

# Inpatient Addiction Medicine Consultation and Post-Hospital Substance Use Disorder Treatment Engagement: a Propensity-Matched Analysis



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**BACKGROUND:** Hospitalizations due to medical and surgical complications of substance use disorder (SUD) are rising. Most hospitals lack systems to treat SUD, and most people with SUD do not engage in treatment after discharge.

**OBJECTIVE:** Determine the effect of a hospital-based addiction medicine consult service, the Improving Addiction Care Team (IMPACT), on post-hospital SUD treatment engagement.

**DESIGN:** Cohort study using multivariable analysis of Oregon Medicaid claims comparing IMPACT patients with propensity-matched controls.

**PARTICIPANTS:** 18–64-year-old Oregon Medicaid beneficiaries with SUD, hospitalized at an Oregon hospital between July 1, 2015, and September 30, 2016. IMPACT patients ( $n=208$ ) were matched to controls ( $n=416$ ) using a propensity score that accounted for SUD, gender, age, race, residence region, and diagnoses.

**INTERVENTIONS:** IMPACT included hospital-based consultation care from an interdisciplinary team of addiction medicine physicians, social workers, and peers with lived experience in recovery. IMPACT met patients during hospitalization; offered pharmacotherapy, behavioral treatments, and harm reduction services; and supported linkages to SUD treatment after discharge.

**OUTCOMES:** Healthcare Effectiveness Data and Information Set (HEDIS) measure of SUD treatment engagement, defined as two or more claims on two separate days for SUD care within 34 days of discharge.

**RESULTS:** Only 17.2% of all patients were engaged in SUD treatment before hospitalization. IMPACT patients engaged in SUD treatment following discharge more frequently than controls (38.9% vs. 23.3%,  $p<0.01$ ; aOR 2.15, 95% confidence interval [CI] 1.29–3.58). IMPACT participation remained associated with SUD treatment engagement when limiting the sample to people who were not engaged in treatment prior to hospitalization (aOR 2.63; 95% CI 1.46–4.72).

**CONCLUSIONS:** Hospital-based addiction medicine consultation can improve SUD treatment engagement, which is associated with reduced substance use, mortality, and other important clinical outcomes. National expansion of such models represents an opportunity to address an enduring gap in the SUD treatment continuum.

**KEY WORDS:** substance-related disorders; hospitalization; substance use treatment; Medicaid.

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## INTRODUCTION

Hospitals are increasingly filled with people suffering from medical complications of substance use disorders (SUD).<sup>1,2</sup> One in seven patients in general hospitals has a substance use disorder,<sup>3</sup> and hospitalizations for opioid- and methamphetamine-related diagnoses are surging.<sup>4–6</sup> Patients with SUD have longer lengths of stay, higher costs,<sup>6</sup> and higher readmission rates.<sup>3</sup> Over the last decade, costs related to SUD-associated hospitalizations have quadrupled, with an estimated \$15 billion due to hospitalizations related to opioid use disorder in 2012 alone.<sup>2</sup>

Despite frequent hospitalizations and high healthcare costs, most hospitalized patients with SUD are not engaged in SUD care before hospitalization, and most hospitals do not treat SUD during the acute inpatient encounter.<sup>2,7</sup> Failure to treat SUD in hospitals leads to untreated withdrawal, failure to complete recommended medical therapy, and high rates of against medical advice discharge.<sup>8–10</sup> Though there are decades of evidence showing the effectiveness of medication for opioid<sup>11</sup> and alcohol use disorders,<sup>12</sup> most hospitals lack expertise and systems to treat SUD and do not effectively connect people to treatment after discharge.<sup>13</sup> Barriers include lack of addiction medicine expertise, regulatory concerns, stigma, and silos between hospital and community SUD treatment settings.<sup>8,14</sup>

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Hospitalization is a crucial potential juncture to engage out-of-treatment adults in SUD care.<sup>15,16</sup> Hospitalized patients with SUD have nearly twice the rate of hospital readmission and repeat ED use within 30 days,<sup>3</sup> compared with those without SUD. And the immediate period after hospital discharge is particularly high risk for drug-related death and suicide.<sup>17</sup> SUD treatment engagement is associated with reduced substance use severity,<sup>18–21</sup> higher employment and wages,<sup>22</sup> less future criminal involvement,<sup>21</sup> reduced overdose rates,<sup>11</sup> and reduced all-cause mortality.<sup>11,23</sup> Hospitalization can be a reachable moment to initiate and coordinate SUD care. Although medical and surgical inpatients do not come to the hospital seeking addiction care, a study of hospitalized adults at our hospital found that over half of people with high-risk alcohol use and over two-thirds of people with high-risk drug use reported wanting to cut back or quit.<sup>24</sup> Interventions to improve post-discharge SUD treatment engagement are likely to improve outcomes for people with SUD.

Despite a growing literature of the feasibility and importance of hospital-based addiction care,<sup>25–29</sup> there are no studies using robust causal inference methods to evaluate the effects of inpatient addiction medicine consultation on SUD treatment engagement after discharge. A quasi-experimental study at a single Boston academic medical center comparing patients who received inpatient addiction medicine consultation with those who did not found that patients seen by the consult service were more likely to report SUD treatment engagement at 30 and 90 days after discharge.<sup>30</sup> While promising, this study relied on self-reported outcomes and had 34% loss to follow-up at 30 days and 47% at 90 days. Additional rigorous evaluations to understand the effect of hospital-based addiction medicine care on post-hospital community SUD treatment are critical for broader adoption and dissemination.

We implemented a previously described interprofessional hospital-based addiction medicine consult service called the Improving Addiction Care Team (IMPACT).<sup>8,24,31,32</sup> IMPACT engages adults with opioid, alcohol, methamphetamine, and other substances (excluding tobacco use disorder alone) during the reachable moment of hospitalization and provides rapid-access pathways to community SUD treatment and harm reduction support. The goal of this analysis was to assess post-hospital SUD treatment engagement among Oregon Medicaid recipients who received IMPACT care compared with propensity score-matched controls. We hypothesized that IMPACT participation would be associated with greater post-hospital SUD treatment engagement.

## METHODS

### Intervention

IMPACT is a hospital-based addiction medicine consult service that includes care from addiction medicine physicians, social workers, and peers with lived experience in recovery. Inpatient medical and surgical providers and hospital social

workers refer patients with known or suspected SUD to IMPACT. IMPACT is open to patients with any SUD (excluding people with tobacco use disorders alone) regardless of readiness to change or interest in treatment. Initially IMPACT served patients admitted to medicine, family medicine, cardiology services; or patients needing prolonged intravenous antibiotics admitted to any hospital service. IMPACT expanded to include surgical services in July 2017. IMPACT medical providers and social workers perform an initial comprehensive assessment, including DSM-5 SUD diagnosis assessment; elicit patient-centered goals around the acute hospitalization and SUD; initiate SUD treatment, including pharmacotherapy and behavioral treatments; and offer harm reduction services. IMPACT includes robust referral pathways to post-hospital SUD care and, in some cases, forges relationships with rural SUD providers to coordinate post-hospital care.<sup>24,31,32</sup> Earlier work provides a detailed description of the interprofessional team and intervention.<sup>24,32</sup>

During the study window, IMPACT included 0.7 full-time equivalent (FTE) clinical physician time shared among 5 physicians, 1 social worker, and 2 peer recovery mentors. IMPACT physicians documented a median value of 2 patient visits (range 1–33) and social workers a median 3 (1–33) patient visits per hospitalization. Intervention intensity depended on patient needs, hospital length of stay, and IMPACT capacity.

### Setting and Study Design

Earlier research found that IMPACT created a system-level change by reframing addiction as a treatable chronic disease, increasing provider understanding of how to engage and treat patients with SUD, and creating rapid pathways to care.<sup>8</sup> As such, a patient- or provider-level randomized trial would not adequately isolate the intervention effect. Thus, we conducted a multivariable analysis comparing intervention patients with propensity-matched controls across Oregon hospitals. We used Oregon Medicaid claims data, obtained under a data use agreement with the Oregon Health Authority, that included physical/behavioral health and pharmacy claims in calendar years 2015–2016. This study was approved by the Oregon Health & Science University (OHSU) Institutional Review Board.

### Population

All participants were 18–64 years old with Oregon Medicaid insurance, had at least one SUD diagnosis (not including tobacco use disorder), and were hospitalized at an Oregon hospital between July 1, 2015, and September 30, 2016. IMPACT patients had confirmed or suspected SUD and were referred by medical and surgical providers at a large academic center in Portland, OR. Interest in SUD treatment was not required for IMPACT participation. Patients initially referred for IMPACT evaluation were excluded if a DSM-5 SUD diagnosis was not confirmed. We included individuals with

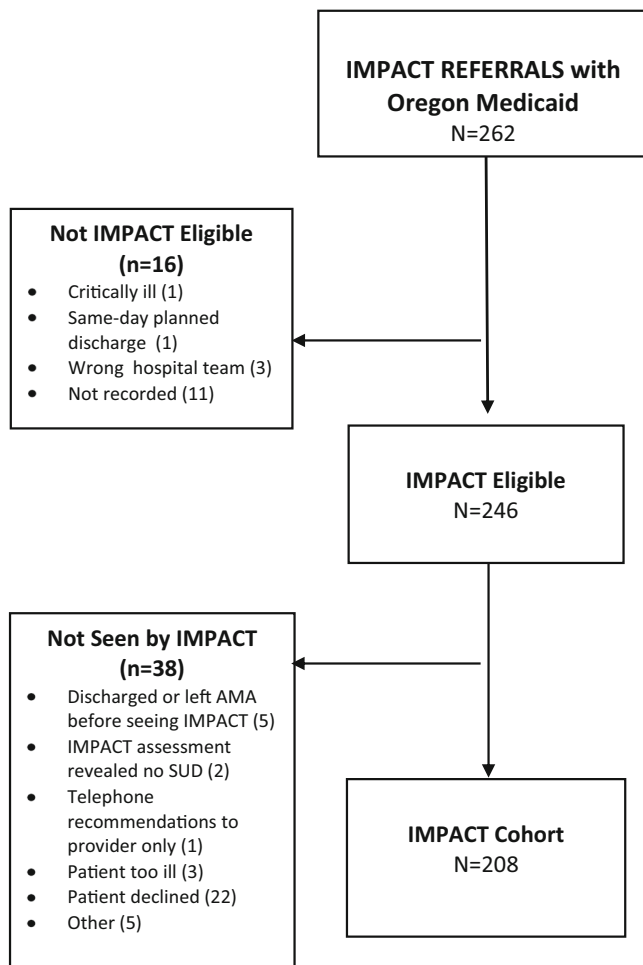


Figure 1 IMPACT participant flow diagram.

past SUD treatment because acute illness and hospitalization can interrupt SUD treatment<sup>33</sup> and precipitate return to use, and IMPACT coordinates and supports care continuity for hospitalized patients already engaged in treatment. During the study window, IMPACT had 357 referrals. Of those, 269 (75.3%) had Oregon Medicaid, of which 264 were eligible for IMPACT and 208 were seen by IMPACT and comprise the IMPACT cohort (Fig. 1).

We used propensity score matching to reduce bias by ensuring that cases and controls had comparable covariate distributions.<sup>34</sup> First, we calculated a propensity score using all inpatient admissions with an SUD diagnosis. We calculated a propensity score using backward stepwise logistic regression and accounted for SUD type, gender, age, race, residence region, and diagnoses, including the Chronic Illness & Disability Payment System (CDPS)<sup>35</sup> risk score, which consists of 17 distinct disease categories that include physical and psychiatric diagnoses. Next, we matched IMPACT participants to potential controls matching on mutually exclusive SUD categories. For example, we matched patients with co-occurring opioid and methamphetamine use only to controls with co-occurring opioids and methamphetamine use. This allowed us to account for polysubstance use. Then, within

each exactly matched SUD group, we nearest-neighbor matched each IMPACT patient to two controls, without replacement, based on propensity score.

## Measures

The primary outcome, was the Healthcare Effectiveness Data and Information Set (HEDIS) National Committee for Quality Assurance (NCQA) definition of post-discharge SUD treatment engagement,<sup>36</sup> which includes two or more of the following occurring on at least two separate days within 34 days of discharge: (1) a filled prescription for medication treatment (e.g., buprenorphine), (2) a procedure code for SUD treatment (e.g., methadone administration at an opioid treatment program, behavioral treatment for stimulant use disorder), or (3) a clinic visit with an SUD ICD-9 or ICD-10 code (Appendix in the [Electronic Supplementary Material \(ESM\)](#)). Filled prescriptions were limited to FDA-approved medications for SUD (excluding medication for tobacco use disorder). Medications dispensed from a hospital pharmacy at the time of discharge (for example, a bridging prescription for buprenorphine) do not appear in Oregon Medicaid claims; instead, they are included as part of the inpatient admission. In general, IMPACT's practice is to provide a 7–14-day bridge prescription for buprenorphine and up to 28 days for oral naltrexone or acamprosate at hospital discharge. A single prescription in the 34 days after discharge or one-time administration of a long-acting injectable medication would appear as a single encounter and not meet the criteria for HEDIS treatment engagement. Both of these factors might lead to an underestimate of post-hospital SUD treatment engagement using our primary outcome.

Covariates adjusted for in the final model included SUD treatment engagement in the 34 days prior to hospitalization, SUD type (opioid SUD vs. non-opioid SUD), gender, age, race/ethnicity, Portland tri-county area residence as a surrogate marker for urban versus non-urban healthcare systems, Medicare Severity Diagnosis-Related Group (MS-DRG)<sup>37</sup> category, and Chronic Illness & Disability Payment System risk score.<sup>35</sup>

## Analysis

We used multivariable logistic regression to evaluate the effect of IMPACT participation on treatment engagement. Due to small counts for many of the MS-DRGs, we collapsed them into clinically meaningful groups with sufficient numbers to model. High prevalence of polysubstance use led to sizeable overlap when we analyzed the effect of individual substances separately. Hence, we separated patients with any opioid use versus others because of the existence of more effective treatment options for opioid use disorder. Due to concerns that post-hospital treatment engagement could be driven by prior SUD treatment, we also conducted a sensitivity analysis modeling engagement among only those patients who had not engaged in SUD treatment in the 34 days prior to

Table 1 Patient Characteristics: IMPACT Versus Controls

Characteristic	IMPACT, N = 208 N (%)	Controls, N = 416	Total, N = 624	p value <sup>a</sup>
Prior SUD treatment <sup>b</sup>	37 (17.8)	70 (16.8)	107 (17.2)	0.76
SUD type				
Non-opioid SUD <sup>c</sup>	146 (70.2)	292 (70.2)	438 (70.2)	1.00
Any opioid SUD <sup>d</sup>	62 (29.8)	124 (29.8)	186 (29.8)	1.00
Male	127 (61.1)	249 (59.9)	376 (60.3)	0.77
Age				0.19
18–39 years	102 (49.0)	181 (43.5)	283 (45.4)	
40–64 years	106 (51.0)	235 (56.5)	341 (54.7)	
White non-Hispanic	160 (76.9)	341 (82.0)	501 (80.3)	0.14
Portland tri-county area <sup>e</sup>	172 (82.7)	295 (70.9)	467 (74.8)	< 0.01
MS-DRG category <sup>f</sup>				0.01
Alcohol and related complications	44 (21.2)	86 (20.7)	130 (20.8)	
Endocarditis, osteomyelitis, sepsis	65 (31.3)	116 (27.9)	181 (29.0)	
Skin and soft tissue infections	16 (7.7)	10 (2.4)	26 (4.2)	
Non-valvular cardiovascular	13 (6.3)	17 (4.1)	30 (4.8)	
Orthopedic/joint	9 (4.3)	20 (4.8)	29 (4.7)	
Other	61 (29.3)	167 (40.1)	228 (36.5)	
Mean (SD)				
CDPS risk score <sup>g</sup>	4.1 (2.5)	4.08 (2.1)	4.09 (2.2)	0.93

IMPACT, Improving Addiction Care Team; SUD, substance use disorder

<sup>a</sup>We used  $\chi^2$  for categorical variables and T-test for CDPS risk score

<sup>b</sup>Prior treatment defined as  $\geq 2$  encounters for SUD treatment on 2 separate days in 34 days before admission. Codes used to define SUD treatment encounters are detailed in the Appendix in the ESM and include (1) a filled prescription for medication treatment, (2) a procedure code for SUD treatment, or (3) a clinic visit with an SUD ICD-9 or ICD-10 code

<sup>c</sup>Includes alcohol alone, stimulant alone, alcohol + stimulant, other

<sup>d</sup>Includes opioids alone, opioids + alcohol, opioids + stimulant, opioids + alcohol + stimulant

<sup>e</sup>Clackamas, Multnomah, and Washington counties

<sup>f</sup>Medicare Severity Diagnosis Related Group (MS-DRG)

<sup>g</sup>Chronic Illness & Disability Payment System (CDPS), continuous variable

hospitalization. We performed data management and statistical analysis using Stata version 15.1.

## RESULTS

Cases ( $n = 208$ ) and controls ( $n = 416$ ) had similar gender, race and ethnicity, rural residence, age, and mean CDPS risk score distribution (Table 1). 60.3% were male, 54.7% were 40 years or older, and 29.8% had any opioid SUD diagnosis. More cases resided in the Portland tri-county area (82.7% vs. 70.9%). More controls had DRGs in the heterogeneous “other” category (40.1% vs. 29.3%). Only 17.2% of all patients were engaged in treatment in the 34 days prior to hospitalization, with similar rates among IMPACT (12.5–19.2%) and controls (12.3–16.0%). Of the 208 IMPACT patients, 31 received a discharge prescription for buprenorphine, 14 for oral naltrexone, 8 for acamprosate, and 18 received injectable naltrexone during hospitalization with a plan to continue. At the time of discharge, 56 had a plan to continue methadone maintenance. At 34 days, 1 person in IMPACT and 14 people in the control group had died.

In the primary analysis, IMPACT patients engaged in SUD treatment following discharge more frequently than controls (38.9% vs. 23.3%,  $p < 0.01$ ; adjusted odds ratio [aOR] 2.15, 95% confidence interval [CI] 1.29–3.58; Table 2). Predictably, those engaged in treatment before admission had substantially greater odds of receiving treatment after discharge (aOR 11.95; 95% CI 6.31–22.65). A sensitivity analysis limiting

the sample to those without pre-hospital SUD treatment showed similar results, with a significant association between IMPACT and engagement in SUD treatment (aOR 2.63, 95% CI 1.46–4.72). Patients with opioid use disorder were more likely than those without an opioid use disorder to engage in treatment (aOR 1.83, 95% CI 1.03–3.24).

The figure shows the unadjusted proportion of patients receiving treatment in the 6 months before hospitalization and within the 34 days after discharge. Treatment engagement is similar in the months before admission and increases following discharge, more for IMPACT patients than for controls (39.9% vs. 23.3%,  $p < 0.01$ ) (Fig. 2).

## DISCUSSION

Hospitalized Medicaid recipients with SUD who received inpatient addiction medicine consultation had greater odds of post-hospital SUD treatment engagement than matched controls. Few patients were engaged in SUD care prior to hospitalization, highlighting the role of hospitalization as a reachable moment. To our knowledge, this is most rigorously controlled study demonstrating the effectiveness of an inpatient addiction medicine consult service in improving SUD treatment engagement, one of the enduring gaps in the SUD treatment continuum.<sup>38</sup>

Our study extends previous research in several important ways. First, propensity score–matched controls provide a rigorous comparison group which alleviates potential bias due to



Table 2 Model Results: Patient Characteristics Associated with Treatment Engagement

Characteristic	Unadjusted analyses				Adjusted analyses			
	Total	Engaged in treatment <sup>a</sup>		Not engaged in treatment		aOR <sup>b</sup>	95% CI	
	N	N	(%)	N	(%)			
Control	416	97	(23.3)	349	(76.7)	Ref.	–	–
IMPACT	208	81	(38.9)	127	(61.1)	2.15	1.29	3.58
No prior SUD treatment <sup>c</sup>	517	101	(19.5)	416	(80.5)	Ref.	–	–
Prior SUD treatment	107	77	(72.0)	30	(28.0)	12.12	6.44	22.82
SUD type								
Non-opioid SUD <sup>d</sup>	186	36	(19.4)	150	(80.6)	Ref.	–	–
Any opioid SUD <sup>e</sup>	438	142	(32.4)	296	(67.58)	1.83	1.03	3.24
Gender								
Female	248	73	(29.4)	175	(70.6)	Ref.	–	–
Male	376	105	(27.9)	271	(72.1)	1.05	0.63	1.74
Age (years)								
18–39	283	83	(29.3)	200	(70.7)	Ref.	–	–
40–64	341	95	(27.9)	246	(72.1)	0.83	0.48	1.40
Race and ethnicity								
Other	123	38	(30.9)	85	(69.1)	Ref.	–	–
White non-Hispanic	501	140	(27.9)	361	(72.1)	0.92	0.53	1.62
Region								
Non-tri-county area	157	27	(17.2)	130	(82.8)	Ref.	–	–
Portland tri-county area <sup>f</sup>	467	151	(32.3)	316	(67.7)	1.74	0.90	3.34
MS-DRG category <sup>g</sup>								
Alcohol and related complications	130	35	(26.9)	95	(73.1)	Ref.	–	–
Endocarditis, osteomyelitis, sepsis	181	54	(29.8)	127	(70.2)	1.19	0.62	2.28
Skin and soft tissue infections	26	12	(46.2)	14	(53.8)	2.36	0.88	6.32
Non-valvular cardiovascular	30	13	(43.3)	17	(56.7)	2.07	0.80	5.36
Orthopedic/joint	29	6	(20.7)	23	(79.3)	0.49	0.12	2.02
Other	228	58	(25.4)	170	(74.6)	0.98	0.49	1.94
Mean (SD)								
CDPS risk score <sup>h</sup>		4.04	(2.1)	4.11	(2.3)	1.05	0.93	1.19

IMPACT, Improving Addiction Care Team; SUD, substance use disorder

<sup>a</sup>Treatment defined as  $\geq 2$  encounters for SUD treatment on 2 separate days within 34 days of discharge; Healthcare Effectiveness Data and Information Set (HEDIS) measure

<sup>b</sup>Adjusted odds ratio (OR), adjusted for all variables in Table 2

<sup>c</sup>Prior treatment defined as  $\geq 2$  encounters for SUD treatment on 2 separate days in 34 days before admission

<sup>d</sup>Includes alcohol alone, stimulant alone, alcohol + stimulant, other

<sup>e</sup>Includes opioids alone, opioids + alcohol, opioids + stimulant, opioids + alcohol + stimulant

<sup>f</sup>Clackamas, Multnomah, and Washington counties

<sup>g</sup>Medicare Severity Diagnosis-Related Group (MS-DRG)

<sup>h</sup>Chronic Illness & Disability Payment System (CDPS), continuous variable

systematic differences in treatment groups,<sup>39</sup> and we also controlled for known confounders. Our work builds on a quasi-experimental study at a Boston academic medical center that compared patients who received inpatient addiction medicine consultation with those who did not, finding that patients seen by the inpatient consult service were more likely to report SUD treatment engagement at 30 and 90 days after

discharge.<sup>30</sup> While promising, this study was quasi-experimental, relied on self-reported outcomes, and had high loss to follow-up (34% at 30 days, 47% at 90 days). Second, whereas earlier studies<sup>25–27</sup> measure engagement as a single SUD-related encounter, ours ties hospital-initiated care to multiple post-hospital treatment encounters using the NCQA HEDIS measure. Third, our study measured treatment engagement state-wide across any setting, whereas prior studies measured engagement by self-report or referral to a single SUD treatment location.<sup>25,27</sup> Finally, claims data provide a more reliable measure of treatment engagement than self-report.

Patients with opioid use disorder (OUD) had greater odds of engagement than those with non-opioid SUD. We hypothesize that this may be due to greater uptake and effectiveness of medications for OUD compared with non-opioid SUD, particularly for methamphetamine use disorder.

Treatment prior to admission was, unsurprisingly, associated with substantial increased odds of treatment engagement following hospitalization. One might hypothesize that the effect of an intervention such as IMPACT is driven by prior treatment engagement; however, a sensitivity analysis showed IMPACT had a durable effect among patients without prior treatment engagement. This highlights a potential role of inpatient addiction medicine consult services in facility

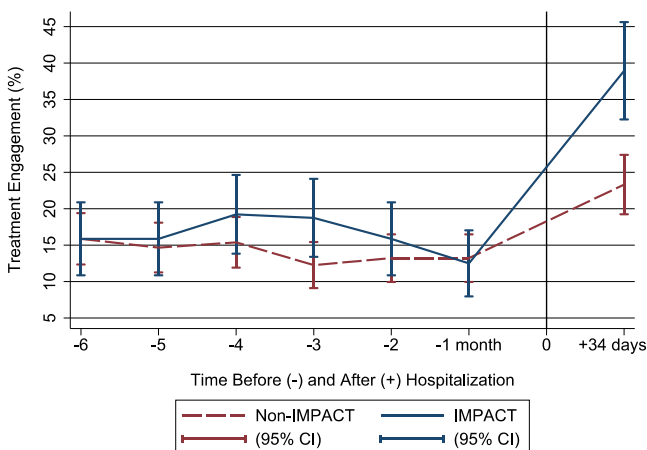


Figure 2 Substance use disorder treatment engagement over time, comparing IMPACT and controls.

treatment retention by avoiding treatment interruption during hospitalization and return to use—another major gap in the SUD treatment continuum.

Our study has several important implications. First, hospitals can and should address SUD. Current hospital practice, which treats acute medical problems resulting from SUD without addressing the underlying cause, is analogous to performing an amputation for a diabetic foot infection without providing insulin or referring to outpatient diabetes care. The finding that inpatient addiction medicine care increases post-hospital treatment engagement further underscores the need to address SUD during hospitalization.

In our study, only 17% of people were engaged in treatment prior to hospitalization. This is consistent with national trends showing that only 7.7% of people with any past-year SUD received treatment.<sup>40</sup> Current reform efforts have focused largely on integrating addiction treatment in primary care. These are critical reforms, and long-term success of hospital-based interventions depends on availability of community treatment. However, integrating SUD care in hospitals should not be overlooked. Hospitals have potential to engage people who are not engaged in primary care, who are medically complex, whose SUD may be particularly severe, and who may be high healthcare utilizers.

Doubling the odds of treatment engagement, with 39% of IMPACT participants engaging in post-hospital SUD care, is important. Our outcome measure may underestimate treatment engagement. However, the patients that did not connect to treatment warrant consideration. Not all hospitalized adults with SUD want treatment, highlighting our continued duty to implement harm reduction practices in hospitals and across communities. Ample evidence supports that harm reduction practices make substance use safer and ultimately can engage people in treatment.<sup>41–44</sup> However, some patients may have wanted to engage in treatment and been unsuccessful because of limited transportation, housing, criminal justice involvement, and medical illness. Hospital interventions can be catalysts for community-level change, but alone they cannot address structural barriers such as federal regulations limiting methadone access, banning of medication for opioid use disorder in jails, and the need for more buprenorphine providers. Rural treatment access is another important consideration. Though it did not meet the statistical threshold for significance, patients with SUD who resided in areas outside of metropolitan Portland less commonly engaged in SUD treatment following discharge, consistent with lack of treatment providers, transportation, and other barriers that limit access to SUD care in rural America.<sup>45,46</sup> Finally, medical frailty presents a significant challenge to SUD treatment engagement. Barriers occur at the level of SUD treatment, where the physical demands of standing in line for methadone or participating in groups can represent insurmountable barriers. And post-acute care settings such as skilled nursing facilities (SNFs) often force people to choose physical rehabilitation or SUD

treatment (also often denying people access to SNF altogether based on a history of SUD).<sup>26</sup> In this regard, hospital-based addiction medicine consult services have potential to improve SUD treatment retention and relapse prevention through care planning—another major gap in the SUD treatment continuum.

Our study has several important limitations. First, claims data are collected primarily for billing and may not accurately reflect all diagnoses. Further, claims do not include non-billable SUD services such as 12-step meetings, syringe exchange services, or prescriptions dispensed on the day of discharge from a hospital pharmacy—a common practice for IMPACT that potentially underestimates its effect. Second, the study is not a randomized controlled trial and thus may be influenced by selection bias or unknown confounders. Due to complexities related to when IMPACT was available across different services, we do not have data on the total number of patients that could have been eligible for IMPACT. It is possible that providers referred patients who would be more or less likely than controls to engage in SUD treatment. For example, providers may have preferentially referred patients who expressed an interest in treatment. Alternatively, providers may have referred patients who declined usual care social work SUD referrals or who had severe medical or behavioral complications (e.g., disruptive behaviors including active in-hospital drug use, leaving against medical advice) associated with lower likelihood of treatment engagement. We mitigated this by (1) making IMPACT broadly inclusive (excluding only those who refused to speak with us and reducing the risk that only motivated patients entered the study), (2) propensity score matching, which can approximate randomization and adjust for unmeasured confounders,<sup>47,48</sup> (3) adjusting for covariates and pre-hospital SUD treatment, and (4) using a stringent outcome which may underestimate the true effect of IMPACT. Third, we limited our study population to adults with Oregon Medicaid; however, Medicaid patients comprise most hospitalized patients with SUD.<sup>49</sup> Fourth, this was not a blinded study; however, we do not expect blinding to affect assessment of the outcome, which was measured using administrative data. Fifth, Medicaid claims data does not reliably include important social factors such as housing and transportation, so we were unable to control for these. Sixth, we were unable to assess follow-up among people who lost Medicaid insurance in the 34 days after discharge, which likely had a minimal effect, and in those who moved out of Oregon following discharge. Because IMPACT occasionally supported people to connect with supportive family and/or treatment out-of-state, this may have underestimated SUD engagement in the IMPACT group. Finally, our study was performed in a single state with low racial and ethnic diversity and was among the first states to expand Medicaid, which may limit generalizability.

Our study shows that hospitalization can be a place to initiate and engage people in SUD care; however, more research is needed to understand how to best support long-term

treatment retention. Recently hospitalized adults may have different treatment needs. Future research examining treatment retention among recently discharged adults with SUD is warranted. This research should include those in treatment before admission and those who initiated treatment during hospitalization.

Future research should define which components of hospital-based addiction care such as IMPACT are most important: for example, for which patients with opioid use disorder is a physician prescribing medication or linking to community treatment sufficient, and which patients need peer support or social work intervention? Additional research is also needed to understand how to adapt an IMPACT model to different settings with different resources. Finally, future research is needed to assess the effect of hospital-based addiction medicine consultation on patient experience, SUD severity, against medical advice discharge rates, physical health outcomes, hospital readmissions, healthcare costs, and mortality.

## CONCLUSIONS

Hospital-based addiction medicine care can improve SUD treatment engagement. National expansion of such models represents an opportunity to address one of the enduring gaps in the SUD treatment continuum.

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### Compliance with Ethical Standards:

This study was approved by the Oregon Health & Science University (OHSU) Institutional Review Board.

**Conflict of Interest:** The authors declare that they do not have a conflict of interest.

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