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Outcomes

Potential disease burden of patients with substance abuse undergoing major abdominal surgery: A propensity score-matched analysis

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ABSTRACT

Background: Over 19 million Americans have a substance abuse disorder. The current study sought to characterize the relationship between substance abuse with in-hospital outcomes following major, elective abdominal surgery.
Methods: The Nationwide Inpatient Sample was used to identify patients who underwent major abdominal surgery between 2007 to 2014. Patients with preoperative substance abuse, including alcohol, opioids, and non-opioid drugs, were identified. Propensity score matching was used to examine the association of substance abuse with perioperative outcomes.
Results: Among 301,659 patients, 7,925 patients (2.6%) had a history of substance abuse. Pancreatectomy was the surgical procedure with the highest proportion of patients with substance abuse history ($n = 844$, 4.7%). Compared with patients without a substance abuse history, patients with a substance abuse history were more likely to be younger (median age, 60 years [interquartile range (IQR) 52–69] vs 63 years [IQR 52–72]), male (n = 5,438, 67.5% vs n = 132,961, 54.7%), and be in the lowest income category (n = 2,062, 26% vs n = 64,345, 21.9%) (all $P < .001$). On propensity score matching, substance abuse was associated with increased odds ratio of experiencing a complication (odds ratio [OR] 1.68, 95% confidence interval [CI] 1.55–1.82), non-home discharge (OR 1.95, 95% CI 1.76–2.16), extended length of stay (OR 1.88, 95% CI 1.76–2.02), and higher expenditure (OR 1.62, 95% CI 1.49–1.77). Stratified by the type of substance abuse, patients with history of alcohol (OR 1.57, 95% CI 1.44–1.71) and drug abuse (OR 1.26, 95% CI 1.14–1.39) were more likely to experience a complication, whereas only history of alcohol abuse was associated with higher odds ratio of in-hospital mortality (OR 1.38, 95% CI 1.07–1.79) (all $P < .05$).
Conclusion: Up to 1 in 50 patients undergoing complex abdominal surgery had a substance abuse history. History of substance abuse was associated with an increased risk of adverse perioperative outcomes and higher healthcare expenditures.

Introduction

According to the National Survey on Drug Use and Health, over 19.7 million Americans battled a substance abuse (SA) disorder in 2017[1]. Specifically, 14.5 million and 7.5 million people had an alcohol use disorder or an illicit drug use disorder, respectively.[1] In addition, roughly 1 in 8 adults have both an alcohol and drug use disorder.[1] In turn, SA disorders can have significant cost implications to the healthcare system. Specifically, abuse of tobacco, alcohol, and illicit drugs costs more than $740 billion annually due to associated crime, loss of work productivity, and health care expenditures.[2]

While the impact of SA on the incidence of certain diseases such as hepatitis C and HIV/AIDS has been well reported, the impact of SA on surgical outcomes has been limited.[3–6] For example, Best et al. reported that drug misuse was associated with a higher odds ratio of complications, including postoperative infection, anemia,

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convulsions, osteomyelitis, and blood transfusion, following primary total hip or knee arthroplasty.[7] Furthermore, among Medicare beneficiaries with prostate cancer, history of SA has been associated with increased number of emergency department and outpatient visits.[8] However, the impact of SA on patients undergoing major abdominal surgery has not been characterized. Specifically, while attention has been focused on minimizing perioperative risk among patients with chronic conditions, such as heart disease, diabetes, and tobacco use undergoing elective surgical procedures, there has been relatively little emphasis on SA.[9,10] Given the prevalence of SA and the possible link to increased morbidity, the objective of the current study was to define the prevalence of preoperative SA among patients undergoing major abdominal surgery. In addition, we sought to characterize the possible relationship between SA with in-hospital postoperative outcomes among patients undergoing major, elective abdominal surgery. Specifically, we hypothesize that postoperative outcomes of patients would vary based on history of SA.

Methods

Study population and data collection

A cross-sectional study of patients who underwent an elective, major abdominal surgery for a benign or malignant indication was performed using discharge records from the Nationwide Inpatient Sample (NIS) between 2007 and 2014 (Supplemental Table I). The NIS database represents the largest, all-payer, inpatient care database in the United States, with data on more than 7 million admissions annually.[11] Patients with preoperative SA, including alcohol abuse, opioid abuse, and non-opioid other drug abuse, were identified using International Classification of Diseases, 9th Revision (ICD-9) diagnosis codes among patients undergoing major abdominal surgery (Supplemental Table I).[12,13] Major abdominal surgical procedures included gastrectomy, hepatectomy, pancreatectomy, and colorectal operations as defined by the respective ICD-9 procedure codes. Patients who were less than 18 years old, as well as individuals who underwent more than 1 procedure, were excluded from the analytic cohort.

Abstracted NIS data included patient, clinical, and hospital characteristics, as well as calendar year and geographic location. Patient demographic factors included sex, age, race, insurance type, and median household income based on zip code. Clinical factors included specific comorbidities, type of operation, diagnosis, and surgical approach. Hospital characteristics included urban/rural location, teaching status, and hospital size based on bed number, as well as geographic location. Postoperative complications were identified and categorized as previously reported.[14] In particular, length of hospital stay (LOS) was calculated from the day of surgery to day of discharge; extended LOS was defined as stay greater than the 75th percentile.[15] Costs were calculated by multiplying total charges with hospital-specific, cost-to-charge ratios published by the Health Cost Utilization Project, with high expenditure outcomes defined as greater than the 75th percentile.[16] Primary outcomes included incidence of in-hospital complications, in-hospital mortality, non-home discharge, extended LOS, and high expenditure after surgical intervention.

Statistical analysis

Descriptive statistics were presented as median (interquartile range [IQR]) and frequency (%) for continuous and categorical variables, respectively. Categorical variables were compared using χ^2 analysis and Fisher exact test, where appropriate. Continuous variables were compared using Wilcoxon rank sum test and Kruskal-Wallis one-way analysis of variance. To overcome selection bias, a 1:1 propensity score matching (PSM) was performed to compare the SA and non-SA cohorts based on age, sex, race, year, insurance type, income, comorbidities, procedure, diagnoses, surgical approach, hospital status, and geographic location. A Greedy 1:1 matching algorithm was applied to obtain optimal matches. In order for a match to be made, the difference in logit of propensity score for pairs of individuals from 2 groups was set to be equal or less than 0.10. After PSM, 7,912 patients were included in each group. Logistic regression was utilized to examine the effect of SA on outcomes of interest, including incidence of an in-hospital complication, in-hospital mortality, non-home discharge, extended LOS, and high expenditure. All multivariable analyses were adjusted for the effects of patient characteristics, year, comorbidities, indication, procedure type, surgical approach, and hospital characteristics. In order to minimize the effect of heterogeneity in SA reporting due to regional and/or hospital-level variation, an additional multivariable model was performed to adjust for the variation among hospitals as random effects, in addition to the aforementioned factors. To account for the possibility of underestimation of SA patients, additional sensitivity analyses were performed to estimate how the results might vary after accounting for differing degrees of misclassification bias.[17,18] In addition, to exclude the risk of overpowering, a post hoc power analysis was performed.[19] All analyses were performed using SAS v 9.4 (SAS Institute, Inc: Cary, NC).

Results

Trends in proportion of patients with SA

Among 301,659 patients, 7,925 patients (2.6%) had a history of SA; history of SA consisted of alcohol abuse (n = 4,867, 61.4%), opioid abuse (n = 470, 5.9%), and non-opioid, other drug abuse (n = 3,020, 38.1%). A minority of patients, 5.5% (n = 432), had a history of abusing 2 or more substances. Overall, the proportion of preoperative SA slightly increased over the study period (2007: 2.2%, 2014: 3.0%; $P < .001$) (Supplemental Table II). The incidence of preoperative alcohol, drug, and opioid abuse each increased over the time periods examined (all $P < .005$) (Fig 1). SA was most prevalent among patients who underwent a pancreatectomy (n = 844, 4.7%) or

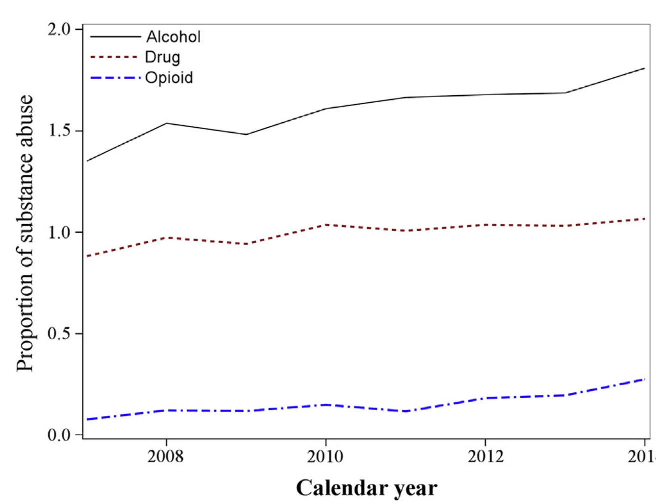

Fig 1. Trends in proportion of patients with each type of SA.

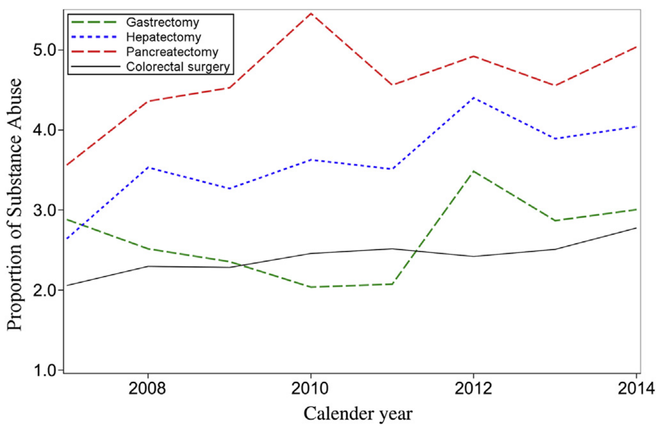

Fig 2. Trends in proportion of patients with preoperative SA by procedure.

hepatectomy (n = 489, 3.7%). Of note, the prevalence of SA among patients undergoing hepatectomy and colorectal surgery steadily increased over the periods examined (hepatectomy: P = .009, colorectal surgery: P < .001) (Fig 2). Patients with a history of SA were disproportionately more likely to be treated at urban teaching (SA versus non-SA, 60.8% vs 57.3%) versus rural (SA versus non-SA, 7.0% vs 7.6%) hospitals (P < .001).

Patient characteristics by SA history

Patients with a history of SA were more likely to be younger (median age, 63 years [IQR 52–72] vs 60 years [IQR 52–69]; P < .001) and male (n = 132,961, 54.7% vs n = 5,438, 67.5%; P < .001) (Table I). Additionally, a greater proportion of patients with a history of SA were in the lowest income category (n = 64,345, 21.9% vs n = 2,062, 26%; P < .001). Patients with a history of SA also had a greater incidence of comorbidities, such as liver disease, renal failure, history of chronic pain, psychoses, and depression (all P < .001). In contrast, a diagnosis of diabetes and obesity was more common among patients without a history of SA (both P < .05). Specifically, the proportion of patients with 3 or more comorbidities was 19.7%, 18.1%, and 29.1% among patients with alcohol, drug, and opioid abuse, respectively; in contrast, the incidence of 3 or more preoperative comorbidities among patients without SA was only 9% (Fig 3).

Effect of SA on postoperative outcomes after PSM

To minimize potential confounding, PSM was utilized to create matched cohorts of 7,912 patients in each PSM group (Table I). On bivariate analysis, patients who had a history of SA remained at a higher risk of post-operative complications, including pulmonary failure, pneumonia, deep vein thrombosis/pulmonary embolism, acute renal failure, and surgical site infection (P < .05) (Table II). In addition, compared with patients who did not have a history of SA, individuals with SA were at higher risk of an extended LOS (odds ratio [OR] 1.72, 95% confidence interval [CI] 1.62–1.84, P < .001), as well as non-home discharge following a complex abdominal surgery (OR 1.70, 95% CI 1.54–1.87, P < .001). Perhaps not surprisingly, patients with a history of SA also had a 45% increased odds ratio of higher health care expenditures associated with the operative episode (OR 1.45, 95% CI 1.35–1.57, P < .001). Specifically, median expenditure for the hospital episode was $12,681 (IQR $18,791–$29,653) among patients with a history of SA vs $10,712 (IQR $15,102–$23,491) among patients without SA.

After controlling for relevant covariates, on multivariable analysis, individuals with history of SA had 68% higher odds ratio (OR 1.68, 95% CI 1.55–1.82, P < .001) of experiencing a post-operative complication. Specifically, SA was associated with the occurrence of pulmonary failure, pneumonia, deep vein thrombosis/pulmonary embolism, acute renal failure, hemorrhage, surgical site infection and gastrointestinal hemorrhage. Additionally, SA remained associated with extended LOS (OR 1.88, 95% CI 1.76–2.02, P < .001), non-home discharge (OR 1.95, 95% CI 1.76–2.16, P < .001), and a high-expenditure hospital stay (OR 1.62, 95% CI 1.49–1.77, P < .001). In contrast, risk of in-hospital mortality was not associated with a history of SA (OR 1.26, 95% CI 0.99–1.60, P = .06). Given that variations in SA documentation may exist secondary to differing structures and processes of hospitals, a multivariable model was constructed using a random effect analysis to account for variations among institutions. SA remained associated with an increased odds ratio of experiencing a postoperative complication (OR 1.65, 95% CI 1.48–1.83, P < .001), extended LOS (OR 1.89, 95% CI 1.73–2.07, P < .001), non-home discharge (OR 1.93, 95% CI 1.69–2.21, P < .001), and a high-expenditure hospital stay (OR 1.87, 95% CI 1.69–2.07, P < .001) (Supplemental Table III).

Stratified by the type of SA history, after adjusting for patient, hospital, and clinical characteristics, patients with a history of alcohol (OR 1.57, 95% CI 1.44–1.71) and non-opioid drug abuse (OR 1.26, 95% CI 1.14–1.39) had a higher odds ratio of experiencing a complication (Table III). Interestingly, patients with a history of opioid abuse had similar odds ratio of a complication compared with individuals without a history of SA (OR 1.15, 95% CI 0.90–1.47, P = .27). Of note, individuals with a history of alcohol abuse had a 38% higher odds ratio (OR 1.38, 95% CI 1.07–1.79, P = .013) of in-hospital mortality. Furthermore, history of alcohol, opioid abuse, or non-opioid drug abuse remained associated with a higher odds ratio of extended LOS, non-home discharge, and high in-hospital expenditures (all P < .05).

Sensitivity analysis for misclassification bias

To understand the magnitude of possible misclassification bias, additional sensitivity analyses were performed to examine the risk of complications and mortality for SA patients (Table IV). Sensitivity analysis demonstrated that the odds of complication or mortality increased among patients who had SA, even after accounting for variable levels of misclassification error rate (ie, patients with true SA classified as nonSA). For example, if 20% of patients coded as having SA were misclassified as nonSA, then the true odds ratio of complication and mortality would still be be 1.94 and 1.77, respectively. Furthermore, if the misclassification rate was 30%, the true odds ratio of complication and mortality would increase to 2.36 and 2.03, respectively. As such, sensitivity analyses revealed an even stronger relationship between SA and complications/mortality with variable misclassification scenarios.

Discussion

In 2017, nearly 20 million Americans suffered from a SA disorder.[1] Given the prevalence of SA and the possible detrimental health implications, we sought to examine the prevalence and outcomes of patients undergoing complex abdominal surgery with and without a history of SA. In the present study, the NIS database

Table I
Demographics data before and after propensity score matching

Variable	Before PSM			After PSM		
	Non-SA n = 293,734	SA n = 7,925	*P*	Non-SA n = 7,912	SA n = 7,912	*P*
Age, median (IQR)	63 (52–72)	60 (52–69)	<.001	61 (51–70)	60 (52–69)	.19
Female	160,773 (54.7%)	2,577 (32.5%)	<.001	2,562 (32.4%)	2,576 (32.6%)	.81
Race			<.001			.77
White	231,974 (79.0%)	6,256 (78.9%)		6,275 (79.3%)	6,245 (78.9%)	
AA	25,100 (8.5%)	866 (10.9%)		862 (10.9%)	866 (10.9%)	
Other	36,660 (12.5%)	803 (10.1%)		775 (9.8%)	801 (10.1%)	
Year			<.001			.73
2007–2008	63,599 (21.7%)	1,543 (19.5%)		1,596 (20.2%)	1,541 (19.5%)	
2009–2010	71,764 (24.4%)	1,868 (23.6%)		1,842 (23.3%)	1,866 (23.6%)	
2011–2012	81,913 (27.9%)	2,257 (28.5%)		2,247 (28.4%)	2,252 (28.5%)	
2013–2014	76,458 (26%)	2,257 (28.5%)		2,227 (28.1%)	2,253 (28.5%)	
Insurance			<.001			.89
Private	130,408 (44.4%)	3,345 (42.2%)		3,348 (42.3%)	3,342 (42.2%)	
Medicare	14,062 (4.8%)	978 (12.3%)		948 (12%)	971 (12.3%)	
Medicaid	134,463 (45.8%)	2,984 (37.7%)		3,013 (38.1%)	2,981 (37.7%)	
Uninsured/Other	14,801 (5.0%)	618 (7.8%)		603 (7.6%)	618 (7.8%)	
Income Quartile			<.001			.88
1st	64,345 (21.9%)	2,062 (26.0%)		2,065 (26.1%)	2,057 (26%)	
2nd	72,101 (24.5%)	2,037 (25.7%)		2,060 (26%)	2,035 (25.7%)	
3rd	75,441 (25.7%)	1,971 (24.9%)		1,978 (25%)	1,969 (24.9%)	
4th	81,847 (27.9%)	1,855 (23.4%)		1,809 (22.9%)	1,851 (23.4%)	
Comorbidity						
Sleep-related breathing disorder	13,564 (4.6%)	321 (4.1%)	.017	308 (3.9%)	321 (4.1%)	.6
Chronic pulmonary disease	42,371 (14.4%)	1,940 (24.5%)	<.001	1,978 (25%)	1,934 (24.4%)	.42
History of smoking	29,328 (10.0%)	2,512 (31.7%)	<.001	2,522 (31.9%)	2,500 (31.6%)	.71
Congestive heart failure	11,306 (3.8%)	448 (5.7%)	<.001	451 (5.7%)	448 (5.7%)	.92
Liver disease	7,660 (2.6%)	952 (12.0%)	<.001	888 (11.2%)	939 (11.9%)	.20
Renal failure	12,672 (4.3%)	428 (5.4%)	<.001	440 (5.6%)	428 (5.4%)	.68
Diabetes	49,760 (16.9%)	1,147 (14.5%)	.005	1,151 (14.5%)	1,147 (14.5%)	.93
Obesity	38,081 (13.0%)	897 (11.3%)	<.001	904 (11.4%)	897 (11.3%)	.86
Solid tumor	8,371 (2.8%)	243 (3.1%)	.25	252 (3.2%)	242 (3.1%)	.65
Metastatic cancer	37,262 (12.7%)	974 (12.3%)	.30	999 (12.6%)	974 (12.3%)	.55
Rheumatoid arthritis	6,089 (2.1%)	140 (1.8%)	.06	136 (1.7%)	140 (1.8%)	.81
Osteoarthritis	1,026 (0.3%)	34 (0.4%)	.24	32 (0.4%)	34 (0.4%)	.81
History of chronic pain	5,153 (1.8%)	436 (5.5%)	<.001	417 (5.3%)	430 (5.4%)	.65
Psychoses	5,590 (1.9%)	498 (6.3%)	<.001	470 (5.9%)	493 (6.2%)	.44
Depression	24,207 (8.2%)	1,156 (14.6%)	<.001	1,223 (15.5%)	1,151 (14.5%)	.11
Procedure			<.001			
Gastrectomy	27,486 (9.4%)	708 (8.9%)		704 (8.9%)	704 (8.9%)	1.0
Hepatectomy	12,809 (4.4%)	489 (6.2%)		487 (6.2%)	487 (6.2%)	1.0
Pancreatectomy	17,152 (5.8%)	844 (10.6%)		840 (10.6%)	840 (10.6%)	1.0
Colorectal surgery	236,287 (80.4%)	5,884 (74.2%)		5,881 (74.3%)	5,881 (74.3%)	1.0
Diagnosis			<.001			.70
Benign	169,134 (57.6%)	4,387 (55.4%)		4,406 (55.7%)	4,382 (55.4%)	
Malignancy	124,600 (42.4%)	3,538 (44.6%)		3,506 (44.3%)	3,530 (44.6%)	
Surgical approach			<.001			.035
Open	203,541 (69.3%)	6,022 (76.0%)		6,121 (77.4%)	6,009 (75.9%)	
MIS	90,193 (30.7%)	1,903 (24.0%)		1,791 (22.6%)	1,903 (24.1%)	
Hospital's location and teaching status			<.001			.80
Rural	22,346 (7.6%)	556 (7.0%)		576 (7.3%)	556 (7.0%)	
Urban non-teaching	103,101 (35.1%)	2,552 (32.2%)		2,523 (31.9%)	2,546 (32.2%)	
Urban teaching	168,287 (57.3%)	4,817 (60.8%)		4,813 (60.8%)	4,810 (60.8%)	
Hospital size			.50			.47
Small	35,654 (12.1%)	950 (12.0%)		997 (12.6%)	948 (12.0%)	
Medium	69,504 (23.7%)	1,920 (24.2%)		1,889 (23.9%)	1,918 (24.2%)	
Large	188,576 (64.2%)	5,055 (63.8%)		5,026 (63.5%)	5,046 (63.8%)	
Geographic location			<.001			.94
Northeast	56,705 (19.3%)	1,476 (18.6%)		1,467 (18.5%)	1,471 (18.6%)	
Midwest	56,661 (19.3%)	1,467 (18.5%)		1,482 (18.7%)	1,466 (18.5%)	
South	120,069 (40.9%)	2,940 (37.1%)		2,956 (37.4%)	2,937 (37.1%)	
West	60,299 (20.5%)	2,042 (25.8%)		2,007 (25.4%)	2,038 (25.8%)	

AA, African American; *MIS*, minimally invasive surgery.

was used to assess the prevalence of SA among patients undergoing abdominal surgery. Patients undergoing complex abdominal surgery are already at a higher risk of postoperative complications compared with the general surgery population.[20,21] Given this, there has been a specific focus on risk mitigation among this population of surgical patients. To date, however, these strategies have largely focused on surgeon-specific (eg, volume threshold, learning curve, etc) or hospital-specific (eg, nurse-to-bed ratio, structural quality measures, etc) factors.[22,23] While some risk calculators have included patient specific factors, these variables

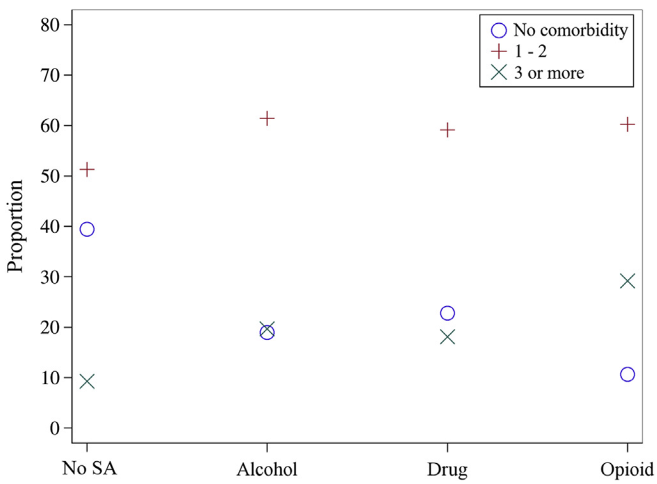

Fig 3. Proportion of patients with no, 1–2, and ≤3 comorbidities by the type of SA.

have largely focused on traditional items linked to potential morbidity, such as age and Charlson comorbidity score.[24,25] The current study was important because it specifically focused on the association of SA and postoperative outcomes among patients undergoing complex abdominal surgery. Of note, roughly 1 in 50 patients who underwent a complex abdominal surgery had a reported history of SA. Importantly, data from the current study was the first to quantify risk of postoperative complications, in-hospital mortality, and LOS relative to SA using a large, national database. Patients who had a SA history were much more likely to have preoperative comorbidities versus individuals who did not have a history of SA. Perhaps more importantly, even after controlling for these comorbidities on PSM and multivariable analyses, patients with a history of SA still had a 1.68-fold increased risk of complications, as well as almost a 2-fold increased chance of an extended LOS following a complex abdominal operation.

The American College of Surgeons (ACS) Committee on Trauma has called for routine screening of alcohol abuse due to health risks associated with excessive drinking.[26] Similarly, in 2017 the ACS Division of Advocacy and Health Policy and Division of Education Patient Education Committee jointly developed a statement on the opioid abuse epidemic, highlighting the importance of prevention of opioid abuse and addiction, though strategies on SA screening have yet to be elucidated.[27] However, screening and detection of SA may be important due to the concurrent medical comorbidity and chronic illness burden associated with patients who have a SA history.[28] For example, in the current surgical cohort, patients with history of SA were more likely to have 3 or more medical comorbidities versus individuals who did not have a history of SA. In contrast, among orthopedic patients, the comorbidity burden among patients with or without a history of SA was not consistent.[7,29] Differences in the comorbidity burden among patients with SA may be secondary to variations in the patient population. For example, in the study by Best et al, patients undergoing primary total hip or knee arthroplasty had an average age of 51 years versus 60 years among patients with SA in the current study.[7] Additionally, a greater proportion of patients without a history of SA had a diagnosis of diabetes or obesity compared with patients who had a history of SA. This finding may be explained in part on underlying malnutrition or poor nutrition among patients with a history of SA.[30–32] Collectively, the current data highlight the clinical complexity of patients with a history of SA, which in turn may have a significant impact on postoperative outcomes.

In a systematic review, Eliasen et al noted that preoperative alcohol consumption was associated with an increased risk of postoperative morbidity, infections, wound complications, pulmonary complications, and prolonged LOS.[33] In a different study, Gupta et al reported that patients with a history of opioid abuse or dependence had a higher odds ratio of readmission and healthcare utilization following surgery.[34] The present study was consistent with and expanded on these previous findings. Importantly, we noted that a history of SA had a marked impact on the odds ratio of morbidity, extended LOS, and expenditures among patients undergoing a complex surgical operation. Specifically, patients with a history of SA had 68% and 95% higher odds ratios of a complication and discharge to a place other than home, respectively, compared with individuals without a history of SA. Furthermore, similar trends were noted among patients with a history of alcohol and opioid misuse. Collectively, these data suggest that SA may be a significant risk factor for unfavorable outcomes, such as pulmonary failure and pneumonia. Currently, the ACS Surgical Risk Calculator only includes tobacco use within the last year to estimate patient-specific risk for any of the 18 different outcomes.[35,36] Data from the current study strongly suggest that the incorporation of SA history may better predict outcomes and guide surgical decision making and perioperative

Table II
Bivariate and multivariable odds ratio of postoperative outcomes relative to SA versus non-SA after PSM

Variable	Bivariate			Multivariable		
	OR	95% CI	*P*	OR	95% CI	*P*
Any complication	1.59	1.47–1.72	<.001	1.68	1.55–1.82	<.001
Pulmonary failure	1.87	1.61–2.22	<.001	1.96	1.66–2.32	<.001
Pneumonia	2.51	2.02–3.12	<.001	2.61	2.09–3.26	<.001
Myocardial infarction	1.21	0.85–1.71	.29	1.23	0.86–1.76	.26
DVT/PE	1.48	1.12–1.95	.005	1.50	1.14–1.98	.004
Acute renal failure	1.40	1.24–1.58	<.001	1.52	1.33–1.74	<.001
Hemorrhage	1.41	1.19–1.69	<.001	1.42	1.19–1.69	<.001
Surgical site infection	1.49	1.33–1.67	<.001	1.51	1.35–1.70	<.001
GI hemorrhage	1.89	1.25–2.87	<.001	1.88	1.23–2.85	<.001
Mortality	1.22	0.97–1.55	.10	1.26	0.99–1.60	.06
Non-home discharge	1.70	1.54–1.87	<.001	1.95	1.76–2.16	<.001
Extended LOS	1.72	1.62–1.84	<.001	1.88	1.76–2.02	<.001
High expenditure	1.45	1.35–1.57	<.001	1.62	1.49–1.77	<.001

DVT, deep vein thrombosis; *GI*, gastrointestinal; *PE*, pulmonary embolism.

Table III
Multivariable odds ratio of postoperative outcomes by the type of SA after propensity score matching

Variable	Alcohol			Drug			Opioid		
	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*
Any complication	1.57	1.44–1.71	<.001	1.26	1.14–1.39	<.001	1.15	0.90–1.47	.27
Mortality	1.38	1.07–1.79	.013	0.93	0.67–1.29	.67	0.90	0.36–2.27	.82
Non-home discharge	1.69	1.52–1.87	<.001	1.44	1.28–1.63	<.001	1.44	1.05–1.97	.025
Extended LOS	1.58	1.47–1.71	<.001	1.50	1.37–1.63	<.001	1.35	1.10–1.65	.004
High expenditure	1.53	1.39–1.67	<.001	1.21	1.09–1.35	<.001	1.39	1.06–1.81	.018

risk estimation. To this end, the current study specifically elucidated the importance of SA screening as part of the preoperative counsultation for patients undergoing complex abdominal surgery. Tools such as the Alcohol, Smoking and Substance Involvement Screening Test can identify patients who have a history of hazardous drinking and/or use of mood-alterings substances.[37–40] Interestingly, even patients with a remote history of SA may be at higher perioperative risk. For example, Jergesen et al noted that, despite a 1-year sobriety pathway, patients with SA history undergoing hip and knee arthroplasty had a higher incidence of complications than patients without a history of SA.[41] In a separate study, Tedesco et al reported that patients with a history of SA had comparable weight loss results as patients without SA following bariatric surgery.[42] As such, while use of a screening tool may be important to identify patients with a history of SA, future studies are needed to define how patients with SA might be better prepared for elective operations. At a minimum, identification of patients with a SA history can help surgeons counsel patients on their preoperative risk of postoperative morbidity.

The present study is one of the first studies specifically to examine the association of alcohol, opioids, and other drugs on short term outcomes among patients undergoing complex abdominal surgery. Prior studies noted that a history of intravenous drug use was associated with increased postdischarge complications and need of additional procedures among patients undergoing hip or knee arthroplasty.[43,44] Furthermore, among alcohol misusers with head and neck cancers, Kaka et al noted that alcohol abstinence was associated with shorter LOS and decreased morbidity.[45] Similarly, alcohol use has been associated with increased healthcare utilization, including prolonged intensive care unit admission and complications.[46–48] In turn, increased healthcare utilization can have cost implications.[2] To this point, after controlling for relevant covariates, the current study noted that a history of SA was significantly associated with higher inpatient expenditures. Specifically, SA was associated with a 62% higher odds ratio of high expenditure. The association of cost and SA was noted when separately examining alcohol, opioid, and other drug abuse. As such, targeting SA interventions in the perioperative period may help improve overall outcomes and decrease associated healthcare costs.

Table IV
Change in odds ratio of any complication and mortality by varying sensitivity of SA in each group

Sensitivity (comp +)	Sensitivity (comp -)				
	90%	80%	70%	60%	50%
90%	1.64	1.42	1.19	0.97	0.75
80%	1.94	1.67	1.41	1.14	0.88
70%	2.36	2.04	1.72	1.40	1.07
60%	3.03	2.61	2.20	1.79	1.37
50%	4.21	3.63	3.06	2.48	1.91
Sensitivity (mortality +)	**Sensitivity (mortality -)**				
	90%	80%	70%	60%	50%
90%	1.57	1.39	1.21	1.04	0.86
80%	1.77	1.57	1.37	1.17	0.97
70%	2.03	1.80	1.57	1.34	1.11
60%	2.38	2.11	1.84	1.57	1.30
50%	2.87	2.55	2.22	1.90	1.57

The current study had several limitations that should be considered when interpreting the results. Similar to other retrospective database studies, ICD-9 codes were utilized to abstract information and, as such, the study was subject to information/coding bias.[49] To limit information bias, ICD-9 diagnosis codes that have been endorsed by the Agency for Healthcare Research and Quality to identify SA were utilized.[12] Despite using previously published codes, the severity or timing of SA relative to the date of surgery was not known, which may affect outcomes. Additionally, claim codes not directly related to reimbursement may be prone to variation in coding practices; as such, SA history may have been undercoded.[50] In turn, the prevalence of SA may have been underestimated among patients undergoing major abdominal surgery secondary to misclassification error. In order to limit this effect, we performed additional sensitivity analysis to examine how misclassification errors may have affected outcomes. Additionally, while PSM reduced bias secondary to confounding, PSM cannot fully adjust for all potential differences in the SA versus nonSA groups, such as education level, health literacy, and length of sobriety, among other factors. Although multivariable regression analysis was also performed in the matched cohort to limit bias, some residual differences in the SA versus non-SA groups may have been possible. To overcome possible "overpowering," post hoc analyses were performed, which demonstrated that the observed sample size provided enough power to detect a minimum effect size of as little 0.041 between the 2 groups, assuming 95% power and $\alpha = 0.05$. Further, when only considering the 2 groups after PSM, there was power to detect an effect size as small as 0.057, assuming 95% power and $\alpha = 0.05$. Post hoc power analyses have been commonly used when examining administrative claims data such as the NIS database.[19,51,52]

In conclusion, patients with SA had a higher risk of experiencing in-hospital complications, non-home discharge, extended LOS, and higher expenditure following major abdominal surgery. These findings highlight the need to screen patients for history of SA in order to better counsel, plan, and prevent possible adverse outcomes. Identification and treatment of SA prior to major abdominal surgery may represent a means to improve patient care and decrease healthcare costs. Further research is needed to determine evidence-based methods to improve outcomes for the growing population of patients with SA.

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Conflict of interest/Disclosure

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Supplementary materials

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