

The Burden of Substance Abuse Related Admissions to the Medical Intensive Care Unit

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Abstract:

Background: Admissions to intensive care unit (ICU) related to alcohol, prescription and illicit drugs shown to be widespread and costly. In 1993, study by Baldwin et al. revealed 28% of ICU admissions at Johns Hopkins Hospital related to substance abuse and accrued 39% costs. Since then, healthcare expenditures have increased, and substance abuse treatment admissions have risen. We conducted a study to provide updated data on ICU utilization and costs related to licit and illicit abuse at a large county hospital in Indianapolis, Indiana.

Methods: All admissions to medical ICU at Eskenazi Hospital reviewed from March to October 2017. Demographics, reason for admission, relation to substance abuse and specific substance, ICU and hospital length of stay, APACHE II scores, mortality, insurance status, and hospital charges were collected based on chart review.

Results: 611 admissions generated \$74,587,280.35 in charges. 25.7% admissions related to substance abuse accounted for 23.1% of total charges. Illicit drugs were 13% of total admissions generating 11% charges. Alcohol related admissions were 9.5% total admissions generating 7.6% charges. Prescription drugs were 2.9% admissions generating 4.2% charges. Substance abuse admissions were male, 40 to 64 years old with longer ICU stay, higher APACHE II scores, and higher mortality.

Conclusion: Substance abuse admissions make up almost a quarter of resources utilized by our ICU. Patients tend to be younger and sicker with a higher risk of death. Identifying and accurately describing the landscape of this current health crisis will help us take appropriate action in the future.

Abbreviations:

ICU- Intensive Care Unit

APACHE II- Acute Physiology and Chronic Health Evaluation II

Background:

Admissions to the intensive care unit (ICU) related to the abuse of alcohol, prescription and illicit drugs have been shown to be both common and costly. In 1993, a study by Baldwin et al. revealed 28% of ICU admissions over a 15-week period at Johns Hopkins Hospital were related to substance abuse and accrued 39% of the costs¹. Of note, tobacco-related admissions accounted for 14% of the substance abuse admissions and 16% of the costs¹. Since that time, healthcare expenditures have increased. From 2000 to 2010, annual critical care medicine costs have swelled from \$56.6 billion to \$108 billion². This represents 13.2% of hospital costs, 4.1% of national health expenditures and 0.72% of the gross domestic product². Substance abuse treatment admissions have risen, with admission rates increasing six-fold from 1999 to 2009³. In addition, mortality related to opioid overdose admissions has increased from 3.7 opioid overdose-related deaths per 10,000 ICU admissions in 2011 to 7.3 in 2015, a 97% increase⁴. Since 1993, there is limited data pertaining to substance abuse ICU admissions despite these social and financial shifts. We decided to conduct the current study to provide updated data on ICU utilization and costs related to licit and illicit abuse at a large county hospital in Indianapolis, Indiana.

Materials and Methods:

We conducted a retrospective, electronic chart review utilizing all admissions to the medical ICU of Eskenazi Hospital, a tertiary care, urban health care center over a six-month period from May 2017 to October 2017. The reason for admission, whether related to substance abuse or not, age, sex, race, ICU length of stay, hospital length of stay, mortality and Acute Physiology and Chronic Health Evaluation (APACHE II) score were recorded for each patient. The study methods have been reviewed and approved by the Indiana University Institutional Review Board and Eskenazi Health Research Committee (1904571086). Substance abuse admissions are defined as those related to alcohol use, illicit drug use, and prescription drug use based on history and laboratory data. Alcohol related admissions include those related to overdose, withdrawal or delirium tremens, alcohol related seizures, alcoholic gastritis, alcoholic pancreatitis, alcoholic hepatitis, alcoholic cirrhosis complicated by bleeding, coagulopathy, encephalopathy, peritonitis, hepatorenal syndrome¹. Illicit drug related admissions are defined as those related, but not limited to, heroin, cocaine, marijuana, phencyclidine, barbiturates, and amphetamines¹. Admissions were considered illicit drug related when patients had a positive urine drug screen, positive serum drug screen, or history of illicit drug use with concomitant physical exam suggesting illicit drug use (For example, physical exam consistent with an opioid toxidrome). Prescription drug related admissions are those related to misuse of prescribed drugs. Medication reconciliation was utilized to determine known prescriptions. In addition, the insurance status and hospital charges (excluding physician charges) for each patient were collected in cooperation with Eskenazi Health's Billing department. Insurance status was recorded as Medicare, Medicaid, Healthy Indiana Plan (HIP, an affordable health plan for low-income adult Hoosiers between the ages of 19 and 64, sponsored by the state), commercial, self-pay, insurance through Veterans Affairs, or incarceration.

Statistical Analysis

Prior to models we included baseline comparison tests. Statistical evaluation was completed using a mixed effects logistic regression model to determine if patient characteristics (Age, sex, race, insurance status, mortality) differed between substance abuse related and non-substance abuse related admissions to the MICU. These models included a random effect to account for within-patient variation for those patients with multiple MICU admissions, and a fixed effect for the patient characteristics.

Mixed effects linear regression was used to model whether continuous variables (APACHE II, charges, length of stay) differed by substance abuse status. Logarithmic analysis was utilized to evaluate total charges, hospital length of stay, and ICU length of stay due to the skewed distribution of these variables. All analyses were performed using SAS v9.4.

Results:

There were 611 unique admissions for 594 patients during the study period. Table 1 describes the baseline demographic characteristics of study patients. 56% of patients were 40 to 64 years old, 47% were females and 43% were African American. The most common insurance payor was Medicare (37.6%). Median ICU length of stay was 4 days and median hospital length of stay was 6 days. In-hospital mortality rate was 14%. Median APACHE II score was 13. Patient characteristics of substance abuse admissions versus non-substance abuse admissions are also depicted in Table 1. Patients admitted for substance abuse tended to be younger [median age of 44 years compared to 59 years in non-substance abuse admissions ($p<0.001$)]. In addition, substance abuse admissions were more frequently male [64% vs 48% ($p=0.003$)] and less likely to have Medicare as a payor source [13% vs 47% ($p<0.001$)]. APACHE II scores were higher in substance abuse related admissions [median score 15 vs 13 ($p=0.014$)]. There was no significant difference in race observed between the two groups.

Table 1: Comparison of Patient Characteristics by Substance Abuse (n=611)

| | Overall Population (n=611) | Non-Substance Abuse (n=454) | Substance Abuse (n=157) | P-value |
|---|-----------------------------------|------------------------------------|--------------------------------|----------------|
| Age | | | | <0.001 |
| % <40yo (n) | 20.1 (123) | 13.4 (61) | 39.5 (62) | |
| % 40-64yo (n) | 56.7 (340) | 55.1 (250) | 57.3 (90) | |
| % >64yo (n) | 24.2 (148) | 31.5 (143) | 3.2 (5) | |
| Median (IQR) | 56 (44-64) | 59 (50-67) | 44 (32-56) | <0.001 |
| Sex | | | | |
| % Male (n) | 52.2 (319) | 48 (218) | 64.3 (101) | 0.004 |
| % Female (n) | 47.8 (292) | 52 (236) | 35.7 (56) | |
| Race | | | | 0.132 |
| % White (n) | 48.0 (293) | 45.4 (206) | 55.4 (87) | |
| % Black (n) | 43.2 (264) | 45.4 (206) | 36.9 (58) | |
| % Other ¹ (n) | 8.8 (54) | 9.2 (42) | 7.6 (12) | |
| Insurance | | | | <0.001 |
| % Medicare (n) | 37.6 (233) | 46.7 (212) | 13.4 (21) | |
| % Medicaid (n) | 25.4 (147) | 24.4 (111) | 22.9 (36) | |
| % HIP (n) | 16.2 (102) | 10.6 (48) | 34.4 (54) | |
| % Commercial (n) | 8.7 (54) | 9.5 (43) | 7.0 (11) | |
| % Other ² (n) | 12.3 (75) | 8.8 (40) | 22.3 (35) | |
| APACHE II | | | | |
| Median (IQR) | 13 (8-20) | 13 (7-19) | 15 (9-21) | 0.014 |
| Mortality | 14.4% (88) | 13.9% (63) | 15.9% (25) | 0.539 |
| ICU LOS (d) | 4 (3-6) | 4 (3-6) | 4 (3-6) | 0.692 |
| Hospital LOS (d) | 6 (4-11) | 6 (4-12) | 5 (3-9) | 0.088 |
| Hispanic, Asian ¹ | | | | |
| Self-pay, Veterans Affairs, Incarcerated ² | | | | |

Table 2 describes the frequency and amount of hospital charges related to substance abuse admissions. In total, 25.7 % of admissions were related to substance abuse (157/611) accruing 23.1% of total hospital charges. Illicit drug related admissions were the most common category of substance abuse admissions at 13.1% (80/611) generating 11.1% of total hospital charges. Alcohol related admissions accounted for 9.7% (59/611) of admissions representing 7.8% of total charges. Prescription drug related admissions were 2.9% (18/611) of admissions causing 4.2% of total charges. The frequency and charges of specific illicit drug and prescription drug admissions are shown in Table 3. Polysubstance abuse was by far the most common category in both illicit drug (40% illicit drug admissions and 3.9% total charges) and prescription drug subgroups (33.3% prescription drug admissions and 1.6% total charges). Fifteen patients were admitted twice and one was admitted thrice. Fourteen of these patients were admitted for non-substance abuse etiologies while two patients were admitted due to substance abuse.

Table 2: Frequency and Charges of Substance Abuse-Related Admissions (n=157)

| | # Admissions | % Total Admissions | Charges (\$) | % Total Charges |
|------------------------------------|--------------|--------------------|---------------|-----------------|
| Alcohol Related | 59 | 9.7 | 5,836,426.61 | 7.8 |
| Illicit Drug Related | 80 | 13.1 | 8,259,955.63 | 11.1 |
| Prescription Drug Related | 18 | 2.9 | 3,097,695.24 | 4.2 |
| All Substance Abuse Related | 157 | 25.7 | 17,194,077.48 | 23.1 |
| Not Substance Abuse Related | 454 | 74.3 | 57,393,202.87 | 76.9 |
| Total Admissions | 611 | 100 | 74,587,280.35 | 100 |

Table 3: Specific Illicit Drug and Prescription Drug Frequency and Charges

| Illicit Drugs (n=80) | No. (%) | Charges (%Total) |
|----------------------------------|----------------|-------------------------|
| Polysubstance | 32 (40%) | 2,890,191.72 (3.9) |
| Opioid | 18 (22.5) | 1,667,997.23 (2.2) |
| Cocaine | 11 (13.7) | 1,852,695.81 (2.5) |
| Amphetamines | 11 (13.7) | 1,308,328.40 (1.8) |
| Marijuana | 5 (6.3) | 322,635.83 (0.4) |
| Synthetic Cannabinoids | 2 (2.5) | 166,202.64 (0.2) |
| Phencyclidine | 1 (1.3) | 51,904 (0.7) |
| Prescription Drugs (n=18) | | |
| Polysubstance | 6 (33.3) | 1,201,868.77 (1.6) |
| Acetaminophen | 3 (16.7) | 1,241,020.58 (1.7) |
| Tricyclic Anti-depressants | 2 (11.1) | 126,860.01 (0.2) |
| Quetiapine | 1 (5.6) | 38,721.25 (0.1) |
| Bupropion | 1 (5.6) | 10,7761.78 (0.1) |
| Morphine | 1 (5.6) | 98,201.12 (0.1) |
| Lamotrigine | 1 (5.6) | 166,905.04 (0.2) |
| Diphenhydramine | 1 (5.6) | 23,440.25 (0.03) |
| Baclofen | 1 (5.6) | 69,962.33 (0.1) |
| Salicylate | 1 (5.6) | 22,954.09 (0.03) |

Table 4 describes differences in patient outcomes in relation to substance abuse. Median charges were significantly less in substance abuse related admissions ($p=0.018$). After adjusting for patient characteristics, there were no significant differences in ICU and hospital length of stay.

Table 4: Comparison of Patient Outcomes by Substance Abuse

| | Non-Substance Abuse (n=454) | Substance Abuse (n=157) | Unadjusted P-value | Adjusted P-value |
|-------------------------|------------------------------------|--------------------------------|---------------------------|-------------------------|
| All Discharges | | | | |
| Median ICU LOS (d) | 4 (3-6) | 4 (3-6) | 0.692 | 0.395 |
| Median Hospital LOS (d) | 6 (4-12) | 5 (3-9) | 0.088 | 0.252 |
| Median Charges (\$) | 83,517 (46,359-147,096) | 61,669 (38,721-109,504) | 0.018 | 0.017 |
| Mortality % (n) | 13.9 (63) | 15.9 (25) | 0.539 | 0.257 |
| | | | | |
| | Non-Substance Abuse (n=391) | Substance Abuse (n=132) | Unadjusted P-value | Adjusted P-value |
| Discharged Alive | | | | |
| Median ICU LOS (d) | 4 (3-6) | 4 (3-5) | 0.989 | 0.232 |
| Median Hospital LOS (d) | 6 (4-11) | 4 (3-8) | 0.084 | 0.208 |
| Median Charges (\$) | 77443 (44525-133,644) | 57151 (35443-96516) | 0.010 | 0.022 |

Table 5 describes the interaction of age and substance abuse on charges. When adjusting for patient characteristics, we found a significant interaction between age and substance abuse ($p=0.022$). There is a significant difference in mean charges for younger substance abuse patients compared to those without substance abuse. Younger substance abuse patients incur significantly fewer charges than non-substance abuse patients, but this significant difference disappears as age increases.

Table 5: Age and Substance Abuse Interaction on Charges¹

| Age | Estimated Differences (Log Scale) | | | Estimated Means (Log Scale) | | Estimated Means (Exponent) | |
|-----|-----------------------------------|-------|---------|-----------------------------|----------------|----------------------------|----------------|
| | Estimate | SE | P-value | SA ² Related | Not SA Related | SA Related | Not SA Related |
| 30 | -0.499 | 0.132 | 0.002 | 10.932 | 11.431 | \$55,910 | \$92,114 |
| 40 | -0.349 | 0.098 | 0.004 | 11.086 | 11.435 | \$65,253 | \$92,524 |
| 50 | -0.199 | 0.092 | 0.049 | 11.241 | 11.440 | \$76,158 | \$92,936 |
| 55 | -0.124 | 0.102 | 0.243 | 11.318 | 11.442 | \$82,276 | \$93,143 |
| 60 | -0.049 | 0.118 | 0.684 | 11.395 | 11.444 | \$88,885 | \$93,350 |
| 65 | 0.026 | 0.138 | 0.853 | 11.472 | 11.446 | \$96,025 | \$93,558 |

¹Estimate differences were calculated from the interaction terms of age and substance abuse admission at specific ages from a mixed effect model with log(charges) as the outcome. Estimated means were obtained by calculating predicted scores for a given age assuming a patient was male, white, had other insurance, and an APACHE II of 15.

²SA=Substance Abuse

Discussion:

Substance abuse has recently received intense attention not only by health professionals, but also the media⁶. The awareness of substance abuse as a social issue has risen exponentially with increased deaths related to the opioid epidemic, and in recent times deaths related to prescription drug overdoses^{7,8}. Many of these overdose related admissions to the hospital require ICU level of care and resources. Yet, only one study has examined substance abuse and its impact on cost in relation to ICU admissions. Our study evaluated substance abuse related admissions over a 6-month period and replaced prescription drug related admissions for tobacco related admissions. Baldwin et al. investigated substance abuse related admissions to the surgical and medical ICU at Johns Hopkins Hospital over a 15-week period in 1993¹. In their study, 28% of admissions were related to substance abuse that generated 39% of costs¹. However, tobacco related admissions were included in the substance abuse definition and were 14% of admissions accruing 16% of costs¹. In Baldwin's study, substance abuse admissions tended to be male, black, uninsured with longer lengths of hospital stay and larger costs compared to non-substance abuse admissions. Both studies were completed at large community hospitals with a trauma center and university affiliation. Substance abuse admissions accounted for 25.7% of total admissions to the ICU amassing 23.1% of the charges. Illicit drugs were the most common category of substance abuse, followed by alcohol related admissions. Polysubstance abuse was the most frequent sub-category of illicit and prescription drug admissions.

As in Baldwin et al.'s study, patients tended to be young and male, but with more uninsured and Medicare. The difference in insurance status between our studies is likely reflective of the average age difference and the Affordable Care Act. Substance abuse admissions greater than 64 years old represented 22% in Baldwin et al.'s study but accounted for only 3% in our study. In addition, the Affordable Care Act has increased medical insurance coverage substantially since passed in 2010 and has led to the expansion of private and Medicaid coverage⁹. Differences in patient outcomes is likely also affected by the significant age disparity.

An interesting result was substance abuse admissions had significantly higher APACHE II scores, but also tended to incur substantially lower hospital charges than non-substance abuse admissions. Again, patient age plays a substantial role in these findings. Table 5 provides insight into this interaction showing that younger substance abuse patients have significantly fewer charges than non-substance abuse patients, but this significant difference disappears as age increases. Substance abuse patients are frequently admitted critically ill with multi-system organ failure, requiring mechanical ventilation and other ICU level resources. As compared to Baldwin et al.'s study, our younger patient population likely has less co-morbidities and therefore a higher likelihood of quick recovery after the substance is metabolized and no longer present. This can lead to shorter lengths of stay and therefore less charges. As APACHE II scores take age into account (higher score with older patients), our finding of significantly higher APACHE II scores in the substance abuse population provides more insight into the severity of illness. It is important to note that this patient population presents significantly sicker, tends to have a higher likelihood of quick recovery, but is just as likely to die as the average ICU patient.

Our study had several limitations: 1) Single institution study completed during the Summer and Fall months. Ideally, our study would have included the entire year given seasonal variations in admissions¹⁰. A six-month interval was chosen instead of a full year due to the large number of admissions at our center and constraints on research time availability. Caution should be made when extrapolating findings generally from a single center. 2) Trauma and surgical ICU related admissions were not included in our analysis. This decision was made given the large volume of admissions to both intensive care units and focusing on a well-defined medical population 3) Total hospital charges did not include physician charges. Our billing data was provided from the billing department, which does not have access to this data readily. 4) Substance abuse admissions require a high level of suspicion for diagnosis. It is almost certain that not all substance abuse admissions were recognized, restricting our analysis. We would like to emphasize that the burden of substance abuse at our center is likely underestimated by our findings.

Conclusion:

Over the years, there have been significant changes in the number and type of substance abuse admissions in the ICU. These admissions make up almost a quarter of resources utilized by our ICU. Substance abuse related admissions to the ICU tend to be young males with higher severity of illness and do not accrue higher hospital charges compared to non-substance abuse related admissions. Given the rising costs of health care and growing concern of the opioid epidemic, studies such as this are important to accurately describe the landscape of this current health crisis and to take relevant action in the future.

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