Inpatient Addiction Medicine Consultation Service Impact on Post-discharge Patient Mortality: a Propensity-Matched Analysis

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BACKGROUND: Inpatient addiction medicine consultation services (AMCS) have grown rapidly, but there is limited research of their impact on patient outcomes.
OBJECTIVE: To examine whether AMCS is associated with all-cause mortality and hospital utilization post-discharge.
DESIGN: This was a propensity-score-matchedcase-control study from 2018 to 2020.
PARTICIPANTS: The intervention group included patients referred to the AMCS from October 2018 to March 2020. Matched control participants included patients hospitalized from October 2017 to September 2018 at an urban academic hospital with a large suburban and rural catchment area.
MAIN MEASURES: The effect of treatment was estimated as the difference between the proportion of subjects experiencing the event (7-day and 30-day readmission, emergency department visits, and mortality within 90 days) for each group in the matched sample.
KEY RESULTS: There were 711 patients in the intervention group and 2172 patients in the control group. The most common substance use disorders among the intervention group were primary alcohol use disorder (n=181; 25.5%) and primary opioid use disorder (n=175, 24.6%) with over a third with polysubstance use (n=257, 36.1%). Intervention patients showed a reduction in 90-day mortality post-hospital discharge (average treatment effect [ATE]: −2.35%, 95% CI: −3.57, −1.13; p-value <0.001) compared to propensity-matched controls. We found a statistically significant reduction in 7-day hospital readmission by 2.15% (95% CI: −3.65, −0.65; p=0.005) and a nonsignificant reduction in 30-day readmission (ATE: −2.38%, 95% CI: −5.20, 0.45; p=0.099). There was a statistically significant increase in 30-day emergency department visits (ATE: 5.32%, 95% CI: 2.19, 8.46; 0.001) compared to matched controls.
CONCLUSIONS: There was a reduction in 90-day all-cause mortality for the AMCS intervention group compared to matched controls, although the impact on hospital utilization was mixed. AMCS are systems interventions that are effective tools to improve patient health and reduce all-cause mortality.

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INTRODUCTION

Hospitalizations for people with substance use disorders (SUD) increase hospital costs, and lead to longer lengths of stay and higher rates of readmission, all of which tax the healthcare system (1–3). Despite patients describing hospitalization as an ideal moment for SUD treatment as they have both increased motivation and also an interruption in regular substance use (4), multiple studies have demonstrated that the bulk of patients fail to receive evidence-based treatment during acute hospitalization (5–7).

Inpatient addiction medicine consultation services (AMCS) have grown rapidly in response to the growing needs of health systems to care for patients hospitalized with complications from their substance use (8). Inpatient AMCS provide clinical expertise in the treatment and management of acute withdrawal, support to initiate and maintain SUD pharmacotherapy, and facilitate referral to SUD treatment post-discharge (8–10). Mounting evidence indicates AMCS improve engagement in SUD treatment after discharge (11), reduce substance use (12), and reduce rates of readmission (13, 14). However, many of these studies are limited by patient-reported outcomes and have small sample sizes limiting their ability to report on rare occurrences, like mortality.

As record numbers of overdose deaths continue to rise in the USA (15), it is crucial to understand the impact of structural interventions, such as the AMCS on patient outcomes, particularly all-cause mortality. To date there have been limited evaluations of the impact of AMCS on all-cause mortality. We analyzed the impact of a multi-disciplinary inpatient AMCS on patient outcomes following acute hospitalization using a propensity-matched analysis. We hypothesized involvement of the AMCS would be associated with reduced all-cause mortality post-hospitalization and reduced hospital utilization.

METHODS

Setting

The AMCS was started in October 2018 at an urban academic hospital with a large suburban and rural catchment area. The multidisciplinary team included a physician (an internist boarded in addiction medicine or a toxicologist), Certified Addiction Registered Nurse, licensed social worker, and peer navigator with lived experience. The AMCS managed substance use withdrawal, promoted engagement through brief intervention and motivational interviewing, linked to SUD treatment post-discharge, and initiated pharmacotherapy during acute hospitalization.

Patient Population and Study Design

This was a propensity-score-matchedcase-control study. Intervention group participants were referred to the AMCS from October 2018 to March 2020 and identified from an electronic registry including all referred patients to the AMCS. Matched control participants included patients hospitalized from October 2017 to September 2018 with an International Classification of Diseases-10(ICD-10) code consistent with any SUD, excluding those with only ICD-10 codes for tobacco use disorder. Among the AMCS cohort, we only excluded individuals from analysis if they were under 18 years of age (n=0), died during the index hospitalization (n=9), or used only cannabis (n=6). The research protocol was deemed exempt by University of Pittsburgh Institutional Review Board as it was considered quality improvement. It was approved as a quality improvement project by the UPMC Quality Improvement Review Committee.

Covariates were extracted from the electronic health record and included age, sex, race, Elixhauser Comorbidity count (16), intensive care unit length of stay, previous inpatient or emergency department (ED) visits during the 6 months prior to the index hospitalization, and Diagnosis Related Group. Outcomes included 90-day mortality, and 7-day and 30-day readmissions and ED visits. Ninety-day mortality was identified through use of the Social Security Administration Death Index and included both out-of-hospital mortalities and those deaths that occurred at other institutions. We analyzed 7-day and 30-day readmissions as a categorical variable (yes/no).

Cohort Creation

Propensity-score matching was carried out by matching on patient age, sex, race, Elixhauser Comorbidity Index (count of conditions), ED visits, and inpatient stays within 6 months prior to the index account (Y/N binary outcome), intensive care unit length of stay, and patient Diagnosis Related Group. Propensity scores were generated for each patient by using the average of outcomes of similar subjects (based on the predefined matching variables) that received the other treatment level (AMCS patient vs. non-AMCS patient). We calculated balance between the matching variables by using the standardized differences, which is preferable for matched data over p-values and is not influenced by sample size (17). A difference <0.1 indicates an ideal balance.

Analysis

Each addiction medicine consult was paired 1:1 with a control patient who had a similar propensity score. The treatment effect was estimated by comparing outcomes between the pairs. This method of matching provided an estimated average treatment effect (ATE), which is the average of the difference between the observed and potential outcomes for each patient. The effect of treatment was estimated as the difference between the proportion of subjects experiencing the event (7-day and 30-day readmission, emergency department visits, and mortality within 90 days) for each group in the matched sample. For continuous outcomes (length of stay), the effect of treatment was estimated as the difference between mean outcomes for the control and intervention groups in the matched sample. We conducted sub-analyses for those with exclusively alcohol use disorder (AUD), exclusively opioid use disorder (OUD), or any OUD (which included those with exclusively OUD *as well as* those who had OUD plus another SUD).

RESULTS

There were 711 patients in the intervention group and 2172 patients in the control group (Table 1). The most common substance use disorders among the intervention group were patients with AUD (n=181; 25.5%) followed closely by those with OUD (n=175, 24.6%). Over a third of the sample received SUD codes consistent with polysubstance use (n=257, 36.1%).

Intervention patients showed a reduction in 90-day mortality post-hospital discharge (average treatment effect [ATE]: −2.35%, 95% CI: −3.57, −1.13; p-value<0.001) compared to propensity-score-matched controls (Table 2). Sub-analyses of patients with exclusively AUD showed a similar significant reduction in likelihood of 90-day mortality compared to matched controls (−4.08%, 95%CI: −6.12, −2.04; $p\leq0.001$). Among those with exclusively OUD, there was a 3.21% reduction in likelihood of 90-day mortality (95%CI −5.52, −0.90; p=0.006) and also a reduction in likelihood of 7-day readmission (−3.28, −6.19, −.0.37; p=0.027) compared to matched controls.

The findings on hospital utilization were mixed (Table 2). Across the entire sample, we found a statistically significant reduction in 7-day hospital readmission by 2.15% (95% CI: −3.65, −0.65; p=0.005); a nonsignificant reduction in 30-day readmission (ATE: −2.38%, 95% CI: −5.20, 0.45; p=0.099); and a significant increase in 30-day emergency department visits (ATE: 5.32%, 95% CI: 2.19, 8.46; 0.001) compared to matched controls.

Table 1. Patient Characteristics of Population Seen by AMCS for Unadjusted Sample Before and After Matching Using Propensity Scoring

	Unadjusted before matching			After propensity matching		
Patient characteristics	**Control**	**AMCS**	**Standardized difference**	**Control**	**AMCS**	**Standardized difference[a]**
Age (mean)	49.5	44.1	0.385	48.1	48.0	0.004
Sex (%)						
Male	62.8	58.5	0.087	62.0	61.5	0.011
Female	37.2	41.5	0.087	38.0	38.5	0.011
Race (%)						
White	75.1	72.3	0.065	75.1	75.0	0.002
Black, African-American	16.5	18.3	0.048	16.5	18.4	0.05
Elixhauser Comorbidity Index (mean)	4.5	4.7	0.078	4.6	4.6	0.012
ED visit in past 6 months Yes, (%)	39.7	47.4	0.155	41.2	41.3	0.001
Inpatient stay in past 6 months Yes, (%)	27.3	32.5	0.112	29.0	26.7	0.05
Intensive care length of stay Mean days	2.5	2.1	0.049	2.5	2.4	0.015
Top DRGs (%)						
Cirrhosis and alcoholic hepatitis	4.0	9.8	0.234	5.6	5.4	0.008
Alcohol or drug use/dependence	4.7	6.8	0.091	5.0	5.9	0.040
Poisoning and toxic effects of drugs	10.5	5.5	0.187	9.1	11.1	0.067
Disorders of pancreas except malignancy	2.6	3.4	0.044	2.8	2.8	0.002
Septicemia or severe sepsis	2.1	3.1	0.064	2.0	2.7	0.044

[a]*Standardized differences are preferred for matched data as they are not influenced by sample size. A difference of <0.1 indicates an ideal balance.*

DISCUSSION

This study is among the first to show a reduction in 90-day all-cause mortality among patients with SUD seen by an inpatient AMCS compared to propensity-score-matched controls. While previous research has shown that AMCS are important tools to link patients to SUD treatment after discharge (8–11), our findings show they are also effective tools to improve patient health and reduce mortality more broadly.

The mortality benefit seen from the AMCS is likely related to, but not limited to, the effects seen from improved provision of medications for OUD (MOUD). MOUD has been shown to improve treatment linkage (18), reduce substance use (12), and reduce all-cause mortality (19, 20). Our findings do not show similar reductions in mortality among those seen with OUD as part of a constellation of polysubstance use. The lack of mortality benefit may be a result of limited effective therapies to treat comorbid substance use disorders, like stimulant use disorder (21). It may also be a result of untreated or ongoing substance use leading to a lower retention in treatment with MOUD as seen for stimulant use in other studies (22).

Sub-analyses showed a reduction in mortality among those with exclusively AUD; however, the mechanism by which the AMCS exerts its effects is unclear. In contrast to MOUD, it is unlikely that increased provision of medications for AUD (MAUD) was the primary driver. Previous research has not shown MAUD to impact mortality (23). MAUD do, however, reduce craving and rewarding effects from alcohol use leading to reduced use and reduced binge use (24–26), and these factors may enable patients to have improved adherence to other medical therapies. For example, MAUD receipt among patients with HIV has been associated with improved adherence to medications to treat HIV and improved CD4 count (27). In addition, the brief interventions and motivational interviewing conducted by the AMCS may have led to improved self-care and chronic or acute disease management for this group separate from the provision of medical therapy. Future studies that identify the components of the AMCS that seem to be most essential and their relative contributions to improving patient outcomes are necessary.

Our findings demonstrating the impact of the AMCS on health utilization were mixed. We found that in aggregate, patients had an increased likelihood of 30-day ED visits, but a reduction in 7-day readmissions compared to matched controls. Studies demonstrate that individuals with SUD who have negative treatment-seeking experiences, such as experiencing stigma from health providers, may be less willing to present for subsequent medical evaluation (28–30). In our sample, the emergency department utilization may be increased for patients treated by the AMCS who met a sympathetic multidisciplinary team and who were offered appropriate addiction treatment during their previous hospitalization. It may be that these patients were then in turn more likely to present to care for subsequent health problems. While our lower 7-day readmission rates are similar to patterns seen in studies of AMCS at other institutions (13, 14), we did not find statistically significant differences in the number of 30-day readmissions. The more frequent emergency department visits reported by our sample may have led to the higher than anticipated hospital 30-day readmission rates compared to other studies, although readmission rates were lower for certain sub-populations and trended lower across the entire sample. We may also have been underpowered to detect differences in 30-day readmission rates.

While our study used propensity score matching to reduce potential biases, there are limitations. While we attempted to

Table 2. Average Treatment Effect[a] for Intervention Group (Defined by Referral to Addiction Medicine Consultation Service) and Propensity-Matched Controls, by Substance Use.

Outcomes	Average treatment effect	95% CI	*p*-value
Total sample (*N*=711 intervention group; *n*=2172 control group)			
90-day mortality (%)	−2.35	−3.57, −1.13	<0.001
Length of stay (days)	2.39	1.35, 3.43	<0.001
Emergency department visits (%)			
7-day	2.24	−0.35, 4.82	0.090
30-day	5.32	2.19, 8.46	0.001
Hospital readmission (%)			
7-day	−2.15	−3.65, −0.65	0.005
30-day	−2.38	−5.20, 0.45	0.099
Exclusively opioid use disorder (*n*=175 intervention group;*n*=373 control group)			
90-day mortality (%)	−3.21	−5.52, −0.90	0.006
Length of stay (days)	1.70	−0.28, 3.69	0.092
Emergency department visits (%)			
7-day	−0.36	−4.30, 3.57	0.856
30-day	4.20	−0.63, 9.02	0.088
Hospital readmission (%)			
7-day	−3.28	−6.19, −0.37	0.027
30-day	−0.91	−16.04, 14.21	0.906
Any opioid use disorder (*n*=390 intervention group;*n*=564 control group)			
90-day mortality (%)	−1.23	−2.90, 0.43	0.148
Length of stay (days)	1.59	0.77, 2.41	<0.001
Emergency department visits (%)			
7-day	0.42	−2.51, 3.34	0.779
30-day	5.14	1.13, 9.14	0.012
Hospital readmission (%)			
7-day	−3.67	−5.71, −1.62	<0.001
30-day	−4.72	−8.16, −1.26	0.007
Exclusively alcohol use disorder (*n*=181 intervention group;*n*=684 control group)			
90-day mortality (%)	−4.08	−6.12, −2.04	<0.001
Length of stay (days)	0.58	−3.08, 4.23	0.757
Emergency department visits (%)			
7-day	0.12	−1.72, 1.95	0.902
30-day	8.90	−3.18, 20.98	0.149
Hospital readmission (%)			
7-day	−0.06	−3.93, 3.81	0.977
30-day	1.91	−3.22, 7.03	0.466

[a]*Average treatment effect reflects the average of the difference between the observed and potential outcomes for each patient. The effect of treatment was estimated as the difference between the proportion of subjects experiencing the event or the difference between mean outcomes for the control and intervention groups.*

minimize confounders through our analysis, differences may arise from unmeasured variables. As we included all patients referred to the AMCS regardless of willingness to see our team or accept our treatment recommendations, our findings are likely an underestimation of the potential effect for those who chose to engage with the AMCS. We are limited in this analysis in our ability to identify treatment follow-up and linkage to care following hospital discharge and so can only speculate on what aspects of care may have led to reduced mortality. Our findings may also reflect selection bias in that only those patients who exhibited signs and symptoms of severe SUD may have been referred to the service and so future expansion may not improve outcomes in a less severely ill patient population. Additionally, while our data includes all hospitals within our health system's broad catchment area across Western PA, we cannot capture patients who sought emergency medical care or were admitted outside of our health care system. We do have access to mortality data that includes out-of-hospital deaths and deaths at other institutions, and so our primary outcome is not subject to the same limitations as our utilization metrics.

In summary, our findings add to the growing body of literature showing AMCS are important tools to improve health for patients with substance use disorders. Consult services not only improve linkage to substance use treatment and reductions in substance use following hospital discharge (11–13), but our findings show they may also directly impact patient health through reduction in all-cause mortality.

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Declarations:

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

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