

## Hospital Costs of Injection Drug Use in Florida

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People who inject drugs (PWID) experience significant injection-related infections (IRIs) at significant healthcare system cost. This study used and validated an algorithm based on the *International Classification of Diseases, Tenth Revision*, to estimate hospitalized PWID populations, assess the total statewide morbidity for IRIs among PWID, and calculate associated costs of care.

**Keywords.** people who inject drugs; injection-related infections; skin and soft-tissue infections; bacterial endocarditis.

According to the Centers for Disease Control and Prevention, opioid injection-related hospital admissions increased 622% between 2004 and 2014 among people aged 18–29 years [1]. In addition to significant personal hardship for people who inject drugs (PWID), infectious sequelae produce major expenses for healthcare systems because many PWID are uninsured. An analysis of people with diagnosed substance use disorder in North Carolina found that hospital costs for these patients increased from \$1.1 million to \$22.2 million between 2010 and 2015 [2]. A survey of English PWID revealed that nearly half (47%) reported an emergency department visit in the prior year, and of those, 78% were admitted as inpatients [3]. From this survey, the authors estimated annual PWID-associated healthcare costs between £15.5 and £45 million (\$17–\$52 million) [3].

As a regional epicenter of the contemporary US opioid crisis, Florida saw significant increases in opioid use and injection drug use (IDU) sequelae, including preventable overdoses and injection-related infections (IRIs), such as endocarditis and skin and soft-tissue infections (SSTIs) [3–6]. Tookes et al [7] estimated that the cost of PWID admissions

at one Florida safety-net hospital amounted to \$11.4 million per year. However, the effects of preventable morbidity among PWID are poorly understood on a statewide level in the United States. Identifying and quantifying the epidemiological scope and economic impact of IDU sequelae in Florida is essential for informing policy strategies aimed at mitigating consequences. The current study used data from Florida's Agency for Health Care Administration (AHCA) to quantify and describe hospitalizations related to IDU in Florida and the fiscal impacts of these admissions.

### METHODS

#### Study Design

We conducted a retrospective review of patients hospitalized for IRIs in Florida from 1 July 2016 to 30 June 2017 (fiscal year 2017) using the AHCA Hospital Inpatient Limited Data Set from the Florida Center for Health Information and Transparency. The AHCA disclaims responsibility for analysis, interpretations, and conclusions.

#### Setting and Participants

The sample comprised 21 336 hospital admissions of PWID in Florida during fiscal year 2017. We used an algorithm (Supplementary Table 1) based on *International Classification of Diseases, Tenth Revision (ICD-10)*, codes for drug use and sequelae to identify PWID populations and IRIs. The algorithm based on these codes was externally evaluated against a comparable algorithm (hospitalizations within a single year) in the British Columbia Hepatitis Testers Cohort (BC-HTC), similar to a validation study conducted in British Columbia, Canada [8]. The BC-HTC algorithm has been used previously to validate US-based PWID healthcare services use data [9–12]. We defined PWID as patients with an inpatient admission involving a drug use diagnosis (opioid, cocaine, amphetamine, other psychoactive drugs, and/or overdose) and an IRI diagnosis. IRIs included SSTIs, endocarditis, bacteremia/sepsis, and osteomyelitis. Patients aged 18–75 years and length of stay (LOS) < 60 days were included to increase algorithm specificity. The data from this study were compared with the BC-HTC algorithm during a restricted 12-month period (2014).

#### Analysis

Descriptive statistics were created for demographic information (sex, race/ethnicity, insurance status), LOS, human immunodeficiency virus (HIV), and hepatitis C virus (HCV) infection, discharge status, and IRIs. We reported continuous variables with means and interquartile ranges (IQRs) and categorical variables with percentages and number per category. We

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represented total charges as sum, median charge, and IQR, categorized by insurance type, and we calculated total costs using Medicaid cost-to-charge ratios reported by facilities to AHCA.

We used a multivariable linear regression to assess associations between infection types and hospital charges and an unstructured correlation matrix to account for within-hospital correlations using a generalized estimating equation model. We limited the data to total charges >\$1800 and LOS >0 days and adjusted the final data set for age, race/ethnicity, insurance type, HIV status, and opioid use. All analyses were completed using SAS software, version 9.4 (SAS Institute).

## RESULTS

### Demographics

The PWID identification algorithm had a sensitivity of 63% and a specificity of 100% (Supplementary Table 2). A total of 21 336 admissions were identified. Owing to unavailability of cost-to-charge ratios, the final sample analyzed included 20 001 PWID. The majority of the sample were male (54%) and white (84%). The median patient age was 44 years. More than half (53%) of admissions involved bacteremia or sepsis (Table 1). The majority (80%) of admissions were discharged or transferred to a lower level of care, psychiatric facility, or critical access hospital; 16% of the PWID population left against medical advice, and 4% died during hospitalization.

### Hospitalization Charges

The median charge per admission was \$58 869 (IQR, \$29 696–\$124 882). Most charges were billed to federal insurance (\$668 234 450), followed by state, county, and local insurers (\$589 698 411). After accounting for each hospital's cost-to-charge ratio, the total fiscal year 2017 cost for injection-related admissions totaled \$379 788 291 (Table 2). Costs by county are presented in Supplementary Table 3. After adjustment for age, sex, race/ethnicity, insurance status, HIV infection, and opioid use; of infectious sequelae analyzed, SSTIs were significantly associated with decreased mean hospital charges (–\$6 454; 95% confidence interval, –\$12 601 to –\$308). Bacteremia/sepsis (mean charge, \$66 645; 95% confidence interval, \$60 119–\$73 172), endocarditis (\$64 471; \$54 359–\$74 583), and osteomyelitis (\$38 022; \$31 730–\$44 313) were significantly associated with higher mean hospital charges (Supplementary Table 4).

## DISCUSSION

The societal and health system consequences of the opioid crisis are largely estimated through indirect analyses, such as addiction service provision and opioid-related mortality rates. The BC-HTC algorithm has been used previously to validate HIV, HCV, and infective endocarditis data among PWID [8–10, 12].

**Table 1. Hospitalizations for Infection Among People Who Inject Drugs in Florida (Fiscal Year 2017)**

Characteristic	PWID Admissions, No. (%)
<b>Biological sex</b>	
Male	10 779 (54)
Female	9222 (46)
<b>Ethnicity</b>	
Hispanic or Latinx	1608 (8)
Non-Hispanic or Non-Latinx	17 930 (90)
Unknown	299 (2)
<b>Race</b>	
Black or African American	2281 (12)
White	16 694 (84)
Other	862 (4.4)
<b>Age group</b>	
<29 y	3377 (17)
30–39 y	5071 (25)
40–49 y	3910 (20)
50–59 y	4219 (21)
60–75 y	3424 (17)
Age, median (IQR), y	44 (33–56)
<b>Insurance status</b>	
Federal	5625 (28)
State, county, or local	5045 (25)
Uninsured	6632 (33)
Private insurance	2411 (12)
Other	124 (0.6)
LOS, median (IQR), d	5 (3–12)
<b>Infectious comorbid conditions</b>	
HIV	885 (4)
Hepatitis C	3748 (19)
<b>Discharge status</b>	
Discharge or transferred	15 913 (80)
Death	755 (4)
Left AMA	3169 (16)
<b>Infection type<sup>a</sup></b>	
Skin and soft tissue	9586 (48)
Osteomyelitis	2669 (14)
Bacteremia/sepsis	10 596 (53)
Endocarditis	1908 (10)

Abbreviations: AMA, against medical advice; HIV, human immunodeficiency virus; IQR, interquartile range; LOS, length of stay; PWID, people who inject drugs.

<sup>a</sup>Many admissions had >1 infection diagnosis coded per admission.

This is the first study of which we are aware that uses a validated ICD-10–based algorithm to assess statewide IRI-associated hospital costs. The most comprehensive study to-date analyzed the National Inpatient Sample, estimating the national cost of PWID SSTI admissions to be \$193.8 million in 2001 [13]. Our findings suggest that IRI-associated costs to healthcare systems are far greater than previously thought, implying that significantly greater effort should be directed toward mitigating these preventable infections. Increased understanding of the prevalence of IRI and associated costs can inform policy to improve investment in and deployment of evidence-based harm reduction interventions, such as syringe service programs (SSPs),

**Table 2. Financial Impact of PWID Hospitalizations for Infections in Florida, Fiscal Year 2017**

	Total	Median	IQR
Total Charges	\$2 110 786 677.00	\$58 869.00	\$29 696.00–\$124 882.00
Total Cost	\$379 788 290.62		
Insurance Status	Total Charges	Median	IQR
Federal	\$668 234 450.00	\$75 411.00	\$39 534.00–\$142 676.00
State, County, Local	\$589 698 411.00	\$63 181.00	\$32 433.00–\$137 360.00
Uninsured	\$537 206 811.00	\$42 487.50	\$22 997.50–\$89 714.50
Private Insurance	\$299 770 362.00	\$64 917.00	\$32 655.00–\$146 101.00

Abbreviation: IQR, interquartile range.

safe injection sites, linkage to HIV and HCV treatment, and other addiction treatment services, including pre-discharge medication-assisted therapy [14].

There are several limitations to this study. One is that the *ICD-10* does not have specific diagnosis codes for IDU or sequelae thereof. Given our model's sensitivity of 63%, we may be underestimating more than one-third of inpatient PWID hospitalizations for IRI in Florida, with major attendant treatment costs. Cases from hospitals without available cost-to-charge ratios (6.3% of cases) were also excluded, resulting in further underestimation of total costs. In addition, this study focused on acute infections requiring hospitalization and did not consider treatment costs for chronic viral infections associated with IDU (eg, HIV or HCV) or those treated in the emergency department or ambulatory settings. The data set did not include data on implementation of opioid substitution therapy (buprenorphine or methadone) or linkages to HIV/HCV treatment during hospitalization. Finally, the database used did not allow for linkage of individual patients across multiple admissions. Using databases capable of collecting diagnosis codes across multiple admissions would increase the algorithm's sensitivity.

Our findings present opportunities for interventions to improve hospitalization outcomes. Sixteen percent of individuals in the cohort left the hospital against medical advice, almost 8 times the national average [15]. Additional unique findings in our data set included that the percentage of female-assigned patients in our cohort (43%) greatly exceeds national estimates of female PWID (30%) [16]. This finding warrants further study to assess sex differences, sequelae, and effective interventions for female PWID.

Importantly, this study broadens current understanding regarding the epidemiology of IRI, LOS trends, and attendant financial impacts of hospitalizations for IRI. The results indicate that SSTI treatment was strongly associated with lower costs, whereas more serious infections (endocarditis, osteomyelitis, sepsis) were significantly more expensive. Medical and surgical management of these infections is more intensive, requiring longer hospital stays. Prevention of these high-cost complications are critical to cost reduction. Public health interventions

that facilitate early care of SSTIs may prevent development of serious sequelae.

Our findings emphasize high morbidity rates and hospital system expenses arising from IRI in the contemporary opioid epidemic. This also provides policy makers with data that can be used to assess the scope and cost of prevention and treatment strategies. In 2019, Florida passed the Infectious Disease Elimination Act, authorizing county-level SSP implementation through local ordinances [17]. The county-level analysis can help policy makers prioritize regions for harm reduction program implementation. Future studies should evaluate public health interventions, including SSP use or introduction of supervised injection sites to mitigate these costs. Finally, other states, regions, and healthcare systems can use this model to assess financial impacts of preventable IRI, model impacts of Medicaid expansion, and evaluate changes in morbidity and mortality associated with reinvestment of these costs in evidence-based interventions to attenuate IDU sequelae.

In conclusion, in this retrospective analysis over a 1-year period, PWID-related admissions cost Florida hospital systems \$379 788 291, with 86% of those admissions uninsured or fiscally supported by publicly funded insurance. High uninsurance rates among these populations resulted in significant per-admission and total costs to Florida residents, healthcare facilities, and state and federally funded insurance programs. High costs of admissions for IDU sequelae highlight the critical need to support evidence-based, effective harm reduction programs and addiction treatment programs to mitigate this crisis.

#### Supplementary Data

Supplementary materials are available at *Clinical Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

#### Notes

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## References

- Centers for Disease Control and Prevention. Persons who inject drugs (PWID). Available at: <http://www.cdc.gov/pwid/index.html>. Accessed 15 December 2019.
- Fleischauer AT, Ruhl L, Rhea S, Barnes E. Hospitalizations for endocarditis and associated health care costs among persons with diagnosed drug dependence—North Carolina, 2010–2015. *MMWR Morb Mortal Wkly Rep* **2017**; 66:569–73.
- Hope V, Kimber J, Vickerman P, Hickman M, Ncube F. Frequency, factors and costs associated with injection site infections: findings from a national multi-site survey of injecting drug users in England. *BMC Infect Dis* **2008**; 8:120.
- Ciccarone D, Unick GJ, Cohen JK, Mars SG, Rosenblum D. Nationwide increase in hospitalizations for heroin-related soft tissue infections: associations with structural market conditions. *Drug Alcohol Depend* **2016**; 163:126–33.
- Kennedy-Hendricks A, Richey M, McGinty EE, Stuart EA, Barry CL, Webster DW. Opioid overdose deaths and Florida's crackdown on pill mills. *Am J Public Health* **2016**; 106:291–7.
- Wurcel AG, Anderson JE, Chui KK, et al. Increasing infectious endocarditis admissions among young people who inject drugs. *Open Forum Infect Dis* **2016**; 3:ofw157.
- Tookes H, Diaz C, Li H, Khalid R, Doblecki-Lewis S. A cost analysis of hospitalizations for infections related to injection drug use at a county safety-net hospital in Miami, Florida. *PLoS One* **2015**; 10:e0129360.
- Janjua NZ, Islam N, Kuo M, et al; BC Hepatitis Testers Cohort Team. Identifying injection drug use and estimating population size of people who inject drugs using healthcare administrative datasets. *Int J Drug Policy* **2018**; 55:31–9.
- Meisner JA, Anesi J, Chen X, Grande D. Changes in infective endocarditis admissions in Pennsylvania during the opioid epidemic. *Clin Infect Dis*, ciz1038. doi:10.1093/cid/ciz1038.
- Bull-Otterson L, Huang Y-LA, Zhu W, King H, Edlin BR, Hoover KW. Human immunodeficiency virus and hepatitis C virus infection testing among commercially insured persons who inject drugs, United States, 2010–2017. *J Infect Dis*, jiaa017. doi:10.1093/infdis/jiaa017.
- Assoumou SA, Wang J, Nolen S, et al. HCV testing and treatment in a national sample of US federally qualified health centers during the opioid epidemic. *J Gen Intern Med* **2020**; 35:1477–83.
- Epstein RL, Wang J, Hagan L, et al. Hepatitis C virus antibody testing among 13- to 21-year-olds in a large sample of US federally qualified health centers. *JAMA* **2019**; 322:2245–8.
- Takahashi TA, Maciejewski ML, Bradley K. US hospitalizations and costs for illicit drug users with soft tissue infections. *J Behav Health Serv Res* **2010**; 37: 508–18.
- Hood JE, Behrends CN, Irwin A, et al. The projected costs and benefits of a supervised injection facility in Seattle, WA, USA. *Int J Drug Policy* **2019**; 67:9–18.
- Stearns CR, Bakamjian A, Sattar S, Weintraub MR. Discharges against medical advice at a county hospital: provider perceptions and practice. *J Hosp Med* **2017**; 12:11–7.
- Degenhardt L, Peacock A, Colledge S, et al. Global prevalence of injecting drug use and sociodemographic characteristics and prevalence of HIV, HBV, and HCV in people who inject drugs: a multistage systematic review. *Lancet Glob Health* **2017**; 5:e1192–207.
- The Florida Senate. CS/CS/SB 366: Infectious Disease Elimination Programs. Available at: <https://www.flsenate.gov/Session/Bill/2019/366/ByVersion>.