Opioid Agonist Therapy During Hospitalization Within the Veterans Health Administration: a Pragmatic Retrospective Cohort Analysis

Kelsey C. Priest, PhD, MPH^{1,2}, Travis I. Lovejoy, PhD, MPH^{2,3,4}, Honora Englander, MD⁵, Sarah Shull, PhD⁴, and Dennis McCarty, PhD²

¹School of Medicine, MD/PhD Program, Oregon Health & Science University, 3181 SW Sam Jackson Park Rd, Mail Code: L357, Portland, OR, USA;

²School of Public Health, Oregon Health & Science University-Portland State University, Portland, OR, USA; ³Department of Psychiatry, Oregon Health & Science University, Portland, OR, USA; ⁴Center to Improve Veteran Involvement in Care, VA Portland Health Care System, Portland, OR, USA; ⁵Division of Hospital Medicine & Section of Addiction Medicine, Department of Medicine, Oregon Health & Science University, Portland, OR, USA.

BACKGROUND: Hospitalization of patients with opioid use disorder (OUD) is increasing, yet little is known about opioid agonist therapy (OAT: methadone and buprenorphine) administration during admission.

OBJECTIVE: Describe and examine patient- and hospital-level characteristics associated with OAT receipt during hospitalization in the Veterans Health Administration (VHA).

PARTICIPANTS: A total of 12,407 unique patients, $\geq$ 18 years old, with an OUD-related ICD-10 diagnosis within 12 months prior to or during index hospitalization in fiscal year 2017 from 109 VHA hospitals in the continental U.S.

MAIN MEASURE: OAT received during hospitalization.

KEY RESULTS: Few admissions received OAT ($n = 1914$; 15%) and when provided it was most often for withdrawal management ($n = 834$; 7%). Among patients not on OAT prior to admission who survived hospitalization ($n = 10,969$), 2.0% ($n = 203$) were newly initiated on OAT with linkage to care after hospital discharge. Hospitals varied in the frequency of OAT delivery (range, 0 to 43% of qualified admissions). Patients with pre-admission OAT (adjusted odds ratio [AOR] = 15.30; 95% CI [13.2, 17.7]), acute OUD diagnosis (AOR = 2.3; 95% CI [1.99, 2.66]), and male gender (AOR 1.52; 95% CI [1.16, 2.01]) had increased odds of OAT receipt. Patients who received non-OAT opioids (AOR 0.53; 95% CI [0.46, 0.61]) or surgical procedures (AOR 0.75; 95% CI [0.57, 0.99]) had decreased odds of OAT receipt. Large-sized (AOR = 2.0; 95% CI [1.39, 3.00]) and medium-sized (AOR = 1.9; 95% CI [1.33, 2.70]) hospitals were more likely to provide OAT.

CONCLUSIONS: In a sample of VHA inpatient medical admissions, OAT delivery was infrequent, varied across the health system, and was associated with specific

patient and hospital characteristics. Policy and educational interventions should promote hospital-based OAT delivery.

KEY WORDS: opioid agonist therapy; methadone; buprenorphine; hospital medicine; opioid use disorder.

J Gen Intern Med 35(8):2365–74

DOI: 10.1007/s11606-020-05815-0

© Society of General Internal Medicine 2020

INTRODUCTION

Surging opioid-related hospitalizations challenge the acute care delivery system in the United States (U.S.).¹ Opioid-related hospitalizations are associated with increased readmissions² and 12% of patients admitted with an OUD-related condition leave the hospital against medical advice.³ OUD-related admissions disproportionately burden public payers^{3,4} and cost more than non-opioid-related admissions.^{3,5} Opioid agonist therapy (OAT)—buprenorphine or methadone⁶—is provided infrequently and variably during hospitalization⁷ or upon discharge.⁸ Underutilization occurs although OAT delivery during hospitalization is feasible^{9,10} and OAT receipt is associated with decreased illicit opioid use upon discharge,⁹ reduced 30- and 90-day readmissions,¹¹ and increased post-hospital substance use disorder (SUD) treatment engagement.^{11,12}

Veterans are particularly vulnerable as they are twice as likely to die from accidental opioid overdose than non-veterans.¹³ OUD diagnoses within the Veterans Health Administration (VHA) have increased nearly twofold between 2004 ($n = 30,093$)¹⁴ and 2017 ($n = 54,078$).¹⁵ The VHA's initiatives to increase OAT access¹⁶ include a system-wide requirement that all VHA facilities provide access to OAT¹⁶ and follow national OUD treatment guidelines.¹⁷ In fiscal year 2017, 41% ($n = 22,179$) of VHA patients with OUD received an OUD-related pharmacotherapy.¹⁵ At the facility-level, OUD-related pharmacotherapy delivery ranged from 2 to 76% across the VHA system.¹⁵ To date, little is known about inpatient practice for this patient population. This multi-

Prior Presentations Dr. Priest's dissertation defense (February 2019); AMERSA's Annual Conference (November 2019); and OHSU Family Medicine Grand Rounds (November 2019).

Electronic supplementary material The online version of this article (<https://doi.org/10.1007/s11606-020-05815-0>) contains supplementary material, which is available to authorized users.

Received September 28, 2019

Accepted March 20, 2020

Published online April 14, 2020

hospital retrospective study examines variation in OAT delivery and receipt for hospitalized VHA patients with OUD.

METHODS

Study Design and Cohort

A retrospective sample of unique acute medical and surgical inpatient admissions from fiscal year 2017 was extracted from the VHA Corporate Data Warehouse, a database containing national VHA patient electronic health record data. Eligible individuals were aged 18 or older with a primary or secondary OUD ICD-10 diagnosis from any source (inpatient, outpatient, and community care paid for by VHA) in the year preceding index hospitalization or during index hospitalization in fiscal year 2017. Facilities were restricted to “acute care hospitals” with at least 500 acute bed days of care delivered during the study period and at least 25 index admissions. Patients were excluded if they did not have a primary or secondary admission code, if they had an Elixhauser cancer flag,¹⁸ and if they had a hospital length of stay (LOS) greater than or equal to the 99th percentile (median 82 days, range 51 to 1652 days). The 99th percentile LOS cutoff was chosen to capture those admitted with OUD-related infections warranting 4 to 6 weeks of inpatient antibiotics and to exclude chronic hospitalization (see Fig. 1). The Veterans Affairs Portland Health Care System Institutional Review Board approved this study (no. 4045).

Study Variables

Variable selection and construction were informed by the existing literature, data availability, and prior qualitative research.^{19,20} Study variables included patient demographics (age, gender, race, ethnicity), patient diagnoses present on admission (co-occurring mental health and SUD diagnoses), admission characteristics (intensive care unit [ICU] or surgical services received), and admission-related diagnoses (OUD-related infection, OUD-related diagnoses). Hospital characteristics included admission volume, acute OUD diagnosis volume (the percentage of admissions with an acute OUD diagnosis during hospitalization), hospital geographic location, and hospital size.

Pharmacotherapy variables were coded for three time periods: (1) 30 days pre-admission; (2) during admission; and (3) 30 days post-admission. Non-OAT pharmacotherapy included benzodiazepines, non-OAT opioids (e.g., oxycodone), naltrexone, naloxone, inpatient use of first-line opioid withdrawal adjuvant (clonidine), and second-line withdrawal adjuvants (baclofen, gabapentin/pregabalin, tizanidine) (see Appendix Table 1 for additional details). Admission OAT was categorized by four OAT delivery scenarios (OAT continued, OAT initiated with linkage to care, OAT for withdrawal, and OAT sustained) (see Table 1). Categories and calculations involving post-admission care excluded patients who died during admission.

Statistical Analysis

RStudio^{21–27} was used for data management and descriptive statistics. Multilevel logistic regression modeling used Stata²⁸ with an alpha value of 0.05. The dependent variable (level 1) was any OAT received (yes/no) during hospitalization, and covariates were level 1 (patient) and level 2 (hospital) continuous, binary, or categorical variables (see Appendix Table 2 for model covariates). Covariate inclusion was based on literature review, study aims, and model fit. Comparative model fit for nested models used the log-likelihood ratio test, the Akaike information criterion, and the Bayesian information criterion. Regression coefficients, standard errors, adjusted odds ratios (AOR) with 95% confidence intervals, and the intraclass correlation coefficient (ICC) were reported. A sensitivity analysis examined whether a narrower OAT administration definition during hospitalization changed study findings.

RESULTS

Patient Characteristics

The study cohort included 12,407 unique patients with index hospitalizations from 109 VHA acute care hospitals in the continental U.S. Most patients were male ($n = 11,543$; 93%), white ($n = 8880$; 72%) or Black ($n = 2706$; 22%), and non-Hispanic or Latino ($n = 11,476$; 93%) with a median age of 61 years (range 21 to 90). Over half of the patients ($n = 8094$; 65%) had at least one co-occurring mental health diagnosis and nearly half had at least one co-occurring SUD diagnosis ($n = 6024$; 49%).

Admission-Related Characteristics

The median length of hospital stay was 5 days (range 1 to 50 days). Nearly 20% of the patients ($n = 2303$) received ICU services and 6% ($n = 779$) received surgical services. OUD-related infection or primary or secondary OUD-related diagnoses occurred in 20% of admissions ($n = 2491$) and 1% of the patients died during admission ($n = 119$).

Pre- and Post-pharmacotherapy

Approximately one in ten patients received OAT in the 30 days prior to admission ($n = 1325$; 11.5%) and in the 30 days post-hospital discharge ($n = 1420$; 11.6%). Thirty percent of patients ($n = 3766$) had an opioid prescription filled in the 30 days before admission and 35% ($n = 4250$) filled an opioid prescription in the 30 days after discharge.

Admission Pharmacotherapy

The majority of patients did not receive OAT during admission ($n = 10,493$; 85%). In the 15% of admissions with OAT ($n = 1914$), methadone was more common ($n = 1049$; 55%) than buprenorphine ($n = 639$; 33%). A small number of patients ($n = 136$; 7.1%) received more than one type of OAT and 4.7%

Figure 1 Study sample selection.

($n = 90$) had non-specific administration. For patients on OAT prior to admission ($n = 1325$), 65% ($n = 867$) had their OAT continued during admission and 35% ($n = 458$) had their OAT discontinued during admission—regardless of receipt post-admission.

Related to withdrawal management, 9% of patients received the VHA's recommended first-line adjuvant for opioid withdrawal—clonidine—and 39% ($n = 1089$) received a second-line adjuvant (baclofen, gabapentin/pregabalin, or tizanidine).²⁹ Over half of the patients (55%; $n = 6765$) received at least one non-OAT opioid (e.g., oxycodone) during admission.

Hospital OAT by Delivery Scenario

When hospital OAT was delivered for patients not on pre-admission OAT, it was most often provided as withdrawal management ($n = 834$; 44%) and infrequently initiated during hospitalization with linkage to care upon discharge ($n = 203$; 11%). For patients on pre-admission OAT, it was most often delivered as a sustained medication ($n = 722$; 38%)—OAT received before, during, and after admission—and less often

continued during admission, but with subsequent discontinuation after discharge ($n = 140$; 8%) (see Table 2 for additional details on patient and admission-related characteristics and pharmacotherapy).

System-Wide OAT Delivery

Across the 109 VHA hospitals, the median OAT delivery frequency during admission was 11% (SD 0.10; range 0 to 43%). The data had a non-normal distribution skewed towards less OAT delivery (see Fig. 2). The frequency of OAT delivery scenario in each hospital varied. For example, two hospitals did not provide any OAT, and nearly half of the hospitals (48%; $n = 52$) did not have a single admission in which OAT was initiated with linkage to care (range 0 to 16 admissions). Measures of variation (ICC) are reported in Appendix Table 3.

Hospital- and Patient-Level Associations with OAT Receipt

Patient-Level Covariates. In the fully specified model, 13 covariates were associated with hospital OAT receipt. Six

Table 1 Hospital OAT Delivery by Scenario

Variable	Pharmacotherapy
Any OAT Received	Any OAT received during admission
OAT Continuation	OAT received during pre-admission and admission, but not post-admission
OAT Initiation & Linkage to Care	OAT received during admission and post-admission, but not pre-admission
OAT Sustained	OAT received pre-admission, during admission and post-admission
OAT Withdrawal	OAT received during admission, but not pre or post-admission

Table Notes. OAT = opioid agonist therapy; Pre-Admission OAT: VHA OTP visit or Healthcare Common Procedure Coding System (HCPCS) codes (H0033; J0574; J0575; J0571; S0109) or outpatient buprenorphine filled prescriptions: buprenorphine film buccal; buprenorphine sublingual tablet; buprenorphine/naloxone film sublingual; buprenorphine/naloxone sublingual tablet; Admission OAT: VHA OTP visit or HCPCS codes (H0033; J0571; S0109) or any formulation of buprenorphine or methadone administered: buprenorphine sublingual tablet; buprenorphine/naloxone sublingual film; buprenorphine/naloxone sublingual tablet; buprenorphine injection; buprenorphine patch; methadone injection; methadone solution concentrate; methadone solution oral; methadone tablet; methadone tablet effervescent; and methadone unknown formulation; Post-admission OAT: VHA OTP visit or HCPCS codes (H0033; J0574; J0575; J0571; S0109) or outpatient buprenorphine filled prescriptions: buprenorphine film buccal; buprenorphine sublingual tablet; buprenorphine/naloxone film sublingual; and buprenorphine/naloxone sublingual tablet.

covariates increased the odds of receiving OAT during hospitalization: pre-admission OAT receipt (AOR 15.3; 95% CI [13.2, 17.7]); an OUD diagnosis or OUD-related infection during admission (AOR 2.30; 95% CI [1.99, 2.66]); male gender (AOR 1.52; 95% CI [1.16, 2.01]); receipt of adjuvant medication for opioid withdrawal during admission (AOR 1.52; 95% CI [1.32, 1.75]); an opioid withdrawal diagnosis (AOR 1.47; 95% CI [1.12, 1.92]); and an increased length of hospital stay (AOR 1.04; 95% CI [1.03, 1.05]). Seven covariates were associated with decreased odds of OAT receipt: the receipt of pre-admission naltrexone (AOR 0.26; 95% CI [0.12, 0.56]); an unintentional overdose diagnosis (AOR 0.29; 95% CI [0.16, 0.52]); the receipt of admission naltrexone (AOR 0.31; 95% CI [0.14, 0.66]); pre-admission non-OAT opioid receipt (AOR 0.49; 95% CI [0.41, 0.58]); non-OAT opioid receipt during admission (AOR 0.53; 95% CI [0.46, 0.61]); surgical service receipt during admission (AOR 0.75; 95% CI [0.57, 0.99]); and having a co-occurring SUD diagnosis (AOR 0.77; 95% CI [0.67, 0.88]) (see Appendix Table 4).

Hospital-Level Covariates. Four hospital-level covariates were associated with hospital OAT receipt. Patients admitted to large-sized (AOR 2.04; 95% CI [1.39, 3.00]) and medium-sized (AOR 1.90; 95% CI [1.33, 2.70]) hospitals had increased odds of OAT receipt compared with small hospitals. Patients admitted to hospitals located in the northeast (AOR 1.80; 95% CI [1.30, 2.49]) and west (AOR 1.62; 95% CI [1.19, 2.22]) had increased odds of OAT receipt compared with those in the south (see Table 3 for the fully specified model output).

Sensitivity Analysis. A pre-specified sensitivity analysis examined if a narrower OAT definition would change study findings, specifically, removing non-FDA-approved

formulations of OAT for the treatment of OUD (e.g., injectable methadone) from the admission OAT variable. In this sensitivity analysis, surgical service received during admission was no longer statistically significant. No other differences were observed with statistical significance or the directionality of the relationships between covariates and the primary outcome (see Appendix Table 5).

DISCUSSION

This retrospective cohort analysis of 12,407 VHA hospitalized individuals with a past year or admission-related ICD-10 OUD diagnosis suggests that hospital OAT receipt was rare. This study is the first to examine hospital OAT delivery across multiple hospitals. A limited research base has examined hospital OAT delivery. A 10-year (2004 to 2014) retrospective chart review of patients with intravenous drug use-associated infective endocarditis—from a single Massachusetts hospital—observed that only 11% of OUD admissions had plans for OAT or naltrexone at discharge.⁷ Our national study confirms and expands upon these findings. Only 15% of patients in our study received any OAT during admission ($n = 1914$) and the vast majority (91%) of patients not on OAT prior to admission did not receive any OAT during hospitalization ($n = 10,035$).

Further, only 203 patients in our cohort were initiated on OAT and subsequently linked to care—a nationally recommend best-practice.^{6,30} Instead most patients (80%) were provided opioid withdrawal management, representing a missed opportunity to continue OUD treatment beyond hospitalization. Moreover, hospital admission interrupted ongoing outpatient OUD treatment. Over a third of patients had their outpatient OAT discontinued during admission.

Table 2 Patient, Admission, and Hospital Characteristics

Variable	Frequency % Count
Patient Characteristics (n = 12,407)	
Age	Median 61; Mean 58.5 Range 21 to 90
Gender	
Male	93.0% (11,543)
Female	6.8% (864)
Race	
American Indian or Alaska Native	1.2% (147)
Asian	<1% (43)
Black or African American	21.8% (2,706)
Native Hawaiian or Pacific Islander	< 1% (106)
White	71.6% (8,880)
Unknown/Declined to Answer	4.2% (525)
Ethnicity	
Hispanic or Latino	4.8% (595)
Non-Hispanic or Latino	92.5% (11,476)
Unknown	2.7% (336)
Co-Occurring Mental Health Diagnosis	65.2% (8,094)
Co-Occurring Substance Use Disorder Diagnosis	48.6% (6,024)
Co-Occurring Mental Health and Substance Use Disorder Diagnoses	41.0% (5,091)
Admission-Related Characteristics (n = 12,407)	
Length of Stay	Median, 5; Mean 6.6 Range 1 to 50
Admission Source	
Outpatient Treatment	49.1% (6,095)
Other Direct Admission	45.3% (5,616)
Other	4.9% (696)
Services Received	
ICU Services	18.6% (2,303)
Surgical Services	6.3% (779)
Acute OUD Infection Diagnosis	5.5% (691)
OUD-Related Diagnosis Primary and/or Secondary	14.9% (1,848)
OUD-Related Diagnosis and/or Acute OUD Infection	20.1% (2,491)
Pre-Admission Pharmacotherapy (n = 12,407)	
No OAT Received	89.3% (11,082)
Pre-Admission OAT^a	10.7% (1,325)
Buprenorphine Only ^b	5.0% (625)
Non-Specific Administration ^c	4.7% (577)
>1 Type of OAT Received ^d	<1% (112)
Methadone Only ^e	<1% (11)
Non-OAT Opioid Prescription Filled	30.4% (3,766)
Naltrexone Received or Prescription Filled	2.0% (244)
Naloxone Prescription Filled	3.8% (477)
Admission Pharmacotherapy (n = 12,407)	
No OAT Received	84.6% (10,493)
Admission OAT^a	15.4% (1,914)
Methadone Only ^e	8.5% (1,049)
Buprenorphine Only ^b	5.2% (639)
>1 Type of OAT Received ^d	1.1% (136)

Table 2.(continued)

Non-Specific Administration Only ^c	<1% (90)
Any Withdrawal Adjuvants	44.4% (5,502)
First-Line Adjuvant—Clonidine	8.8% (1,089)
Second-Line Adjuvant—Baclofen, Gabapentin/Pregabalin, or Tizanidine	39.3% (4,882)
Both Adjuvants	3.4% (469)
Non-OAT Opioid Received	54.5% (6,765)
Naltrexone Received	1.4% (168)
Post-Admission Pharmacotherapy^f (n = 12, 288)	
No OAT Received	88.4% (10,868)
Post-Admission OAT^a	11.6% (1,420)
Buprenorphine Only ^b	5.2% (633)
Non-Specific Administration Only ^c	5.1% (628)
>1 Type of OAT Received ^d	1.2% (142)
Methadone Only ^e	<1% (17)
Non-OAT Opioid Prescription Filled	34.6% (4,250)
Naltrexone Received or Prescription Filled	2.8% (341)
Naloxone Prescription Filled	6.2% (765)
Hospital OAT Delivery by Scenario^f (n = 12, 288)	
OAT for Withdrawal Management	6.8% (834)
OAT Sustained	5.9% (722)
OAT Initiated with Linkage to Care	1.7% (203)
OAT Continued	1.2% (140)
Secondary Outcomes	
Left Hospital Against Medical Advice ^f	5.7% (701)
In-Hospital Mortality	1.0% (119)
Pre-OAT Received	<1% (6)
Pre-OAT Not Received	1.0% (113)
Death within 30 Days of Discharge ^f	<1% (110)
Emergency Department Visit within 30 Days of Discharge ^f	27.9% (3,434)
Hospital Readmission within 30 Days of Discharge ^f	13.3% (1,630)
Hospital Characteristics (n = 109)	
Hospital Size	
Small: 1 to 49 beds	25.7% (28)
Medium: 50 to 99 beds	33.0% (36)
Large: ≥100 beds	41.3% (45)
Hospital Region	
Midwest	22.9% (25)
Northeast	16.5% (18)
South	39.4% (43)
West	21.1% (23)
Admission Volume	Median 98; Mean 114 Range 26 to 430; IQR 97
Acute OUD Relative Volume	Median 32% Range 13% to 83%

Contemporary guidance strongly recommends continuing outpatient OAT during admission, including for patients who are undergoing surgical procedures.^{6,31} It is possible that evolving practice recommendations were not reflected in our sample. Anesthesiologists may recommend buprenorphine discontinuation prior to surgery. However, only 6% of our cohort received surgery and only 12% of those

patients were on OAT prior to admission; thus, it is unlikely that this is driving observed findings. Moreover, OAT discontinuation during admission may reflect challenges related to care transitions.²⁰

Previous research in the VHA describes system-wide variation in OUD-related pharmacotherapy delivery,

Figure 2 Hospital OAT delivery relative frequency histogram.

Table 3 Multilevel Logistic Regression Model: Hospital OAT Delivery

Parameters	<i>B</i>	SE	AOR	95% CI	
Intercept	− 2.78***	0.00	0.04	0.03	0.13
Patient-level covariates					
Age	0.00	0.08	1.00	1.00	1.01
Gender: male (ref. female)	0.42**	0.18	1.52	1.16	2.01
Race: non-white (ref. white)	− 0.05	0.14	0.95	0.82	1.11
Race: unknown (ref. white)	− 0.18	0.21	0.84	0.59	1.19
Ethnicity: Hispanic (ref. non-Hispanic)	0.02	0.07	1.02	0.77	1.34
Ethnicity: unknown (ref. non-Hispanic)	0.17	0.07	1.2	0.80	1.81
Acute OUD diagnosis/infection	0.83***	0.07	2.30	1.99	2.66
Co-occurring substance use disorder diagnosis	− 0.26***	0.30	0.77	0.67	0.88
Co-occurring mental health diagnosis	− 0.04	0.14	0.97	0.84	1.11
Unintentional overdose diagnosis during admission	− 1.24***	0.00	0.29	0.16	0.52
Opioid withdrawal diagnosis during admission	0.38**	0.08	1.47	1.12	1.92
Hospital length of stay	0.04***	0.14	1.04	1.03	1.05
ICU services received during admission	− 0.13	0.14	0.88	0.74	1.03
Surgical services received during admission	− 0.29*	0.08	0.75	0.57	0.99
Pre-admission OAT received	2.73***	0.12	15.3	13.1	17.7
Pre-admission non-OAT opioid prescription filled	− 0.72***	0.38	0.49	0.41	0.58
Pre-admission benzodiazepine prescription filled	0.03	0.08	1.03	0.81	1.32
Pre-admission naltrexone received or prescription filled	− 1.33***	0.00	0.26	0.12	0.56
Pre-admission gabapentin/pregabalin prescription filled	− 0.12	0.14	0.89	0.77	1.04
Admission source: other (ref. outpatient)	− 0.13	0.07	0.88	0.66	1.16
Admission source: direct (ref. outpatient)	− 0.01	0.07	0.99	0.85	1.15
During admission non-OAT opioid received	− 0.64***	0.07	0.53	0.46	0.61
During admission adjuvant received	0.42***	0.39	1.52	1.32	1.75
During admission benzodiazepine received	− 0.08	0.08	0.92	0.80	1.06
During admission naltrexone received	− 1.17**	0.09	0.31	0.14	0.66
Hospital-level covariates					
Acute OUD diagnoses volume ^a	− 0.02**	0.01	0.98	0.97	0.99
Hospital size: medium (ref. small)	0.64***	0.18	1.90	1.33	2.70
Hospital size: large (ref. small)	0.71***	0.20	2.04	1.39	3.00
Census region: midwest (ref. south)	0.24	0.16	1.27	0.93	1.72
Census region: northeast (ref. south)	0.59***	0.17	1.80	1.30	2.49
Census region: west (ref. south)	0.48**	0.16	1.62	1.19	2.22
Admission volume	0.00	0.00	1.00	1.00	1.00

Bold indicates statistical significance; $p < 0.05^*$; $p < 0.01^{**}$; $p < 0.001^{***}$

^aThis relatively small effect size likely has little practical relevance, thus, was omitted from the manuscript text

which ranged from 2 to 76% of qualified patients per facility.¹⁵ That analysis, however, did not examine variation specifically for hospital admissions. Our study aligns with and builds upon these prior findings. We observed OAT delivery frequency per hospital ranging from 0 to 43% of qualified admissions.

Prior VHA research suggests that specific patient characteristics are positively associated with OAT receipt including male gender, age 56 years or older, and those without a co-occurring mental health diagnosis.³² Gender disparities in SUD treatment and engagement have been described in other care delivery settings.³³ Our study builds upon these findings, suggesting that women-identified patients may be less likely to receive OAT during hospitalization. Associations from this study also suggest that outpatient OAT preceding hospitalization influences subsequent hospital OAT delivery, highlighting the importance of OAT engagement prior to admission. Further, specific care received during admission decreased OAT receipt; for example, patients who received non-OAT opioids or surgical procedures were less likely to receive OAT during hospitalization. These two clinical scenarios should not influence hospital OAT administration. Finally, immutable hospital characteristics (e.g., size and location) influenced OAT delivery and may reflect unmeasurable internal hospital attributes (e.g., resources or culture).²⁰ These findings could also reflect the contribution of elements outside the hospital, for example, local beliefs about addiction and availability of community-based treatment resources.²⁰

Study Limitations

This is an observational, unmatched, retrospective cohort study; thus, causal relationships cannot be established. There are limitations to the generalizability of study findings because of the cohort (Veterans, older, white, mostly men) and the health system setting (VHA); however, given that the VHA is an integrated health system that has prioritized OAT delivery, it is possible that VHA OAT delivery outperforms non-VHA hospitals. We elected to include patients with an OUD diagnosis in the prior year, not just patients with an admission diagnosis; thus, for 80% of patients, OUD was not the primary reason for hospitalization. The pragmatic study sample selection may be seen as a limitation, but we believe it reflects the realities of acute care delivery for patients hospitalized with complications related to OUD and other chronic illnesses. Patients in our cohort may have been misclassified with an OUD diagnosis and thus were not valid OAT candidates. The challenges of using diagnosis-based denominators for cross-facility comparisons are discussed elsewhere.³⁴ Conversely, OUD is also underdiagnosed and eligible patients may have been inadvertently excluded. Further, our study only includes VHA pharmacotherapy data; thus, it is possible that patients received OAT after discharge at a non-VHA facility. Nonetheless, this is unlikely to significantly influence our results

because there were only six cases with post-admission non-VHA OAT receipt in the original data extraction. Another study limitation was our inability to discern why OAT was not delivered (e.g., patients may have declined OAT). Finally, the study data are from 2017, a specific moment in time that does not capture potential changes in practice over time.

Implications for Practice, Research, and Policy

The findings from this study may motivate practice improvement, future research, and inform policy to increase hospital-based OAT delivery in the midst of the opioid-related overdose crisis.

Practice Improvement

National authorities recommend OAT continuation or initiation in the hospital⁶ and a National Academies of Science, Engineering, & Medicine consensus report concluded that: “Withholding or failing to have available all classes of FDA-approved medication for the treatment of opioid use disorder in any care or criminal justice setting is denying appropriate medical treatment” (p. 3).³⁰ Further, hospitalization is a reachable moment for treatment initiation and engagement.^{35,36} Unfortunately, our study suggests that hospital OAT delivery frequency may be far from optimal. The current practice is not only a missed opportunity for treatment engagement, but may also cause harm by disrupting life-saving care.

A recent systematic review suggests that the provision of addiction-related services for hospitalized patients with OUD improves patient, provider, and health care outcomes.³⁷ Interventions to improve OAT delivery may include an organizational intervention—the addiction consult service (ACS), which provides clinical, educational, and policy-based addiction services and programming in the hospital.³⁸ ACSs, however, are unlikely to be available or feasible across all hospitals. Further, it is likely that many hospital providers have limited addiction training³⁹ and are less confident in providing OAT and delivering other OUD-related services. To address this issue, the VHA and other national hospital decisionmakers could publish specific guidance promoting evidence-based addictions hospital care⁴⁰ or create educational campaigns encouraging hospital-based OAT delivery. These initiatives would likely need to address provider knowledge gaps and addiction-related stigma,^{20,41} describe pathways to OAT after discharge, and identify policies impeding care inside and outside the hospital setting.²⁰

Future Research

Research should explore barriers to OAT initiation during hospitalization at the VHA and reasons for practice variation at patient, hospital, and system levels. Given the VHA’s prioritization of OUD treatment, it is possible that the VHA may be outperforming non-VHA hospitals. Future research may confirm this impression. Policymakers and researchers need to

consider data access issues. One of the primary challenges to studying hospital OAT delivery is the widespread use of diagnosis-related groupings (DRG) in hospital billing. DRG billing allows hospitals to bill payers through a bundled payment algorithm to account for illness acuity.⁴² Study replication using Medicaid claims data, for example, is not feasible because most admission-related medications are not captured in the bundled claims data.

Policy Interventions

The VHA has already mandated national standards to enhance services for patients with OUD. Additional policy interventions outside the VHA may be warranted. Policies requiring all hospitals to offer OAT could be leveraged through hospital-related accrediting bodies (e.g., the Joint Commission). At present, there are no accreditation requirements related to hospital care for persons with OUD and SUDs. It is within the authority of the Joint Commission to require reporting and performance measurement for OAT and to mandate addiction-related technologies for hospital accreditation (e.g., presence of addiction physicians or ACS). Another approach is local legislation. In August 2018, the Massachusetts legislature passed House Bill 4866, *Prevention and Access to Appropriate Care and Treatment of Addiction*,⁴³ which requires Massachusetts' emergency departments to offer OAT for patients with an opioid overdose and to link them to outpatient services.⁴³ Similar policies could be created for inpatient service delivery. Finally, there is interest in reforming restrictive federal OAT policies, specifically, to abolish buprenorphine X-waiver requirements.⁴⁴

CONCLUSIONS

In a retrospective, unmatched pragmatic VHA patient cohort, hospital OAT delivery varied widely, was infrequently delivered, and was most commonly administered as a continued outpatient medication or for withdrawal management. This study is the first multisite description of hospital OAT delivery and reveals characteristics that require further exploration to understand how to increase OAT access to patients hospitalized with OUD.

Acknowledgments: Dr. Priest's dissertation committee.

Corresponding Author: Kelsey C. Priest, PhD, MPH; School of Public Health Oregon Health & Science University-Portland State University, Portland, OR, USA (e-mail: priest@ohsu.edu).

Funding Information This study was funded by the National Institute on Drug Abuse (F30 DA044700, R33 DA035640, UG1 DA015815), the Greenlick Family Scholarship Fund, and the United States Department of Veterans Affairs Health Services Research & Development (IK2HX001516). The funding organizations were not involved in the design of the study, data collection, data analysis, the interpretation of data, or writing of the manuscript.

Compliance with Ethical Standards:

The Veterans Affairs Portland Health Care System Institutional Review Board approved this study (no. 4045).

Conflict of Interest: Dr. Lovejoy reports grants from VA Health Services Research & Development during the conduct of the study and grants from National Institutes of Health outside the submitted work. Dr. Priest reports grants from National Institutes of Health and the Greenlick Family Scholarship Fund during the conduct of the study. Drs. Englander, McCarty, and Shull have nothing to disclose.

Disclaimer: The contents of the manuscript are those of the authors and do not represent the views of the US Department of Veterans Affairs or the US Government.

REFERENCES

1. Weiss AJ, Elixhauser A, Barret ML, Steiner CA, Bailey MK, O'Malley L. HCUP statistical brief #219: Opioid-related inpatient stays and emergency department visits by state, 2009–2014. Agency for Healthcare Research and Quality;2016.
2. Peterson C, Liu Y, Xu L, Nataraj N, Zhang K, Mikosz CA. US National 90-Day Readmissions After Opioid Overdose Discharge. *Am J Prev Med*. 2019. doi: <https://doi.org/10.1016/j.amepre.2018.12.003>.
3. Ronan MV, Herzig SJ. Hospitalizations related to opioid abuse/dependence and associated serious infections increased sharply, 2002–12. *Health Aff (Millwood)*. 2016;35(5):832–837. doi: <https://doi.org/10.1377/hlthaff.2015.1424>.
4. Weiss AJ, Heslin KC. HCUP statistical brief #239: Payers of opioid-related inpatient stays and emergency department visits nationally and by state, 2010 and 2015. Agency for Healthcare Research and Quality;2018.
5. Weiss AJ, Elixhauser A. HCUP statistical brief #180: Overview of hospital stays in the United States, 2012. Agency for Healthcare Research and Quality;2014.
6. Substance Abuse and Mental Health Services Administration. Treatment Improvement Protocol 63: Medications for opioid use disorder. 2018.
7. Rosenthal ES, Karchmer AW, Theisen-Toupal J, Castillo RA, Rowley CF. Suboptimal addiction interventions for patients hospitalized with injection drug use-associated infective endocarditis. *Am J Med*. 2015;129(5):481–485. doi: <https://doi.org/10.1016/j.amjmed.2015.09.024>.
8. Naeger S, Ali MM, Mutter R, Mark T, Hughey L. Prescriptions filled following an opioid-related hospitalization. *Psychiatr Serv*. 2016;67(11):1262–1264. doi: <https://doi.org/10.1176/appi.ps.201500538>.
9. Liebschutz JM, Crooks D, Herman D, et al. Buprenorphine treatment for hospitalized, opioid-dependent patients: A randomized clinical trial. *JAMA Internal Medicine*. 2014;174(8):1369–1376. doi: <https://doi.org/10.1001/jamainternmed.2014.2556>.
10. Trowbridge P, Weinstein ZM, Kerensky T, et al. Addiction consultation services – Linking hospitalized patients to outpatient addiction treatment. *J Subst Abuse Treat*. 2017;79:1–5. doi: <https://doi.org/10.1016/j.jsat.2017.05.007>.
11. Moreno JL, Wakeman SE, Duprey MS, Roberts RJ, Jacobson JS, Devlin JW. Predictors for 30-day and 90-day hospital readmission among patients with opioid use disorder. *J Addict Med*. 2019. doi: <https://doi.org/10.1097/ADM.0000000000000499>.
12. Englander H, Dobberty K, Lind BK, et al. Inpatient addiction medicine consultation and post-hospital substance use disorder treatment engagement: A propensity matched analysis. *J Gen Intern Med*. 2019;34(12). doi: <https://doi.org/10.1007/s11606-019-05251-9>.
13. Bohnert AS, Ilgen MA, Galea S, McCarthy JF, Blow FC. Accidental poisoning mortality among patients in the Department of Veterans Affairs Health System. *Med Care*. 2011;49(4):393–396. doi: <https://doi.org/10.1097/MLR.0b013e318202aa27>.
14. Oliva EM, Trafton JA, Harris AH, Gordon AJ. Trends in opioid agonist therapy in the Veterans Health Administration: Is supply keeping up with demand? *Am J Drug Alcohol Abuse*. 2013;39(2):103–107. doi: <https://doi.org/10.3109/00952990.2012.741167>.
15. Finlay AK, Binswanger IA, Timko C, et al. Facility-level changes in receipt of pharmacotherapy for opioid use disorder: Implications for

- implementation science. *J Subst Abuse Treat.* 2018;95:43–47. doi: <https://doi.org/10.1016/j.jsat.2018.09.006>.
16. Wyse JJ, Gordon AJ, Dobscha SK, et al. Medications for opioid use disorder in the Department of Veterans Affairs (VA) health care system: Historical perspective, lessons learned, and next steps. *Substance abuse.* 2018;39(2):139–144. doi: <https://doi.org/10.1080/08897077.2018.1452327>.
 17. U.S. Department of Veterans Affairs. VA/DoD clinical practice guidelines: Management of substance use disorder (SUD). 2017; <https://www.healthquality.va.gov/guidelines/mh/sud/>. Accessed 2/9/2020.
 18. Agency for Healthcare Research and Quality. Beta Elixhauser Comorbidity Software for ICD-10-CM. 2018; https://www.hcup-us.ahrq.gov/tools-software/comorbidityicd10/comorbidity_icd10.jsp#description. Accessed 2/9/2020.
 19. Priest KC. Hospital-based services for opioid use disorder: A study of supply-side attributes. *Dissertations and Theses.* 2019;Paper 4829. doi: https://pdxscholar.library.pdx.edu/open_access_etds/4829
 20. Priest KC, Englander H, McCarty D. "Now hospital leaders are paying attention": A qualitative study of internal and external factors influencing addiction consult services. *J Subst Abuse Treat.* 2020;110:59–65. doi: <https://doi.org/10.1016/j.jsat.2019.12.003>.
 21. RStudio: Integrated development for R. [computer program]. Boston, MA RStudio, Inc.; 2015.
 22. Car [computer program]. Thousand Oaks, CA: SAGE Publications; 2011.
 23. Dunn.test: Dunn's Test of multiple comparisons using rank sums [computer program]. 2017.
 24. icd: Comorbidity calculations and tools for ICD-9 and ICD-10 codes [computer program]. 2018.
 25. Wickham H. plyr: The split-apply-combine strategy for data analysis. *Journal of Statistical Software.* 2011;40(1). doi: <https://doi.org/10.18637/jss.v040.i01>
 26. Psych: Procedures for personality and psychological research [computer program]. Evanston, IL: Northwestern University; 2018.
 27. tidyverse: Easily install and load the 'Tidyverse'. [computer program]. 2017.
 28. Stata Statistical Software: Release 15 [computer program]. College Station, TX: StataCorp LLC; 2017.
 29. U.S. Department of Veterans Affairs. VHA opioid taper decision tool. 2016.
 30. National Academies of Sciences, Engineering, and Medicine. *Medications for Opioid Use Disorder Save Lives.* Washington, DC: The National Academies Press; 2019.
 31. Haber L, DeFries T, Martin M. Things We Do for No Reason™: Discontinuing Buprenorphine When Treating Acute Pain. *J Hosp Med.* 2019;14(10):633. doi: <https://doi.org/10.12788/jhm.3265>.
 32. Oliva EM, Harris AHS, Trafton JA, Gordon AJ. Receipt of opioid agonist treatment in the Veterans Health Administration: Facility and patient factors. *Drug Alcohol Depend.* 2012;122(3):241–246. doi: <https://doi.org/10.1016/j.drugalcdep.2011.10.004>.
 33. Lind BK, McCarty D, Gu Y, Baker R, McConnell JK. Predictors of substance use treatment initiation and engagement among adult and adolescent Medicaid recipients. *Substance abuse.* 2019;1–7. doi: <https://doi.org/10.1080/08897077.2018.1550467>.
 34. Harris AHS, Rubinsky AD, Hoggatt KJ. Possible alternatives to diagnosis-based denominators for addiction treatment quality measures. *J Subst Abuse Treat.* 2015;58:62–66. doi: <https://doi.org/10.1016/j.jsat.2015.06.004>.
 35. Englander H, Weimer M, Solotaroff R, et al. Planning and designing the Improving Addiction Care Team (IMPACT) for hospitalized adults with substance use disorder. *J Hosp Med.* 2017;12(5):339–342. doi: <https://doi.org/10.12788/jhm.2736>.
 36. Velez CM, Nicolaidis C, Korthuis PT, Englander H. "It's been an experience, a life learning experience": A qualitative study of hospitalized patients with substance use disorders. *J Gen Intern Med.* 2017;32(3):296–303. doi: <https://doi.org/10.1007/s11606-016-3919-4>.
 37. Weimer M, Morford K, Donroe J. Treatment of opioid use disorder in the acute hospital setting: A critical review of the literature (2014–2019). *Current Addiction Reports.* 2019;1–16. doi: <https://doi.org/10.1007/s40429-019-00267-x>.
 38. Velez CM, McCarty D. Role of the hospital in the 21st Century opioid overdose epidemic: The addiction medicine consult service. *J Addict Med.* 2019;Mar/Apr 13(2):104–112. doi: <https://doi.org/10.1097/ADM.0000000000000496>.
 39. Englander H, Collins D, Perry SP, Rabinowitz M, Phoutrides E, Nicolaidis C. "We've learned it's a medical illness, not a moral choice": Qualitative study of the effects of a multicomponent addiction intervention on hospital providers' attitudes and experiences. *J Hosp Med.* 2018;13(11):752–758. <https://doi.org/10.12788/jhm.2993>.
 40. Englander H, Priest KC, Snyder H, Martin M, Calcatera S, Gregg J. A call to action: Hospitalists' role in addressing substance use disorder. *J Hosp Med.* 2019;Online October 2019. doi: <https://doi.org/10.12788/jhm.3311>.
 41. Ashford RD, Brown AM, McDaniel J, Curtis B. Biased labels: An experimental study of language and stigma among individuals in recovery and health professionals. *Substance use & misuse.* 2019;1–9. doi: <https://doi.org/10.1080/10826084.2019.1581221>.
 42. Quinn K. New directions in Medicaid payment for hospital care. *Health Aff (Millwood).* 2008;27(1):269–280. doi: <https://doi.org/10.1377/hlthaff.27.1.269>.
 43. WBUR News & Wire Services. Lawmakers send opioid bill to Baker's desk. 2018; <https://www.wbur.org/commonhealth/2018/08/01/opioid-legislation-to-governor>. Accessed 2/9/2020.
 44. Fiscella K, Wakeman SE, Beletsky L. Buprenorphine deregulation and mainstreaming treatment for opioid use disorder: X the X waiver. *JAMA Psychiatry.* 2019;76(3):229–230. doi: <https://doi.org/10.1001/jama.2019.0000>.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Publisher's Note: Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.