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Impact of COVID-19 on 30-Day Readmission Rates in Individuals with Substance Use Disorders

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Abstract

Patients with substance use disorders (SUD) often experience frequent hospitalizations, early discharges, and elevated rates of readmission shortly after discharge. The COVID-19 pandemic further interrupted addiction treatment services, increasing the risks faced by hospitalized individuals. Understanding inpatient factors associated with lower 30-day readmission rates could inform strategies to enhance post-discharge outcomes in this vulnerable population. We retrospectively examined adults with substance use disorders admitted to Penn State Health Hershey Medical Center from January 1 to December 30, 2021, who received addiction medicine consultations. Information on patients' social, clinical profiles, and demographic was collected from electronic health records. We used logistic regression to explore how addiction-focused interventions—including counseling, initiation of pharmacotherapy, and referrals—were associated with 30-day all-cause readmission, controlling for factors such as sex, age, insurance coverage, marital status, and comorbidities. Out of 561 patients (average 62% male; age 42 years), 139 (25%) were readmitted within 30 days. Nearly half of the cohort had a diagnosis of depression or anxiety (44%), and 42% reported polysubstance use. Single patients and those with at least one comorbidity were more likely to be readmitted, with adjusted odds ratios (aOR) of 2.41 (95% CI, 1.06–5.45; P = .035) and 2.82 (95% CI, 1.45–5.52; P = .002), respectively. Participation in educational counseling was associated with a significantly lower likelihood of readmission (95% CI, 0.31–0.90; aOR, 0.53; P = .02), while starting addiction-related medications showed a non-significant trend toward reduced readmission risk (95% CI, 0.32–1.21; aOR, 0.62; P = .16). Conversely, patients who left the hospital against medical advice had more than three times the odds of readmission (95% CI, 1.36–6.73; aOR, 3.02; P = .007). Among hospitalized patients with substance use disorders, engagement in addiction-focused interventions during admission was linked to a notable reduction in 30-day readmissions. Both educational counseling and initiation of pharmacotherapy were associated with decreased readmission risk, while patients who left the hospital against medical advice faced substantially higher odds of returning. These results highlight the importance of incorporating structured addiction consultation services to enhance post-discharge outcomes and help prevent avoidable hospitalizations.

Keywords: Inpatient consultation, Addiction medicine, Substance use disorder, Health services research, Pharmacotherapy, Hospital readmission

Introduction

The United States is facing a severe public health crisis due to substance use disorders (SUDs), which contribute to both immediate and long-term medical complications. In 2021, more than 100,000 deaths were linked to drug overdoses [1]. Individuals with SUD frequently encounter difficulties in adhering to healthcare recommendations and demonstrate higher rates of hospital utilization [2]. Research from 2017 indicates that 18% to 26% of patients with substance misuse experience hospital readmission [3]. Hospital-initiated pharmacotherapy offers a promising approach to bridge patients to outpatient addiction services and improve continuity of care [4–8].

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Medications targeting opioid use disorder (MOUD), such as methadone, buprenorphine, and extended-release naltrexone, as well as treatments for alcohol use disorder (MAUD), including naltrexone and acamprosate, have proven effective when started during hospitalization. These interventions not only reduce the likelihood of overdose but also enhance engagement in follow-up care and lower the chances of mortality and readmission [6]. Evidence from both controlled trials and observational studies shows that early initiation of MOUD during inpatient stays improves retention in post-discharge treatment programs and decreases subsequent illicit substance use compared with delayed therapy or referral alone [8]. Despite these benefits, the adoption of hospital-based pharmacotherapy remains limited, often due to provider shortages, stigma, and operational barriers.

Hospitalizations associated with opioid-related complications have risen markedly over the last decade, especially among people who inject drugs [9]. Many admissions might be preventable with stronger preventive measures and improved adherence to prescribed treatments [10, 11]. We proposed that structured inpatient interventions—including counseling, motivational interviewing, peer support, medication initiation, and coordinated referrals to outpatient care—could reduce the risk of readmission, relapse, and overdose. The present study investigates patient- and service-level factors influencing hospital readmissions during the COVID-19 pandemic, a period during which the continuity of addiction care faced unprecedented disruptions.

Materials and Methods

Data source

This study included patients aged 18 years or older who received an inpatient addiction medicine consultation at Penn State Health Hershey Medical Center between January 1 and December 30, 2021. Records were examined retrospectively, with patients who died during hospitalization excluded from the analysis. Participants were admitted across medical, surgical, and intensive care units. All data were retrieved from the Penn State Health electronic health record system (Cerner Millennium) via SQL queries executed by the hospital's data analytics team.

SUD definition

For this study, SUD was determined through a combination of clinician notes and ICD-10 codes documented in the electronic health record, covering alcohol, opioid, stimulant, cannabis, and sedative use disorders. Prior research has demonstrated that these ICD-10 codes are highly specific and moderately sensitive when compared to structured clinical evaluations, making them suitable for use in large-scale epidemiologic studies [12, 13].

Interventions

Inpatient addiction interventions were provided by a specialized team of clinicians trained in addiction medicine, including physicians and certified nurse practitioners, through the hospital's Addiction Consultation Service. The delivery of these interventions was documented using structured data sources, such as consult order codes and medication administration records, as well as standardized clinical notes. All interventions occurred during the patient's index hospitalization before discharge, and the initiation of pharmacotherapy was confirmed via medication administration records or pharmacy verification.

For this study, interventions were grouped into three main categories. Educational support consisted of counseling focused on recovery, including information about community-based programs (e.g., Alcoholics Anonymous, Narcotics Anonymous), relapse prevention techniques, harm reduction strategies, and connections to peer recovery specialists when available. Pharmacologic interventions involved starting eligible patients on evidence-based medications for opioid or alcohol use disorders, including buprenorphine, methadone, extended-release naltrexone, oral or injectable naltrexone, acamprosate, and disulfiram, with oversight by addiction-trained clinicians to ensure continuity of care after discharge. Additional services and referrals encompassed linking patients to higher levels of care or supportive programs, such as inpatient or outpatient detoxification, residential rehabilitation, psychiatric services, skilled nursing facilities, and other community-based recovery resources. Patients could receive multiple types of interventions during their hospital stay.

Covariate definitions

Patient demographic and clinical information—including substance use type, race, comorbid conditions, and insurance coverage—was obtained from structured electronic health record (EHR) fields. Ethnicity and Race

were recorded based on patient self-report. Comorbidities such as anxiety, depression, chronic pancreatitis and chronic pain, were identified using ICD-10 codes listed in the problem list or recorded during the admission encounter. Marital status, type of insurance, and discharge information, including whether the patient left the hospital against medical advice, were extracted from admission and discharge records. For adjusted analyses, additional covariates included the type of hospital service (medical versus surgical) and the presence of mental health diagnoses.

Statistical analysis

We summarized continuous variables using means with standard deviations for normally distributed data, and medians with interquartile ranges for skewed data. Categorical variables were described using counts and percentages. Covariates were selected beforehand based on clinical importance and existing literature linking patient demographics, psychosocial factors, and comorbidities to hospital readmission risk, rather than employing automated variable selection.

The primary goal was to evaluate the association between inpatient addiction interventions and 30-day readmission. Interventions were classified into four categories: educational counseling; initiation of pharmacotherapy for substance use disorders—including medications such as Vivitrol or methadone administered through office-based addiction treatment; post-discharge referrals, including rehabilitation, psychiatric care, skilled nursing, or hospital transfers; and self-directed discharge. Patients who declined any intervention served as the reference group. Multivariable logistic regression models incorporated all clinically relevant covariates simultaneously, without the use of stepwise or backward elimination techniques. The outcome of interest was any-cause readmission within 30 days of discharge, and only the first hospitalization and first readmission per patient were analyzed to avoid repeated measures and correlated outcomes. Readmissions were tracked exclusively within the same healthcare system.

Potential confounding variables included age, sex, race, marital status, comorbidities, psychiatric diagnoses (including anxiety or depression), chronic pancreatitis, type of hospital service (medical vs. surgical), and insurance status. Odds ratios (ORs) with 95% confidence intervals (CIs) were reported to quantify associations. Kaplan–Meier curves were generated to visualize cumulative 30-day readmission across intervention groups, with differences assessed using the log-rank test. Analyses were exploratory and hypothesis-generating; no formal power or sample size calculations were performed. All analyses and figure generation were conducted in R (version 4.2.2; Vienna, Austria), with statistical significance defined as a two-sided P-value <.05.

Results and Discussion

Cohort description

A total of 561 adults hospitalized with substance use disorders were included in this study. As shown in **Table 1**, the cohort had a mean age of 42 years (SD 14), and men represented 62% of patients. The racial composition was predominantly White (74%), with smaller proportions of Hispanic (5%) and Black (10%) individuals. opioid and Alcohol use disorders were the most frequently documented primary diagnoses, affecting 42% and 53% of the cohort, respectively. Additionally, polysubstance use was reported by 42% of patients, highlighting the common occurrence of multiple substance involvement in this population.

Table 1. Clinical and demographic characteristics of hospitalized adults with substance use disorders, stratified by 30-day readmission.

Variable	Overall (n = 561), n (%)	Readmission (n = 139), n (%)	No Readmission (n = 422), n (%)
Age, years, mean (SD)	42.1 (13.8)	41.7 (13.5)	43.5 (14.5)
Sex, male	349 (62.2)	85 (61.2)	264 (62.6)
Race			
– White	417 (74.3)	98 (70.1)	319 (75.6)
– Black	56 (10.0)	16 (11.5)	40 (9.5)
– Asian	6 (1.1)	1 (0.7)	5 (1.2)
– Hispanic	28 (5.0)	7 (5.0)	21 (5.0)
– Native American	3 (0.5)	1 (0.7)	2 (0.5)

– Other	49 (8.7)	15 (10.8)	34 (8.1)
Substance Use			
– Alcohol	297 (52.9)	69 (49.6)	228 (54.0)
– Tobacco/Vaping	147 (26.2)	34 (24.4)	113 (26.8)
– Cannabis/Synthetic cannabinoids	101 (18.0)	22 (15.8)	79 (18.7)
– Benzodiazepines/Barbiturates	31 (5.5)	7 (5.0)	24 (5.7)
– Opioids	234 (41.7)	58 (41.7)	176 (41.7)
– Stimulants	106 (18.9)	21 (15.1)	85 (20.1)
– Other	20 (3.6)	4 (2.9)	16 (3.8)
– Polysubstance use	235 (41.9)	51 (36.7)	184 (43.6)
Comorbidities			
– Depression/Anxiety	248 (44.2)	66 (47.5)	182 (43.1)
– Chronic/Neuropathic Pain	90 (16.0)	30 (21.6)	60 (14.2)
– Chronic Pancreatitis	33 (5.9)	9 (6.5)	24 (5.7)

Continuous variables are summarized using means and standard deviations, whereas categorical variables are described using frequencies and percentages. Stimulant exposure was defined as use of cocaine or amphetamine-type drugs based on diagnostic coding and toxicology results. The race category labeled “Other” comprises individuals who did not report identification as White, Black, Asian, or Hispanic, including those identifying as multiracial, Pacific Islander, or selecting “Other.” Polysubstance use refers to the presence of two or more simultaneous substance use disorder diagnoses.

Table 1 outlines the demographic and clinical profiles of hospitalized individuals with substance use disorders, grouped according to whether they experienced a readmission within 30 days of discharge.

Mental health conditions were prevalent in this population, with nearly half of patients diagnosed with depression or anxiety, and a notable proportion reporting chronic pain disorders. In addition, several serious medical conditions—such as chronic pancreatitis and liver cirrhosis—were identified, highlighting the significant medical burden carried by these patients.

Following hospitalization, the Addiction Consultation Service delivered a range of interventions. Over one-third of patients participated in counseling sessions focused on recovery support and harm reduction. Medications for the treatment of substance use disorder, including buprenorphine, naltrexone, and methadone, were initiated in a subset of patients, while others were connected to inpatient or outpatient rehabilitation programs or psychiatric services. A sizable proportion declined any form of intervention, and a small percentage left the hospital prior to completion of care. Overall, one in four patients was readmitted for any cause within 30 days, representing 139 of the 561 individuals included in the analysis.

Factors influencing 30-day readmission

Figure 1 illustrates the Kaplan–Meier curves for cumulative 30-day readmissions, categorized by the type of post-discharge recommendations provided by the Addiction Consultation Service. Individuals who left the hospital through self-directed discharge exhibited the greatest likelihood of readmission, with rates surpassing 50% within 30 days (log-rank $P < .0001$). Conversely, patients who received either recovery-focused education or medication-based treatment for addiction consistently experienced the lowest probability of readmission over the observation period.

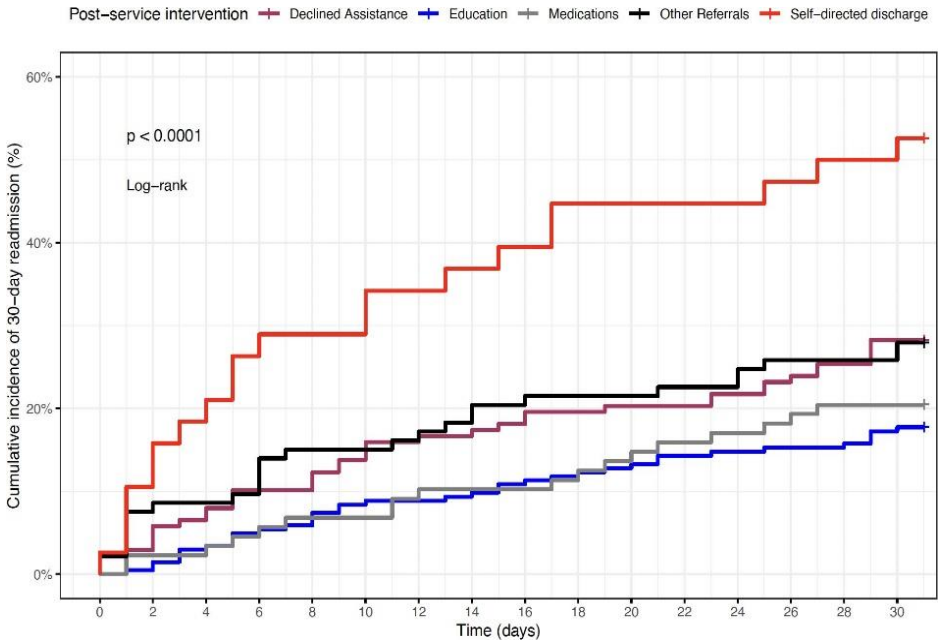

Figure 1. Time-to-readmission within 30 days following discharge, shown by category of intervention recommended by the Addiction Consultation Service.

Results from the adjusted modeling analysis are detailed in **Table 2.** Using multivariable logistic regression to account for differences in patient demographics and clinical characteristics, several post-discharge factors emerged as significant predictors of early rehospitalization. Engagement in educational counseling was associated with a meaningful reduction in readmission risk when compared with refusal of services, corresponding to approximately half the odds of 30-day readmission (adjusted OR, 0.31–0.90; p = 0.019, 0.53; 95% CI). Initiation of medications for substance use disorder, including methadone, buprenorphine, and naltrexone, was also associated with a lower likelihood of readmission, though the confidence interval crossed unity and the finding was not statistically significant (adjusted OR, 0.32–1.21; p = 0.16, 0.62; 95% CI). In contrast, premature departure from the hospital was strongly linked to adverse outcomes; patients who self-discharged experienced a markedly elevated risk of rehospitalization, with more than a threefold increase in the odds of readmission relative to those who declined consultation (adjusted OR, 3.02; 95% CI, 1.36–6.73; p = 0.007).

Table 2. Adjusted regression analysis examining predictors of 30-day hospital readmission among individuals admitted with substance use disorders.

Variable	Category	Adjusted Odds Ratio	95% Confidence Interval	p-value
Post-service recommendation	Educational intervention	0.53	0.31–0.90	0.019
	Medication initiation (OBAT/Vivitrol/methadone)	0.62	0.32–1.21	0.159
	Other referrals (rehab, SNF, psychiatry, transfer, outpatient counseling)	0.85	0.46–1.57	0.607
	Self-directed discharge	3.02	1.36–6.73	0.007
	Declined assistance	Reference	Reference	Reference
Comorbidities	≥1 comorbidity	2.41	1.06–5.45	0.035
Specific mental health conditions	Depression or anxiety	1.03	0.66–1.62	0.887
	Other mental illness	0.88	0.52–1.49	0.627

Other medical conditions	Chronic pancreatitis	0.93	0.40–2.18	0.875
	Hepatitis or cirrhosis	1.51	0.92–2.46	0.101
Service type	Medical service (vs. surgical)	1.69	0.75–3.82	0.206
Age	Per year increase	1.02	1.00–1.04	0.013
Sex	Women (vs. men)	1.01	0.65–1.59	0.955
Race	White (vs. non-White)	0.84	0.52–1.33	0.447
Marital status	Single	2.82	1.45–5.52	0.002
	Married	1.76	0.83–3.75	0.142
	Widowed	1.93	0.65–5.74	0.237
	Divorced/Separated	Reference	Reference	Reference
Insurance type	Government	1.55	0.30–7.99	0.598
	Private	1.52	0.29–7.82	0.617
	Self-pay	1.43	0.23–9.14	0.705
	No insurance	Reference	Reference	Reference

The regression model used odds ratios with 95% confidence intervals to estimate associations, with the designated reference category serving as the comparator. Abbreviations include OBAT (office-based addiction treatment), SNF (skilled nursing facility), and SUD (substance use disorder). Data completeness was high, with fewer than 5% of observations missing across covariates; analyses were therefore conducted using complete cases, and alternative models applying simple imputation produced nearly identical results.

Table 2. Predictors of 30-day hospital readmission identified through adjusted logistic regression modeling. In addition to care-related factors, several demographic and clinical characteristics were linked to early rehospitalization. Patients with any documented comorbid condition demonstrated substantially elevated readmission risk, more than doubling the odds compared with those without comorbidities (adjusted OR, 2.41; 95% CI, 1.06–5.45). Relationship status was also influential: individuals who were unmarried had markedly higher odds of readmission than those who were divorced or separated (adjusted OR, 2.82; 95% CI, 1.45–5.52). Age showed a gradual but meaningful association, with each additional year corresponding to a small increase in readmission likelihood (adjusted OR per year, 1.02; 95% CI, 1.00–1.04). By contrast, no statistically meaningful associations were identified for sex, racial or ethnic group, or insurance classification.

This retrospective study revealed that addiction interventions provided by the hospital's Addiction Consultation Service were linked to substantially reduced odds of 30-day readmission in patients with substance use disorders. Individuals who received educational counseling or were started on medications for opioid or alcohol use disorders showed notably lower risks of readmission compared to those who refused help. Conversely, patients who left the hospital against medical advice faced over three times greater odds of readmission, emphasizing the particular vulnerability of this group. These results highlight the value of organized inpatient addiction care and stress the importance of targeted approaches to prevent early discharges and enhance post-hospital care continuity. While the study did not assess patients' ongoing involvement in treatment after discharge, it is plausible that the benefits observed stem, at least in part, from sustained adherence to recommended therapies.

Our observation that self-directed discharge was associated with more than a threefold increase in 30-day readmission risk is consistent with existing literature, confirming the heightened vulnerability in this group. Leaving against medical advice interrupts care continuity, hinders the start of necessary treatments, and restricts connections to outpatient recovery resources, all of which increase the chances of early readmission and worse outcomes. Large-scale studies have repeatedly shown that self-directed discharge is an independent predictor of higher 30-day readmission and mortality, even after controlling for comorbidities and disease severity [14]. In patients with substance use disorders, this risk is further magnified, as such discharges frequently prevent completion of detoxification or the initiation of medications for opioid or alcohol use disorders [15]. The substantial risk seen in our sample emphasizes the urgency of hospital-based interventions to decrease self-directed discharges, including prompt involvement of addiction experts, quick start of SUD medications, peer recovery support, and coordinated

transitions to outpatient services. By identifying and assisting patients at risk of early discharge, hospitals could help prevent avoidable readmissions and better support ongoing addiction treatment.

The interventions from the addiction consultation service likely gain effectiveness from their systematic delivery and the specialized knowledge of addiction-trained physicians or advanced practitioners who manage medication initiation [16]. Although the specific impact of peer recovery specialists was not evaluated, their role in patient education and motivation may play a key part [17]. Nevertheless, the retrospective nature of this study restricts insights into post-discharge treatment participation, such as attendance at outpatient sessions, therapy, or mutual support groups. Starting pharmacotherapy for opioid or alcohol use disorders in the hospital has been demonstrated to promote stabilization, alleviate withdrawal, and boost readiness for ongoing outpatient care [7]. These factors probably account for the lower readmission rates noted in our cohort. Earlier research reporting comparable advantages reinforces the idea of using hospitalization as a key opportunity to deliver evidence-based addiction care and improve care transitions [18].

These results are in line with prior investigations showing that hospital-based addiction treatment enhances outcomes and decreases healthcare use [4, 7]. Such studies advocate for broader adoption of addiction medicine consultation services, noting similar declines in readmissions, overdose rates, and improvements in treatment connections. For instance, beginning buprenorphine in the hospital has been linked to greater retention in outpatient care [7]. Data from Canada likewise indicate that starting opioid agonist therapy during admission leads to better outpatient follow-up and reduced readmissions [19]. Research from Australia reaches similar conclusions; Haber *et al*. [20] reported that combining inpatient and outpatient addiction care improved compliance and reduced hospital visits. Collectively, these findings from various countries support the broader applicability of our results and underline the worldwide need to integrate addiction medicine into hospital settings to optimize patient outcomes.

No significant differences were found in overdose-related mortality or retention in post-discharge treatment; however, these endpoints were not explicitly captured in our data, and the study's sample size and duration may have restricted detection of such effects. Although additional prospective research is required, it is widely recognized that opioid agonist therapy markedly lowers overdose mortality and enhances treatment retention [11, 21]. Thus, our results support—rather than challenge—established evidence by stressing the importance of inpatient treatment initiation as an essential initial phase in the care pathway. We proposed that effective discharge planning with comprehensive service linkages would correlate with fewer negative events, such as relapse, overdose, and readmissions. Although our data indicate a relationship with decreased readmission odds, overdose mortality and treatment retention were not assessed, representing valuable directions for future studies.

The value of this study rests in its ability to inform hospital policies on establishing robust addiction consultation programs. By prioritizing education and medication initiation, providers can lessen the frequency of readmissions and deliver better care for patients with substance use disorders. Upcoming investigations should explore the wider societal and cost-related advantages of these approaches.

Limitation

This study is limited by its retrospective design and confinement to a single hospital, which restricts the generalizability of findings and may affect internal validity. The patient population reflects local demographic, geographic, and socioeconomic factors, as well as institutional practices, which may not represent other settings. Unmeasured factors, such as severity of illness, housing instability, and availability of social support, could have influenced the outcomes observed. Moreover, the educational and referral interventions likely varied in scope and intensity, and their classification depended on clinician documentation, introducing potential misclassification. We were unable to track adherence to prescribed medications, participation in outpatient care, emergency department visits, or overdose events after discharge. The limited cohort size also constrained the ability to conduct robust subgroup analyses. Additionally, the study timeframe may not fully account for seasonal or temporal fluctuations in hospital service utilization, suggesting that patterns observed may not be uniform throughout the year. Data were collected in 2021, during the COVID-19 pandemic, which may have affected hospitalization patterns and readmission rates due to care disruptions, restricted outpatient access, and changes in patient

behavior. Nevertheless, the mechanisms by which inpatient addiction interventions reduce readmissions—such as enhanced treatment engagement, stabilization on medications, and structured discharge planning—remain relevant beyond the pandemic. The structural challenges to continuity of care observed during COVID-19, including fragmented transitions and limited outpatient availability, continue to exist in many healthcare systems, supporting the ongoing applicability of these findings [22].

Due to the small number of patients within specific substance use categories, we could not stratify the effects of medications by type (e.g., MOUD versus MAUD). Future studies with larger, multicenter cohorts should evaluate substance-specific outcomes to better understand differential impacts. Finally, readmissions were captured only within the Penn State Health system, so hospitalizations at other facilities were not included. This limitation may lead to underestimation of true readmission rates and could bias results if patients readmitted elsewhere differed systematically by intervention type.

Conclusion

This study highlights the potential of hospital-based addiction interventions to reduce early readmissions among patients with substance use disorders. Educational counseling and the initiation of evidence-based pharmacologic treatments during hospitalization were linked to lower 30-day rehospitalization rates, while self-directed discharge emerged as a strong predictor of rapid return to the hospital. These findings emphasize the importance of maintaining structured engagement, ensuring continuity of care, and providing timely initiation of treatment during the index admission. Implementing comprehensive inpatient addiction consultation programs that combine individualized patient education, prompt medication management, and coordinated follow-up care may transform hospitalization into a pivotal opportunity to stabilize high-risk patients and decrease preventable readmissions, ultimately supporting improved long-term outcomes.

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