unspecified
F11181	Opioid abuse with opioid-induced sexual dysfunction
F11182	Opioid abuse with opioid-induced sleep disorder
F11188	Opioid abuse with other opioid-induced disorder
F1119	Opioid abuse with unspecified opioid-induced disorder
F1120	Opioid dependence, uncomplicated
F11220	Opioid dependence with intoxication, uncomplicated
F11221	Opioid dependence with intoxication delirium
F11222	Opioid dependence with intoxication with perceptual disturbance
F11229	Opioid dependence with intoxication, unspecified
F1123	Opioid dependence with withdrawal
F1124	Opioid dependence with opioid-induced mood disorder
F11250	Opioid dependence with opioid-induced psychotic disorder with delusions
F11251	Opioid dependence with opioid-induced psychotic disorder with hallucinations
F11259	Opioid dependence with opioid-induced psychotic disorder, unspecified
F11281	Opioid dependence with opioid-induced sexual dysfunction
F11282	Opioid dependence with opioid-induced sleep disorder
F11288	Opioid dependence with other opioid-induced disorder
F1129	Opioid dependence with unspecified opioid-induced disorder
F1190	Opioid use, unspecified, uncomplicated
F11920	Opioid use, unspecified with intoxication, uncomplicated
F11921	Opioid use, unspecified with intoxication delirium
F11922	Opioid use, unspecified with intoxication with perceptual disturbance
F11929	Opioid use, unspecified with intoxication, unspecified
F1193	Opioid use, unspecified with withdrawal
F1194	Opioid use, unspecified with opioid-induced mood disorder

F11950	Opioid use, unspecified with opioid-induced psychotic disorder with delusions
F11951	Opioid use, unspecified with opioid-induced psychotic disorder with hallucinations
F11959	Opioid use, unspecified with opioid-induced psychotic disorder, unspecified
F11981	Opioid use, unspecified with opioid-induced sexual dysfunction
F11982	Opioid use, unspecified with opioid-induced sleep disorder
F11988	Opioid use, unspecified with other opioid-induced disorder
F1199	Opioid use, unspecified with unspecified opioid-induced disorder
F1310	Sedative, hypnotic or anxiolytic abuse, uncomplicated
F13120	Sedative, hypnotic or anxiolytic abuse with intoxication, uncomplicated
F13121	Sedative, hypnotic or anxiolytic abuse with intoxication delirium
F13129	Sedative, hypnotic or anxiolytic abuse with intoxication, unspecified
F13130	Sedative, hypnotic or anxiolytic abuse with withdrawal, uncomplicated
F13131	Sedative, hypnotic or anxiolytic abuse with withdrawal delirium
F13132	Sedative, hypnotic or anxiolytic abuse with withdrawal with perceptual disturbance
F13139	Sedative, hypnotic or anxiolytic abuse with withdrawal, unspecified
F1314	Sedative, hypnotic or anxiolytic abuse with sedative, hypnotic or anxiolytic-induced mood disorder
F13150	Sedative, hypnotic or anxiolytic abuse with sedative, hypnotic or anxiolytic-induced psychotic disorder with delusions
F13151	Sedative, hypnotic or anxiolytic abuse with sedative, hypnotic or anxiolytic-induced psychotic disorder with hallucinations
F13159	Sedative, hypnotic or anxiolytic abuse with sedative, hypnotic or anxiolytic-induced psychotic disorder, unspecified
F13180	Sedative, hypnotic or anxiolytic abuse with sedative, hypnotic or anxiolytic-induced anxiety disorder
F13181	Sedative, hypnotic or anxiolytic abuse with sedative, hypnotic or anxiolytic-induced sexual dysfunction
F13182	Sedative, hypnotic or anxiolytic abuse with sedative, hypnotic or anxiolytic-induced sleep disorder
F13188	Sedative, hypnotic or anxiolytic abuse with other sedative, hypnotic or anxiolytic-induced disorder
F1319	Sedative, hypnotic or anxiolytic abuse with unspecified sedative, hypnotic or anxiolytic-induced disorder
F1320	Sedative, hypnotic or anxiolytic dependence, uncomplicated
F13220	Sedative, hypnotic or anxiolytic dependence with intoxication, uncomplicated
F13221	Sedative, hypnotic or anxiolytic dependence with intoxication delirium
F13229	Sedative, hypnotic or anxiolytic dependence with intoxication, unspecified
F13230	Sedative, hypnotic or anxiolytic dependence with withdrawal, uncomplicated
F13231	Sedative, hypnotic or anxiolytic dependence with withdrawal delirium
F13232	Sedative, hypnotic or anxiolytic dependence with withdrawal with perceptual disturbance
F13239	Sedative, hypnotic or anxiolytic dependence with withdrawal, unspecified
F1324	Sedative, hypnotic or anxiolytic dependence with sedative, hypnotic or anxiolytic-induced mood disorder
F13250	Sedative, hypnotic or anxiolytic dependence with sedative, hypnotic or anxiolytic-induced psychotic disorder with delusions
F13251	Sedative, hypnotic or anxiolytic dependence with sedative, hypnotic or anxiolytic-induced psychotic disorder with hallucinations
F13259	Sedative, hypnotic or anxiolytic dependence with sedative, hypnotic or anxiolytic-induced psychotic disorder, unspecified
F1326	Sedative, hypnotic or anxiolytic dependence with sedative, hypnotic or anxiolytic-induced persisting amnesic disorder

F1327	Sedative, hypnotic or anxiolytic dependence with sedative, hypnotic or anxiolytic-induced persisting dementia
F13280	Sedative, hypnotic or anxiolytic dependence with sedative, hypnotic or anxiolytic-induced anxiety disorder
F13281	Sedative, hypnotic or anxiolytic dependence with sedative, hypnotic or anxiolytic-induced sexual dysfunction
F13282	Sedative, hypnotic or anxiolytic dependence with sedative, hypnotic or anxiolytic-induced sleep disorder
F13288	Sedative, hypnotic or anxiolytic dependence with other sedative, hypnotic or anxiolytic-induced disorder
F1329	Sedative, hypnotic or anxiolytic dependence with unspecified sedative, hypnotic or anxiolytic-induced disorder
F1390	Sedative, hypnotic, or anxiolytic use, unspecified, uncomplicated
F13920	Sedative, hypnotic or anxiolytic use, unspecified with intoxication, uncomplicated
F13921	Sedative, hypnotic or anxiolytic use, unspecified with intoxication delirium
F13929	Sedative, hypnotic or anxiolytic use, unspecified with intoxication, unspecified
F13930	Sedative, hypnotic or anxiolytic use, unspecified with withdrawal, uncomplicated
F13931	Sedative, hypnotic or anxiolytic use, unspecified with withdrawal delirium
F13932	Sedative, hypnotic or anxiolytic use, unspecified with withdrawal with perceptual disturbances
F13939	Sedative, hypnotic or anxiolytic use, unspecified with withdrawal, unspecified
F1394	Sedative, hypnotic or anxiolytic use, unspecified with sedative, hypnotic or anxiolytic-induced mood disorder
F13950	Sedative, hypnotic or anxiolytic use, unspecified with sedative, hypnotic or anxiolytic-induced psychotic disorder with delusions
F13951	Sedative, hypnotic or anxiolytic use, unspecified with sedative, hypnotic or anxiolytic-induced psychotic disorder with hallucinations
F13959	Sedative, hypnotic or anxiolytic use, unspecified with sedative, hypnotic or anxiolytic-induced psychotic disorder, unspecified
F1396	Sedative, hypnotic or anxiolytic use, unspecified with sedative, hypnotic or anxiolytic-induced persisting amnesic disorder
F1397	Sedative, hypnotic or anxiolytic use, unspecified with sedative, hypnotic or anxiolytic-induced persisting dementia
F13980	Sedative, hypnotic or anxiolytic use, unspecified with sedative, hypnotic or anxiolytic-induced anxiety disorder
F13981	Sedative, hypnotic or anxiolytic use, unspecified with sedative, hypnotic or anxiolytic-induced sexual dysfunction
F13982	Sedative, hypnotic or anxiolytic use, unspecified with sedative, hypnotic or anxiolytic-induced sleep disorder
F13988	Sedative, hypnotic or anxiolytic use, unspecified with other sedative, hypnotic or anxiolytic-induced disorder
F1399	Sedative, hypnotic or anxiolytic use, unspecified with unspecified sedative, hypnotic or anxiolytic-induced disorder
F1410	Cocaine abuse, uncomplicated
F14120	Cocaine abuse with intoxication, uncomplicated
F14121	Cocaine abuse with intoxication with delirium
F14122	Cocaine abuse with intoxication with perceptual disturbance
F14129	Cocaine abuse with intoxication, unspecified
F1414	Cocaine abuse with cocaine-induced mood disorder
F14150	Cocaine abuse with cocaine-induced psychotic disorder with delusions
F14151	Cocaine abuse with cocaine-induced psychotic disorder with hallucinations

F14159	Cocaine abuse with cocaine-induced psychotic disorder, unspecified
F14180	Cocaine abuse with cocaine-induced anxiety disorder
F14181	Cocaine abuse with cocaine-induced sexual dysfunction
F14182	Cocaine abuse with cocaine-induced sleep disorder
F14188	Cocaine abuse with other cocaine-induced disorder
F1419	Cocaine abuse with unspecified cocaine-induced disorder
F1420	Cocaine dependence, uncomplicated
F14220	Cocaine dependence with intoxication, uncomplicated
F14221	Cocaine dependence with intoxication delirium
F14222	Cocaine dependence with intoxication with perceptual disturbance
F14229	Cocaine dependence with intoxication, unspecified
F1423	Cocaine dependence with withdrawal
F1424	Cocaine dependence with cocaine-induced mood disorder
F14250	Cocaine dependence with cocaine-induced psychotic disorder with delusions
F14251	Cocaine dependence with cocaine-induced psychotic disorder with hallucinations
F14259	Cocaine dependence with cocaine-induced psychotic disorder, unspecified
F14280	Cocaine dependence with cocaine-induced anxiety disorder
F14281	Cocaine dependence with cocaine-induced sexual dysfunction
F14282	Cocaine dependence with cocaine-induced sleep disorder
F14288	Cocaine dependence with other cocaine-induced disorder
F1429	Cocaine dependence with unspecified cocaine-induced disorder
F1490	Cocaine use, unspecified, uncomplicated
F14920	Cocaine use, unspecified with intoxication, uncomplicated
F14921	Cocaine use, unspecified with intoxication delirium
F14922	Cocaine use, unspecified with intoxication with perceptual disturbance
F14929	Cocaine use, unspecified with intoxication, unspecified
F1494	Cocaine use, unspecified with cocaine-induced mood disorder
F14950	Cocaine use, unspecified with cocaine-induced psychotic disorder with delusions
F14951	Cocaine use, unspecified with cocaine-induced psychotic disorder with hallucinations
F14959	Cocaine use, unspecified with cocaine-induced psychotic disorder, unspecified
F14980	Cocaine use, unspecified with cocaine-induced anxiety disorder
F14981	Cocaine use, unspecified with cocaine-induced sexual dysfunction
F14982	Cocaine use, unspecified with cocaine-induced sleep disorder
F14988	Cocaine use, unspecified with other cocaine-induced disorder
F1499	Cocaine use, unspecified with unspecified cocaine-induced disorder
F1510	Other stimulant abuse, uncomplicated
F15120	Other stimulant abuse with intoxication, uncomplicated
F15121	Other stimulant abuse with intoxication delirium
F15122	Other stimulant abuse with intoxication with perceptual disturbance
F15129	Other stimulant abuse with intoxication, unspecified
F1514	Other stimulant abuse with stimulant-induced mood disorder
F15150	Other stimulant abuse with stimulant-induced psychotic disorder with delusions
F15151	Other stimulant abuse with stimulant-induced psychotic disorder with hallucinations

F15159	Other stimulant abuse with stimulant-induced psychotic disorder, unspecified
F15180	Other stimulant abuse with stimulant-induced anxiety disorder
F15181	Other stimulant abuse with stimulant-induced sexual dysfunction
F15182	Other stimulant abuse with stimulant-induced sleep disorder
F15188	Other stimulant abuse with other stimulant-induced disorder
F1519	Other stimulant abuse with unspecified stimulant-induced disorder
F1520	Other stimulant dependence, uncomplicated
F15220	Other stimulant dependence with intoxication, uncomplicated
F15221	Other stimulant dependence with intoxication delirium
F15222	Other stimulant dependence with intoxication with perceptual disturbance
F15229	Other stimulant dependence with intoxication, unspecified
F1523	Other stimulant dependence with withdrawal
F1524	Other stimulant dependence with stimulant-induced mood disorder
F15250	Other stimulant dependence with stimulant-induced psychotic disorder with delusions
F15251	Other stimulant dependence with stimulant-induced psychotic disorder with hallucinations
F15259	Other stimulant dependence with stimulant-induced psychotic disorder, unspecified
F15280	Other stimulant dependence with stimulant-induced anxiety disorder
F15281	Other stimulant dependence with stimulant-induced sexual dysfunction
F15282	Other stimulant dependence with stimulant-induced sleep disorder
F15288	Other stimulant dependence with other stimulant-induced disorder
F1529	Other stimulant dependence with unspecified stimulant-induced disorder
F1590	Other stimulant use, unspecified, uncomplicated
F15920	Other stimulant use, unspecified with intoxication, uncomplicated
F15921	Other stimulant use, unspecified with intoxication delirium
F15922	Other stimulant use, unspecified with intoxication with perceptual disturbance
F15929	Other stimulant use, unspecified with intoxication, unspecified
F1593	Other stimulant use, unspecified with withdrawal
F1594	Other stimulant use, unspecified with stimulant-induced mood disorder
F15950	Other stimulant use, unspecified with stimulant-induced psychotic disorder with delusions
F15951	Other stimulant use, unspecified with stimulant-induced psychotic disorder with hallucinations
F15959	Other stimulant use, unspecified with stimulant-induced psychotic disorder, unspecified
F15980	Other stimulant use, unspecified with stimulant-induced anxiety disorder
F15981	Other stimulant use, unspecified with stimulant-induced sexual dysfunction
F15982	Other stimulant use, unspecified with stimulant-induced sleep disorder
F15988	Other stimulant use, unspecified with other stimulant-induced disorder
F1599	Other stimulant use, unspecified with unspecified stimulant-induced disorder
F1910	Other psychoactive substance abuse, uncomplicated
F19120	Other psychoactive substance abuse with intoxication, uncomplicated
F19121	Other psychoactive substance abuse with intoxication delirium
F19122	Other psychoactive substance abuse with intoxication with perceptual disturbances
F19129	Other psychoactive substance abuse with intoxication, unspecified
F1914	Other psychoactive substance abuse with psychoactive substance-induced mood disorder

F19150	Other psychoactive substance abuse with psychoactive substance-induced psychotic disorder with delusions
F19151	Other psychoactive substance abuse with psychoactive substance-induced psychotic disorder with hallucinations
F19159	Other psychoactive substance abuse with psychoactive substance-induced psychotic disorder, unspecified
F1916	Other psychoactive substance abuse with psychoactive substance-induced persisting amnestic disorder
F1917	Other psychoactive substance abuse with psychoactive substance-induced persisting dementia
F19180	Other psychoactive substance abuse with psychoactive substance-induced anxiety disorder
F19181	Other psychoactive substance abuse with psychoactive substance-induced sexual dysfunction
F19182	Other psychoactive substance abuse with psychoactive substance-induced sleep disorder
F19188	Other psychoactive substance abuse with other psychoactive substance-induced disorder
F1919	Other psychoactive substance abuse with unspecified psychoactive substance-induced disorder
F1920	Other psychoactive substance dependence, uncomplicated
F19220	Other psychoactive substance dependence with intoxication, uncomplicated
F19221	Other psychoactive substance dependence with intoxication delirium
F19222	Other psychoactive substance dependence with intoxication with perceptual disturbance
F19229	Other psychoactive substance dependence with intoxication, unspecified
F19230	Other psychoactive substance dependence with withdrawal, uncomplicated
F19231	Other psychoactive substance dependence with withdrawal delirium
F19232	Other psychoactive substance dependence with withdrawal with perceptual disturbance
F19239	Other psychoactive substance dependence with withdrawal, unspecified
F1924	Other psychoactive substance dependence with psychoactive substance-induced mood disorder
F19250	Other psychoactive substance dependence with psychoactive substance-induced psychotic disorder with delusions
F19251	Other psychoactive substance dependence with psychoactive substance-induced psychotic disorder with hallucinations
F19259	Other psychoactive substance dependence with psychoactive substance-induced psychotic disorder, unspecified
F1926	Other psychoactive substance dependence with psychoactive substance-induced persisting amnestic disorder
F1927	Other psychoactive substance dependence with psychoactive substance-induced persisting dementia
F19280	Other psychoactive substance dependence with psychoactive substance-induced anxiety disorder
F19281	Other psychoactive substance dependence with psychoactive substance-induced sexual dysfunction
F19282	Other psychoactive substance dependence with psychoactive substance-induced sleep disorder
F19288	Other psychoactive substance dependence with other psychoactive substance-induced disorder
F1929	Other psychoactive substance dependence with unspecified psychoactive substance-induced disorder
F1990	Other psychoactive substance use, unspecified, uncomplicated
F19920	Other psychoactive substance use, unspecified with intoxication, uncomplicated
F19921	Other psychoactive substance use, unspecified with intoxication with delirium
F19922	Other psychoactive substance use, unspecified with intoxication with perceptual disturbance
F19929	Other psychoactive substance use, unspecified with intoxication, unspecified
F19930	Other psychoactive substance use, unspecified with withdrawal, uncomplicated
F19931	Other psychoactive substance use, unspecified with withdrawal delirium
F19932	Other psychoactive substance use, unspecified with withdrawal with perceptual disturbance

F19939	Other psychoactive substance use, unspecified with withdrawal, unspecified
F1994	Other psychoactive substance use, unspecified with psychoactive substance-induced mood disorder
F19950	Other psychoactive substance use, unspecified with psychoactive substance-induced psychotic disorder with delusions
F19951	Other psychoactive substance use, unspecified with psychoactive substance-induced psychotic disorder with hallucinations
F19959	Other psychoactive substance use, unspecified with psychoactive substance-induced psychotic disorder, unspecified
F1996	Other psychoactive substance use, unspecified with psychoactive substance-induced persisting amnesic disorder
F1997	Other psychoactive substance use, unspecified with psychoactive substance-induced persisting dementia
F19980	Other psychoactive substance use, unspecified with psychoactive substance-induced anxiety disorder
F19981	Other psychoactive substance use, unspecified with psychoactive substance-induced sexual dysfunction
F19982	Other psychoactive substance use, unspecified with psychoactive substance-induced sleep disorder
F19988	Other psychoactive substance use, unspecified with other psychoactive substance-induced disorder
F1999	Other psychoactive substance use, unspecified with unspecified psychoactive substance-induced disorder

Appendix B Injection Drug Use Algorithm Exclusions

Appendix Table 2 Important Exclusions from IDU Algorithm

ICD-10 Code	Description
F1111	Opioid abuse, in remission
F1121	Opioid dependence, in remission
F1311	Sedative, hypnotic or anxiolytic abuse, in remission
F1321	Sedative, hypnotic or anxiolytic dependence, in remission
F1411	Cocaine abuse, in remission
F1421	Cocaine dependence, in remission
F1511	Other stimulant abuse, in remission
F1521	Other stimulant dependence, in remission
F1911	Other psychoactive substance abuse, in remission
F1921	Other psychoactive substance dependence, in remission

**Appendix C ICD-10 Codes for Endocarditis, Osteomyelitis, Skin and Soft Tissue Infections,
and *S. aureus* Sepsis**

Appendix Table 3 ICD-10 Codes for Endocarditis, Osteomyelitis, SSTIs, and *S. aureus* Sepsis

ICD-10 Code	Description
Endocarditis*	
B37.6	Candidal endocarditis
I33	Acute and subacute endocarditis
I38	Endocarditis, valve unspecified
I39	Endocarditis and heart valve disorders in diseases classified elsewhere
Osteomyelitis*	
M86.1	Other acute osteomyelitis
M86.2	Subacute osteomyelitis
M86.9	Osteomyelitis, unspecified
M46.2	Osteomyelitis of vertebra
M46.3	Infection of intervertebral disc (pyogenic)
Skin and soft tissue infections*	
A48.0	Gas gangrene
G06	Intracranial and intraspinal abscess and granuloma
G09	Sequelae of inflammatory diseases of central nervous system
K68.12	Psoas muscle abscess
L03	Cellulitis and acute lymphangitis
L08.9	Local infection of the skin and subcutaneous tissue, unspecified
L98.9	Disorder of the skin and subcutaneous tissue, unspecified
M72.6	Necrotizing fasciitis
M54.02	Panniculitis affecting regions of neck and back, cervical region
M79.3	Panniculitis, unspecified
I96	Gangrene, not elsewhere classified
<i>S. aureus</i> Sepsis	
A41.01	Sepsis due to Methicillin susceptible <i>Staphylococcus aureus</i>
A41.02	Sepsis due to Methicillin resistant <i>Staphylococcus aureus</i>

* All codes starting with the following codes

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