Unsuspected Critical Illness Among Emergency Department Patients Presenting for Acute Alcohol Intoxication

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Study objective: Emergency department (ED) visits for acute alcohol intoxication are common, but this population is at risk for decompensation and occult critical illness. The purpose of this study is to describe the incidence and predictors of unsuspected critical illness among patients with acute alcohol intoxication.

Methods: This was a retrospective observational study of ED patients from 2011 to 2016 with acute alcohol intoxication. The study cohort included patients presenting for alcohol intoxication, whose initial assessment was uncomplicated alcohol intoxication without any other active acute medical or traumatic complaints. The primary outcome was defined as the unanticipated subsequent use of critical care resources during the encounter or admission to an ICU. We investigated potential predictors for this outcome with generalized estimating equations.

Results: We identified 31,364 eligible patient encounters (median age 38 years; 71% men; median breath alcohol concentration 234 mg/dL); 325 encounters (1%) used critical care resources. The most common diagnoses per 1,000 ED encounters were acute hypoxic respiratory failure (3.1), alcohol withdrawal (1.7), sepsis or infection (1.1), and intracranial hemorrhage (1.0). Three patients sustained a cardiac arrest. Presence of the following had an increased adjusted odds ratio (aOR) of developing critical illness: hypoglycemia (aOR 9.2), hypotension (aOR 3.8), tachycardia (aOR 1.8), fever (aOR 7.6), hypoxia (aOR 3.8), hypothermia (aOR 4.2), and parenteral sedation (aOR 2.4). The initial blood alcohol concentration aOR was 1.0.

Conclusion: Critical care resources were used for 1% of ED patients with alcohol intoxication who were initially assessed by physicians to have low risk. Abnormal vital signs, hypoglycemia, and chemical sedation were associated with increased odds of critical illness. [Ann Emerg Med. 2018;71:279-288.]

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INTRODUCTION

Background

Emergency department (ED) visits for acute alcohol intoxication are common.[1-3] Most encounters for alcohol intoxication result in an uncomplicated ED course and subsequent discharge after a period of observation, with the patient returning to a normal mental status. This patient population, however, is at risk for serious underlying illness and decompensation.[4-6]

Importance

There are multiple complications that can occur among acutely intoxicated patients. Patients with alcohol intoxication can lose protective airway reflexes or experience hypoxic respiratory failure, necessitating intubation.[7,8] Acute alcohol intoxication may also lead to substantial psychomotor agitation, warranting chemical sedation, which is associated with its own inherent risk.[9,10] Additionally, chronic alcohol use predisposes individuals to sepsis, acute liver failure, and gastrointestinal hemorrhage, among other serious medical comorbidities.[4,11-13] Intracranial hemorrhage is another important consideration in this patient population, given a high prevalence of associated traumatic injuries.[14-16] Identification of any of these concomitant processes may result in the subsequent use of ED critical care resources to stabilize and resuscitate the patient.

Goals of This Investigation

The purpose of this investigation was to determine the incidence of use of critical care resources among patients

Editor's Capsule Summary

What is already known on this topic

Some emergency department (ED) patients assessed as having uncomplicated alcohol intoxication decompensate and receive critical care services.

What question this study addressed

What is the incidence of unsuspected critical illness among 31,364 patients with acute uncomplicated alcohol intoxication?

What this study adds to our knowledge

Approximately 1% of patients admitted to a specialized ED unit for uncomplicated alcohol intoxication subsequently received critical care services. Several clinical findings were associated with receiving critical care services: hypoglycemia, hypotension, tachycardia, fever, hypoxia, hypothermia, and use of parenteral sedation.

How this is relevant to clinical practice

EDs should pay special attention to intoxicated patients with abnormal vital signs or hypoglycemia, and those who receive chemical sedation.

who present to the ED for acute alcohol intoxication. The study population of interest was patients presenting to the ED who were assessed to have low-risk, "uncomplicated" alcohol intoxication, but for whom the encounter unexpectedly resulted in the use of critical care resources. Secondary aims of this study were to determine whether there were potential predictors associated with critical care resource use in this population.

MATERIALS AND METHODS

Study Design and Setting

This was a retrospective, observational cohort study of patients presenting to the ED with acute alcohol intoxication from October 2011 to September 2016. The local institutional review board approved this study.

Hennepin County Medical Center is a tertiary care county hospital located in Minneapolis, MN, with greater than 100,000 annual ED visits. To accommodate for large volumes of alcohol intoxication visits (greater than 7,000 per year), the ED has a dedicated intoxication unit to cluster all alcohol intoxication encounters. This 16-bed area is staffed by 2 registered nurses, a health care technician, a resident physician, and an attending emergency physician. The unit is locked to prevent elopement, but is otherwise functionally the same as the rest of the ED. This unit is not a detoxification center, nor is its intent to treat withdrawal.

Figure 1 demonstrates the flow of intoxication encounters in our ED. Given the staffing constraints of the intoxication unit (lower nursing-to-patient ratios), the unit's intended use is for observing individuals in the ED primarily for uncomplicated alcohol intoxication. As such, triage nurses and paramedics are instructed to room any patient with suspected or known concomitant medical issues needing active treatment elsewhere in the ED.

The second mechanism to ensure that only appropriate patients remain in the intoxication unit is the initial unit nurse and physician evaluation, which occurs generally within 10 minutes of arrival. This initial assessment includes a physical examination, assessment of vital signs (blood pressure, pulse rate, temperature, and oxygen saturation), and a breath alcohol concentration testing (Alco-Sensor III; Intoximeters, Inc., St. Louis, MO). Routine breath alcohol testing is used rather than blood testing. If the physician or unit nurse believes the patient has concomitant medical illness or significant traumatic injury, or that significant resources will be required for the patient, he or she will relocate the patient elsewhere in the ED. The group that remains in the unit after this assessment may have some medical needs (eg, a cough requiring a chest radiograph, an assault requiring a laceration repair, hypoglycemia requiring dextrose or juice), but essentially, the population who remains in this unit are those deemed by staff to be at low risk.

Once the patient is deemed appropriate for the intoxication unit, there are no standard laboratory tests or imaging studies. The one exception to this is a mandatory point-of-care glucose-level test (checked either by emergency medical services [EMS] or in the ED). Patients are observed closely while in the intoxication unit, and serial examinations and vital signs checks are performed until their mental status improves and safe disposition is possible. If unanticipated concerns arise at any point (such as unexpected clinical decompensation or the discovery of initially missed pathology), the physician or nurse can escalate care.

Although the intoxication unit is predominantly used for uncomplicated alcohol intoxication, occasionally other patients are evaluated there (eg, those with drug intoxication, those with psychiatric complaints that require a locked unit). In contrast, occasionally low-risk intoxicated individuals are treated in other parts of the ED if the unit is full (Figure 1).

Selection of Participants

To identify eligible encounters, we queried the electronic medical record (Epic, Verona, WI) for all ED patients aged 18 years and older and with a chief complaint of altered

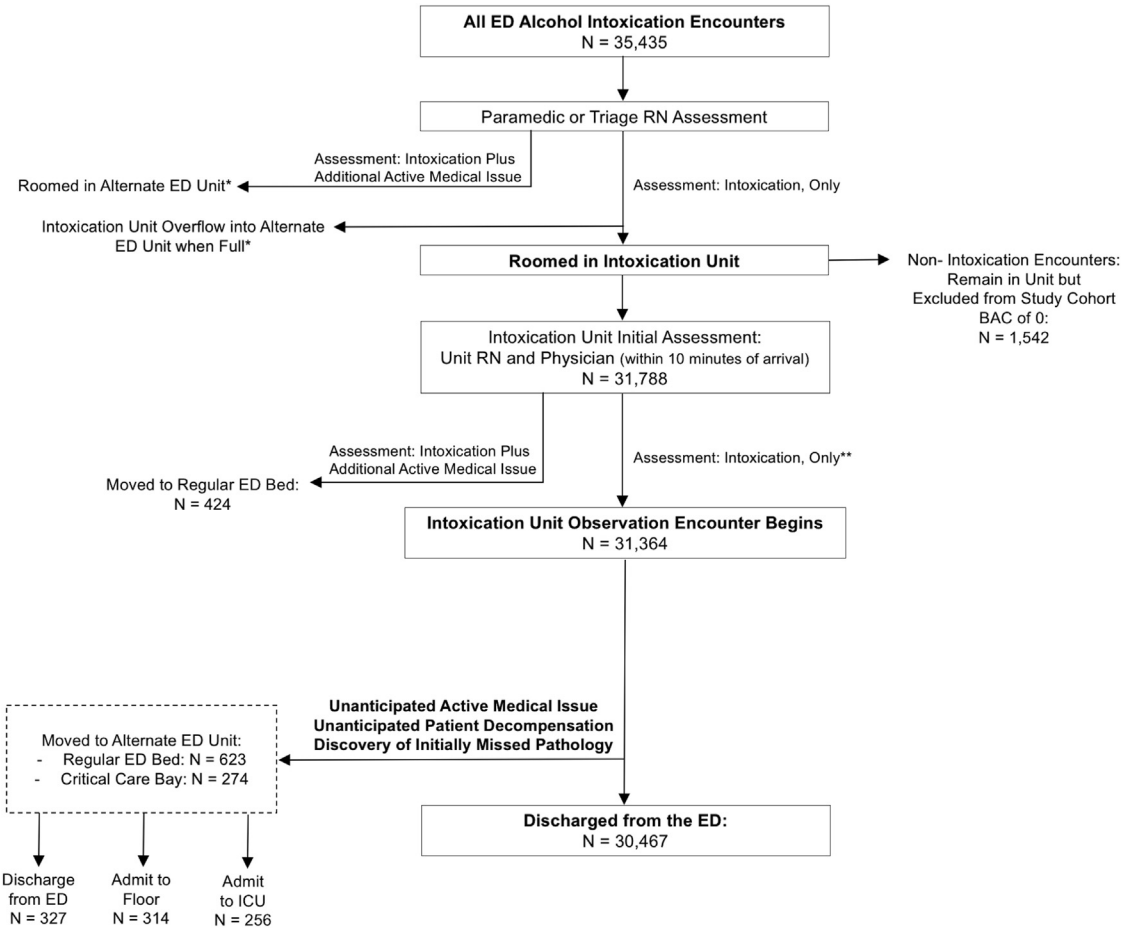

Figure 1. ED flow for alcohol intoxication encounters. *The combined N of patients roomed in an alternate ED unit plus intoxication unit overflow was N=3,647 (regular ED bed=2,740 and critical care bay=907). We were unable to determine retrospectively which nonintoxication unit alcohol intoxication patients were roomed elsewhere because they were considered overflow (unit full), nor could we determine whether there was an initial higher suspicion for serious concomitant illness (ie, significant trauma plus alcohol intoxication); presumably all 907 patients who went directly to the critical care bays were those with a high suspicion for serious concomitant illness. †Some simple interventions can be performed in this unit; for example, a patient with identified hypoglycemia can be treated with juice or with parenteral dextrose if unable to take by mouth. *BAC*, Blood alcohol concentration.

mental status or alcohol intoxication during the study period. These 2 chief complaints were selected because they are the institutional standard chief complaints for all alcohol-related visits (chief complaints are standardized in the electronic medical record without free-text options). Because the chief complaint of altered mental status could refer to other nonalcohol-related pathology, a second inclusion criterion was a breath alcohol level greater than zero (mg/dL).

The final study cohort was identified from this initial query if the patient's initial room was within the intoxication unit (the electronic medical record uniquely codes each ED room). Rather than include all ED patients with alcohol intoxication in any area of the ED, we restricted our final cohort to this specific intoxication unit to represent patients presumed to have low-risk uncomplicated alcohol intoxication encounters, which was the population of interest in this study. Because technically some patients may be initially inappropriately roomed in the intoxication unit by EMS or triage, we excluded patients who were relocated to another room elsewhere in the ED within 10 minutes of arrival.

Methods of Measurement

All study variables were obtained from the electronic medical record. Data were acquired by a blinded data analyst trained in electronic data management and acquisition who used structured query language code. The data obtained included age, sex, mode of arrival, medical comorbidities, psychiatric comorbidities, initial vital signs, initial breath alcohol concentration, chemical sedation medications administered (haloperidol, olanzapine, droperidol, ketamine, or benzodiazepines), laboratory testing results (if

obtained), computed tomography (CT) results (if obtained), ED disposition, admission unit, ED length of stay, and ICU or hospital length of stay (if applicable). The analyst also identified the patient's initial room in the ED and any subsequent rooms he or she was moved to (and what time).

The remainder of the necessary data was obtained from the electronic medical record by 2 trained abstractors (resident physicians) using standardized data collection forms.[17,18] This portion of data collection could not be performed with structured query language abstraction. The data collected in this manner were only for the subgroup found to use critical care resources in the ED. The variables collected by the abstractors included admission diagnosis, cause of critical illness, critical procedures (intubation, central venous access, arterial access, surgery, endoscopy, vasopressors, parenteral sedatives, parenteral antibiotics, or parenteral antiepileptics), and whether cardiac arrest occurred.

Outcome Measures

The primary outcome for this study was use of critical care resources in the ED, defined as the occurrence of either of the following during the patient encounter: patient evaluation and management in a designated critical care resuscitation room of the ED; or admission to the ICU, including the medical, surgical, burn, or pediatric ICU. Critical care resource use was used for the primary outcome because it was an objective surrogate marker for "critical illness" because such resources would be used only for patients deemed to be critically ill by providers. The subgroup of patients who met criteria for the primary outcome will be referred to as the "critical care cohort."

Vital sign abnormalities were coded dichotomously, with the following considered abnormal: hypotension (systolic blood pressure less than 90 mm Hg), hypothermia (temperature less than 35°C [95°F]), fever (temperature greater than 38°C [100.4°F]), tachycardia (pulse rate greater than 110 beats/min), hypoxia (oxygen saturation less than 92%), and hypoglycemia (fingerstick or serum glucose level of less than 60 mg/dL). Because the blood glucose level was usually checked by EMS and the value was therefore unavailable in the electronic medical record, a patient was considered not to have hypoglycemia if the glucose level was not rechecked in the ED and no dextrose was administered.

Primary Data Analysis

Patient and encounter characteristics were analyzed with descriptive statistics, including medians, interquartile ranges, ranges, counts, proportions, and 95% confidence intervals (CIs) when appropriate. We did not perform sample size calculations because to our knowledge there is no previous work to provide expected incidence rates for our outcomes. Patient characteristics were calculated with the total number of unique patients as the denominator, and encounter characteristics used total encounters as the denominator. The incidence rate of critical care resource use for patient encounters with acute alcohol intoxication was calculated. For the critical care cohort, causes of critical illness and details of the subsequent hospital course are described.

Two subgroup analyses were performed including (1) patients in the critical care cohort whose hospital length of stay was less than 24 hours (to characterize the appropriateness of critical care resource use), and (2) those with an admission diagnosis of alcohol withdrawal (to better characterize potential inappropriate initial placement into the intoxication unit).

To determine whether there were variables independently associated with critical care resource use, we created multivariable generalized estimating equation models. A generalized estimating equation with an exchangeable correlation structure was used instead of multivariable logistic regression to account for patients with multiple presentations during the study period; this was particularly relevant in this study, given the predisposition for some individuals to use the ED for alcohol intoxication frequently.

To avoid overfitting the model, we used less than 1 independent variable per 10 outcomes. The independent variables in the model were all determined a priori. Variable selection was based on what could plausibly be related to future critical care resource use and was limited to what could be ascertained early in the patient evaluation. For these reasons, we elected not to include laboratory or imaging results as predictor variables. Variables included in the model were initial breath alcohol concentration, initial vital sign abnormalities (hypotension, tachycardia, hypothermia, fever, and hypoxia), hypoglycemia, need for parenteral sedation for agitation, and whether the patient was a frequent user for alcohol intoxication (defined as greater than 4 additional visits in the previous 30 days). In regard to collinearity, we did not hypothesize any clinically meaningful interaction among independent variables except for tachycardia and hypotension, which was therefore included as an interaction term. Before creating the generalized estimating equation model, we investigated frequency of missing data. Because data were missing very infrequently (all variables were missing in $<0.3\%$ of encounters except temperature, which was missing in 2% of encounters), we elected not to perform any

imputation and left missing data as such. We assessed goodness of fit with the quasi-likelihood under independence model criterion statistic for the generalized estimating equation. Adjusted odds ratios (aORs) are reported. The 95% CIs for the aORs were calculated with robust variance estimation.

To ensure data quality, we performed 2 different assessments of agreement. First, we checked a random sample of 40 charts to ensure that the data electronically abstracted from the electronic medical record were accurate, and calculated a percentage agreement. During this initial review, it was found that the coding for chronic kidney disease was inaccurate, so the data analyst repeated the query, yielding improved results. Next, we calculated interobserver agreement and a κ value for the manually collected data. This included calculations for the manually abstracted variables admission diagnosis, intubation, and cardiac arrest. All statistical analyses were conducted in Stata (version 14; StataCorp, College Station, TX).

RESULTS

Characteristics of Study Subjects

The initial query yielded 46,633 encounters in the ED with a chief complaint of altered mental status or alcohol intoxication during the 5-year period from October 2011 through September 2016. Of 35,435 patients with a breath alcohol concentration greater than zero, 31,788 were initially examined in the intoxication unit. There were 424 excluded encounters because the patient was moved out of the intoxication unit within 10 minutes of arrival (initial assessment interval). This left 31,364 patient encounters that met criteria for inclusion.

Of these 31,364 encounters, there were 11,175 unique patients. The median number of visits during the 5-year period was 1 (interquartile range 1 to 2), with a range of 1 to 227 encounters. Baseline characteristics for the study cohort and encounters are shown in Table 1.

The agreement for the electronically abstracted data (after the chronic kidney disease coding was corrected) was 100%. The interobserver agreement for admission diagnoses was 90% (κ=0.82); for intubation, 100% (κ=1.0); and for cardiac arrest, 100% (κ=1.0).

Main Results

The critical care cohort was composed of 325 intoxication unit encounters during which critical care resources were used. This corresponded to 1% of all encounters for acute alcohol intoxication (95% CI 0.9% to 1.2%). The most common diagnoses for patient encounters in the critical care cohort were acute hypoxic respiratory failure (96/325; 30%), followed by alcohol withdrawal (54/325; 17%) and sepsis or infection (34/325; 10%). The most common procedure was intubation (205/325; 63%), and 256 patients (79%) were admitted to the ICU. Two patients died, both because of a cerebrovascular accident. Additional characteristics of the critical care cohort are described in Table 2.

Three patients had a cardiac arrest while in the intoxication unit. In addition to the alcohol intoxication, contributory factors for each cardiac arrest included a subarachnoid hemorrhage in case 1, tachydysrhythmias in case 2, and significant hyperkalemia in case 3. After resuscitation, all 3 patients had a return of spontaneous circulation and were discharged from the hospital neurologically intact. Case narratives of each cardiac arrest are presented in Figure 2.

The generalized estimating equation model demonstrated that there were several variables associated

Table 1. Patient and encounter characteristics.

Patient variables (N=11,175)	Values
Age, y	38 (range 18–86)
Sex, male	7,964 (71)
Comorbidities	
Alcoholism	3,183 (28)
Bipolar disorder	813 (7)
End-stage liver disease	683 (6)
Intravenous drug use	491 (4)
Chronic kidney disease	462 (4)
Traumatic brain injury	439 (4)
Schizophrenia	352 (3)
Number of encounters during study period	1 (range 1–227)
Encounter variables (N=31,364)	
Mode of arrival	
Ambulance (EMS)	18,941 (60)
Law enforcement	8,464 (27)
Triage (walk-in)	3,959 (13)
Breath alcohol concentration, mg/dL	234 (range 40–545)
Breath alcohol concentration <100 mg/dL	1,254 (4)
Patients receiving any parenteral sedation	12,644 (40)
Drug administered	
Olanzapine	8,132 (26)
Haloperidol	2,925 (9)
Droperidol	2,689 (9)
Lorazepam	306 (1)
Ketamine	69 (0.2)
Midazolam	26 (0.1)
Doses of parenteral sedation per patient, if >0	1 (range 1–9)
CT imaging obtained	1,691 (5)
Laboratory testing obtained	
Chemistry panel	1,982 (6)
CBC count	1,438 (4)
Liver function testing	503 (2)
ED length of stay, min	458 (range 58–1,104)

Count data are presented as No. (%) and continuous data are presented as median (range).

Table 2. Critical care resource use.

Critical care resource use	325 (1; 95% CI 0.9–1.2)
Time elapsed until escalation of care, min	130 (range 18–841)
ICU length of stay, days	2 (range 1–25)
Hospital length of stay, days	3 (range 1–58)

	Count and Proportion of Critical Care Cohort, No., % (95% CI)	Incidence per 1,000 Total Encounters (95% CI)
Admission diagnosis		
Alcohol related	148, 46 (40–51)	4.7 (4.0–5.5)
Acute hypoxic respiratory failure	96, 30 (24–35)	3.1 (2.5–3.8)
Alcohol withdrawal	54, 17 (13–21)	1.7 (1.3–2.2)
Acute agitation	33, 10 (7–14)	1.1 (0.8–1.5)
Trauma	50, 15 (12–20)	1.6 (1.2–2.1)
Intracranial hemorrhage	32, 10 (7–14)	1.0 (0.7–1.4)
Trauma (not intracranial hemorrhage)	18, 6 (3–8)	0.6 (0.4–0.9)
Medical	110, 34 (29–39)	3.5 (2.9–4.2)
Sepsis/infection	34, 10 (7–14)	1.1 (0.8–1.5)
Gastrointestinal hemorrhage	21, 6 (4–10)	0.7 (0.5–1.1)
Overdose (drug)	18, 6 (3–8)	0.6 (0.4–0.9)
Hypothermia/frostbite	10, 3 (2–6)	0.3 (0.2–0.6)
Hypotension, cause unknown	10, 3 (2–6)	0.3 (0.2–0.6)
Hyperkalemia	8, 3 (1–5)	0.3 (0.1–0.5)
Acute coronary syndrome	5, 2 (1–4)	0.2 (0.1–0.4)
Diabetic ketoacidosis	5, 2 (1–4)	0.2 (0.1–0.4)
Seizures/status epilepticus	5, 2 (1–4)	0.2 (0.1–0.4)
Cardiac arrest	3, 1 (0.2–3)	0.1 (0.02–0.3)
Acute ischemic stroke	3, 1 (0.2–3)	0.1 (0.02–0.3)
Procedures		
Intubation	205, 63 (58–69)	6.5 (5.7–7.5)
Intravenous chemical sedation	160, 49 (43–54)	5.1 (4.3–6.0)
Intravenous antibiotics	41, 13 (9–17)	1.3 (1.0–1.8)
Central venous access	27, 8 (5–12)	0.9 (0.6–1.3)
Intravenous antiepileptics	25, 8 (5–11)	0.8 (0.5–1.2)
Percutaneous arterial access	21, 6 (4–10)	0.7 (0.5–1.1)
Upper endoscopy	11, 3 (2–6)	0.4 (0.2–0.7)
Vasopressors	10, 3 (2–6)	0.3 (0.2–0.6)
Disposition		
Admit to ICU	256, 79 (74–83)	8.2 (7.3–9.3)
Admit to intermediate care	34, 10 (7–14)	1.1 (0.8–1.5)
Admit to general floor	7, 2 (1–4)	0.2 (0.1–0.4)
Discharged after stabilization	28, 9 (6–12)	0.9 (0.6–1.3)
Mortality*	2, 1 (0.1–2)	0.1 (0.01–0.3)

Count data are presented as No. (%) and continuous data are presented as median (range). Patients may have had more than one admission diagnosis (total diagnoses N>325).
*Both patients who died received a diagnosis of cerebrovascular accident.

with increased odds of critical care resource use. These variables included hypoglycemia (aOR 9.2), fever (aOR 7.6), hypothermia (aOR 4.2), hypotension (aOR 3.8), hypoxia (aOR 3.8), parenteral sedation (aOR 2.4), and tachycardia (aOR 1.8). Alcohol level was not associated with increased odds of critical care resource use (aOR 1.0). Additional findings from the generalized estimating equation are in Table 3.

There were 68 patients who were in the ICU for less than 24 hours (21%). The causes of critical illness were acute hypoxic respiratory failure (50), agitation (12), alcohol withdrawal (4), and hyperkalemia (2). Among the 60 patients who were admitted for respiratory failure and agitation, 59 (98%) were intubated. The 4 patients with alcohol withdrawal were transitioned from intravenous benzodiazepines to oral agents and discharged. The 2 patients who had hyperkalemia underwent emergency dialysis and were discharged home.

Finally, for patients with an admission diagnosis of alcohol withdrawal, the median time until ICU admission or escalation of care was 176 minutes, with a range of 95 to 841 minutes. The median breath alcohol level for the group admitted for alcohol withdrawal was 248 mg/dL (range 45 to 415 mg/dL), which was not lower than that of the group overall (median blood alcohol concentration 234 mg/dL; range 40 to 545 mg/dL).

Case 1: 47-year-old man brought in by EMS after causing a disturbance. BAC was 270 mg/dL. Was given 10 mg IM olanzapine on arrival. Approximately 3 h later, the patient became more agitated and received 10 mg of haloperidol and 200 mg of ketamine. Providers then brought patient for a head CT, where he developed agonal respirations and then became asystolic. CPR started; patient intubated and given epinephrine. On the next pulse check, ROSC achieved. CT scan showed a moderate SAH. Admitted to surgical ICU. Patient extubated on HD3. Left hospital AMA on HD4 neurologically intact.

Case 2: 45-year-old woman brought in by EMS after found with an empty bottle of alcohol. In the ED, patient was upset, demanding to leave. She did not receive any medications. After 90 min, she became more somnolent, oxygen saturations in the 60s, and she was pulseless. CPR started. She was moved to the resuscitation bay and was in VF. Defibrillated, which led to ROSC. The patient was intubated. In the MICU, she developed frequent tachydysrhythmias, including A-fib with RVR, and polymorphic VT, requiring defibrillation. Cardiology placed an ICD before discharge. She was discharged on HD8 neurologically intact.

Case 3: 29-year-old woman brought in by EMS. She drank an entire bottle of wine. Approximately 40 min later, she was found vomiting, apneic, and pulseless. CPR started. Electrical rhythm was PEA. Her potassium was 23 mEq/L. It was unclear to providers at the time if this was laboratory error, but was shifted with IV insulin and calcium. ROSC was achieved after 25 min. Follow-up serum potassium level was 7.3 mEq/L. At this time, the boyfriend arrived, stating that multiple pills of her potassium supplement were missing (she has a history of hypokalemia because of an eating disorder). In the MICU, she required a tracheostomy and was discharged to a long-term care facility on HD17.

CPR, Cardiopulmonary resuscitation; *ROSC*, return of spontaneous circulation; *SAH*, subarachnoid hemorrhage; *HD*, hospital day; *AMA*, against medical advice; *VF*, ventricular fibrillation; *RVR*, rapid ventricular response; *VT*, ventricular tachycardia; *ICD*, implantable cardioverter defibrillator; *PEA*, pulseless electrical activity; *IV*, intravenous.

Figure 2. Cardiac arrest case narratives.

LIMITATIONS

The main limitation of this study is that there is subjectivity in the definition of our study population. Although we used the objective criteria of patients who remained in the intoxication unit, the decision to place (or relocate) a patient in and out of the unit was at the provider's discretion. We assumed that the patients in our cohort who remained in the unit were considered low risk, but it is possible that there were exceptions. However, we believe that this assumption is reasonable, given the multiple opportunities that paramedics, nurses, and physicians have to relocate a patient if he or she is

Table 3. Univariate comparisons and multivariate generalized estimating equations results for associations with critical care.

Variable	Critical Care Cohort Encounters (n=325), No. (%)	Noncritical Care Cohort Encounters (n=31,039), No. (%)	aOR (95% CI)
Age, mean, y	38	38	1.0 (0.9–1.1)
Sex, male	273 (84)	24,641 (79)	1.4 (1.0–2.2)
Alcohol level, mg/dL	234	235	1.0 (1.0–1.0)
Hypoglycemia	57 (17)	500 (2)	9.2 (6.3–13.6)
Hypotension	15 (5)	333 (1)	3.8 (2.0–7.9)
Tachycardia	62 (19)	3,385 (11)	1.8 (1.2–2.3)
Hypoxia	41 (13)	1,089 (4)	3.8 (2.7–5.5)
Hypothermia	16 (5)	463 (1)	4.2 (2.5–7.1)
Fever	8 (2)	20 (0.1)	7.6 (1.6–24.0)
Parenteral sedation	205 (63)	12,439 (40)	2.4 (1.9–3.3)
Frequent user	116 (36)	12,206 (39)	0.8 (0.6–1.1)

All 95% CIs were calculated with robust variance estimation. The interaction term for hypotension and tachycardia was not significant but was retained in the model. Data are missing for hypotension in 44 encounters (0.1%), missing for tachycardia in 52 (0.2%), missing for hypoxia in 75 (0.2%), and missing for fever in 705 (2.2%), and are otherwise not missing. A review of 40 random charts was performed to ensure completeness and accuracy of all other parameters, and the agreement was 100%.

inappropriately triaged to the intoxication unit. We also identified that the median time of care escalation was 130 minutes into the encounter, and it would be unlikely for a physician to allow a critically ill patient to remain in the intoxication unit for that length of time, given the resources available.

We also recognize that including only patients in the intoxication unit can incur certain biases, but we believe that using data for patients in this unit was the most feasible method to answer the study question, how often will the patient who is "just" intoxicated unexpectedly decompensate while in the ED? The intoxication unit we describe is a unique surrogate for this "low-risk" assessment.

Next, this study lacks a comparison of critical care resource use to alcohol intoxication encounters observed elsewhere in the ED. We also could not completely assess the appropriateness of the critical care resources used. We attempted to address this with a subgroup analysis of patients in the hospital for less than 24 hours; this revealed that 61 (90%) were intubated for respiratory failure, suggesting that their ICU use was necessary. We also recognize that there may be inaccuracies with the use of breath alcohol levels (rather than blood testing), although the device we used correlates well with blood testing (r=0.879).[19] Finally, the interpretation of our results is limited by the retrospective nature of our study, but we took care to avoid problems associated with this design.[17,18,20]

DISCUSSION

ED visits for alcohol intoxication are becoming increasingly common,[1] and care must be taken by emergency physicians to ensure the safe disposition of this high-risk group of individuals. Distinguishing uncomplicated alcohol intoxication from intoxication complicated by serious underlying pathology should be the focus of these encounters. We identified that 1% of encounters for presumed uncomplicated alcohol intoxication ultimately used critical care resources. Although this may seem infrequent, when the millions of visits for alcohol intoxication nationally are considered,[1] this figure represents an important burden on EDs.

The diagnoses we identified also illustrate important themes in regard to the type of patient who may require critical care resources during an encounter for alcohol intoxication. One type of patient is one who decompensates while in the ED, developing respiratory failure or even cardiac arrest. On the other hand, patients with acute alcohol intoxication can also have occult critical pathology present on arrival; these diagnoses may be obscured by the patient's intoxication, or incorrectly assumed to be caused by ethanol alone.

We found that abnormal vital signs (tachycardia, hypotension, hypothermia, fever, and hypoxia), hypoglycemia, and need for chemical sedation were associated with increased odds of critical illness. These findings are intuitive, and few emergency providers would consider these predictors unexpected, but in clinical practice abnormal vital signs may be explained away; one could easily attribute tachycardia to dehydration or agitation, or attribute hypothermia to environmental exposure. Our findings suggest that patients exhibiting these abnormalities may warrant particular attention by providers.

Acute alcohol intoxication places patients at risk for acute respiratory failure. One previous study identified an intubation rate among intoxicated patients of approximately 1%, similar to our finding.[2] The association between alcohol intoxication and respiratory failure is multifactorial. Alcohol can cause hypoxia, apnea, and airway obstruction, and can also result in the loss of protective airway reflexes.[7,21,22] Unfortunately, because of the nature of this study design, we were unable to determine which of these factors contributed to respiratory failure and need for intubation for each patient.

After acute respiratory failure, alcohol withdrawal was the next most common admission diagnosis in the critical care cohort. Alcohol withdrawal as a chief complaint is not primarily observed in the intoxication unit; therefore, presumably all alcohol withdrawal developed while patients were in the ED as an unintended consequence of their stay. This is also supported by the fact that the median breath alcohol concentration in patients admitted for alcohol withdrawal was 248 mg/dL, which was actually higher than that of the cohort overall. As such, the diagnosis of alcohol withdrawal still presumably reflects unsuspected critical illness. Even though it is generally accepted that alcohol withdrawal can develop among intoxicated patients in the hospital, this concept has mostly been described for inpatients.[23,24] To our knowledge, there are no estimates in the literature in regard to expected rates of development of alcohol withdrawal among ED patients.

Acute agitation and other behavioral abnormalities are frequently observed in conjunction with alcohol intoxication; in this cohort, patients with intoxication and severe agitation who received chemical sedation were at increased odds for use of critical care resources (aOR=2.4; 95% CI 1.9 to 3.3). Controversy exists in regard to the ideal agent for sedation of these patients.[25-27] We previously demonstrated that benzodiazepines may have a higher risk of causing respiratory depression in this patient population compared with antipsychotics[28,29]; as such, our

practice has been to primarily use antipsychotics to treat agitation. In the present study, in which 8,132 (26%) patients received olanzapine, 2,925 (9%) received haloperidol, and 2,689 (9%) received droperidol, there were no episodes of torsades de pointes; however, there were 3 cardiac arrests. Similar rates have been reported in previous large studies on droperidol[30] or olanzapine.[31,32] Therefore, we conclude that the increased risk for using critical care resources was likely a marker of the severity of underlying illness, rather than an adverse drug event.

Alcohol and trauma are closely intertwined.[15,33] Alcohol use disorders have also emerged as a significant public health issue for trauma patients, resulting in recommendations for routine screening for chemical dependency during trauma admissions.[34] Our results reiterate that clinicians must be persistent in screening for trauma, particularly in patients with external signs of injury or when a patient's mental status is not improving as expected.

One unexpected result from this study was that a "frequent user" designation was not associated with critical care resource use; we hypothesized the opposite because of the comorbidities of chronic alcohol use.[4] In our analysis, we believe that this unanticipated finding may be due to the fact that there were many frequent user visits, and that the majority of these visits did not use critical care resources; therefore, the subsequent rate of critical care resources use for frequent user visits was actually low. Frequent ED users are the subject of much research, and many studies have identified that alcohol use disorders are associated with frequent ED use.[35,36] There are, however, comparatively few data about frequent users *for* alcohol intoxication; future work is needed to better understand this unique population.

In summary, we sought to identify the rate of critical care needs among patients presenting to the ED for presumed uncomplicated alcohol intoxication. Although most intoxicated patients in our cohort achieved clinical sobriety and were safely discharged home, critical illness did occur 1% of the time in a patient population that was initially perceived to be at low risk by providers. As ED visits for acute alcohol intoxication continue to increase, improved understanding of the potential for occult underlying illness and decompensation will help optimize clinical care for this complex population.

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REFERENCES

1. Mullins PM, Mazer-Amirshahi M, Pines JM. Alcohol-related visits to US emergency departments, 2001-2011. *Alcohol Alcohol*. 2017;52:119-125.
2. Verelst S, Moonen P-J, Desruelles D, et al. Emergency department visits due to alcohol intoxication: characteristics of patients and impact on the emergency room. *Alcohol Alcohol*. 2012;47:433-438.
3. Pletcher MJ, Maselli J, Gonzales R. Uncomplicated alcohol intoxication in the emergency department: an analysis of the National Hospital Ambulatory Medical Care Survey. *Am J Med*. 2004;117:863-867.
4. Mehta AJ. Alcoholism and critical illness: a review. *Pediatr Crit Care Med*. 2016;5:27-35.
5. de Wit M, Jones DG, Sessler CN, et al. Alcohol-use disorders in the critically ill patient. *Chest*. 2010;138:994-1003.
6. Mannelli P, Pae CU. Medical comorbidity and alcohol dependence. *Curr Psychiatry Rep*. 2007;9:217-224.
7. Wilson KC, Saukkonen JJ. Acute respiratory failure from abused substances. *J Intensive Care Med*. 2004;19:183-193.
8. Dua KS, Surapaneni SN, Santharam R, et al. Effect of systemic alcohol and nicotine on airway protective reflexes. *Am J Gastroenterol*. 2009;104:2431-2438.
9. Battaglia J. Pharmacological management of acute agitation. *Drugs*. 2005;65:1207-1222.
10. Miner JR, Gaetz A, Biros MH. The association of a decreased level of awareness and blood alcohol concentration with both agitation and sedation in intoxicated patients in the ED. *Am J Emerg Med*. 2007;25:743-748.
11. Strate LL, Singh P, Boylan MR, et al. A prospective study of alcohol consumption and smoking and the risk of major gastrointestinal bleeding in men. *PLoS One*. 2016;11:e0165278.
12. Moss M. Epidemiology of sepsis: race, sex, and chronic alcohol abuse. *Clin Infect Dis*. 2005;41(Suppl 7):S490-S497.
13. O'Brien JM Jr, Lu B, Ali NA, et al. Alcohol dependence is independently associated with sepsis, septic shock, and hospital mortality among adult intensive care unit patients. *Crit Care Med*. 2007;35:345-350.
14. Moore EE. Alcohol and trauma: the perfect storm. *J Trauma*. 2005;59(3 Suppl):S53-S56.

15. Field CA, Claassen CA, O'Keefe G. Association of alcohol use and other high-risk behaviors among trauma patients. *J Trauma*. 2001;50:13-19.
16. Easter JS, Haukoos JS, Claud J, et al. Traumatic intracranial injury in intoxicated patients with minor head trauma. *Acad Emerg Med*. 2013;20:753-760.
17. Kaji AH, Schriger D, Green S. Looking through the retrospectoscope: reducing bias in emergency medicine chart review studies. *Ann Emerg Med*. 2014;64:292-298.
18. Harris PA, Taylor R, Thielke R, et al. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009;42:377-381.
19. Gibb KA, Yee AS, Johnston CC, et al. Accuracy and usefulness of a breath alcohol analyzer. *Ann Emerg Med*. 1984;13:516-520.
20. Gilbert EH, Lowenstein SR, Koziol-McLain J, et al. Chart reviews in emergency medicine research: where are the methods? *Ann Emerg Med*. 1996;27:305-308.
21. Carole W, Sherry L, Taasan VC, et al. Alcohol increases sleep apnea and oxygen desaturation in asymptomatic men. *Am J Med*. 1981;71:240-245.
22. Happel KI, Nelson S. Alcohol, immunosuppression, and the lung. *Proc Am Thorac Soc*. 2005;2:428-432.
23. Goodson CM, Clark BJ, Douglas IS. Predictors of severe alcohol withdrawal syndrome: a systematic review and meta-analysis. *Alcohol Clin Exp Res*. 2014;38:2664-2677.
24. Salottolo K, McGuire E, Mains CW, et al. Occurrence, predictors, and prognosis of alcohol withdrawal syndrome and delirium tremens following traumatic injury. *Crit Care Med*. 2017;45:867-874.
25. Wilson MP, Pepper D, Currier GW, et al. The psychopharmacology of agitation: consensus statement of the American Association for Emergency Psychiatry Project Beta Psychopharmacology Workgroup. *West J Emerg Med*. 2012;13:26-34.
26. Tanaka E. Toxicological interactions between alcohol and benzodiazepines. *J Toxicol Clin Toxicol*. 2002;40:69-75.
27. Haddad PM, Anderson IM. Antipsychotic-related QTc prolongation, torsade de pointes and sudden death. *Drugs*. 2002;62:1649-1671.
28. Martel M, Sterzinger A, Miner J, et al. Management of acute undifferentiated agitation in the emergency department: a randomized double-blind trial of droperidol, ziprasidone, and midazolam. *Acad Emerg Med*. 2005;12:1167-1172.
29. Martel M, Miner J, Fringer R, et al. Discontinuation of droperidol for the control of acutely agitated out-of-hospital patients. *Prehosp Emerg Care*. 2005;9:44-48.
30. Calver L, Page CB, Downes MA, et al. The safety and effectiveness of droperidol for sedation of acute behavioral disturbance in the emergency department. *Ann Emerg Med*. 2015;66:230-238.e1.
31. Martel ML, Klein LR, Rivard RL, et al. A large retrospective cohort of patients receiving intravenous olanzapine in the emergency department. *Acad Emerg Med*. 2016;23:29-35.
32. Harrigan EP, Miceli JJ, Anziano R, et al. A randomized evaluation of the effects of six antipsychotic agents on QTc, in the absence and presence of metabolic inhibition. *J Clin Psychopharmacol*. 2004;24:62-69.
33. Soderstrom CA, Smith GS, Dischinger PC, et al. Psychoactive substance use disorders among seriously injured trauma center patients. *JAMA*. 1997;277:1769-1774.
34. Gentilello LM. Alcohol and injury: American College of Surgeons committee on trauma requirements for trauma center intervention. *J Trauma*. 2007;62(6 Suppl):S44-S45.
35. Doupe MB, Palatnick W, Day S, et al. Frequent users of emergency departments: developing standard definitions and defining prominent risk factors. *Ann Emerg Med*. 2012;60:24-32.
36. LaCalle E, Rabin E. Frequent users of emergency departments: the myths, the data, and the policy implications. *Ann Emerg Med*. 2010;56:42-48.