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Original Contribution

Emergency department length of stay for ethanol intoxication encounters☆

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ABSTRACT

Background: Emergency Department (ED) encounters for ethanol intoxication are becoming increasingly common. The purpose of this study was to explore factors associated with ED length of stay (LOS) for ethanol intoxication encounters.

Methods: This was a multi-center, retrospective, observational study of patients presenting to the ED for ethanol intoxication. Data were abstracted from the electronic medical record. To explore factors associated with ED LOS, we created a mixed-effects generalized linear model.

Results: We identified 18,664 eligible patients from 6 different EDs during the study period (2012–2016). The median age was 37 years, 69% were male, and the median ethanol concentration was 213 mg/dL. Median LOS was 348 min (range 43–1658). Using a mixed-effects generalized linear model, independent variables associated with a significant increase in ED LOS included use of parenteral sedation (beta = 0.30, increase in LOS = 34%), laboratory testing (beta = 0.21, increase in LOS = 23%), as well as the hour of arrival to the ED, such that patients arriving to the ED during evening hours (between 18:00 and midnight) had up to an 86% increase in LOS. Variables not significantly associated with an increase in LOS included age, gender, ethanol concentration, psychiatric disposition, using the ED frequently for ethanol intoxication, CT use, and daily ED volume.

Conclusion: Variables such as diagnostic testing, treatments, and hour of arrival may influence ED LOS in patients with acute ethanol intoxication. Identification and further exploration of these factors may assist in developing hospital and community based improvements to modify LOS in this population.

1. Introduction

Emergency Department (ED) encounters for acute ethanol intoxication are becoming increasingly common [1,2]. In addition to the number of visits, current National Hospital Ambulatory Care survey data indicates that the total time and the length of stay (LOS) for ethanol- related visits are increasing as well [1]. Despite these trends, the factors associated with LOS for ethanol intoxication encounters have not been previously investigated.

ED LOS is an important metric that has received significant attention given its implications on crowding and patient care quality [3-8]. ED LOS has been shown to be influenced by multiple factors, including ED volume and encounter characteristics (i.e. diagnosis severity or testing performed) [4,5,8,9]. There are, however, other factors relatively unique to ethanol intoxication that may also alter LOS. These variables may include blood ethanol concentration, chemical treatments for concomitant agitation, or compounding psychosocial issues (e.g. those who present with ethanol intoxication may be homeless, have substance abuse disorders, or be otherwise vulnerable).

The purpose of this investigation was to determine if there were factors independently associated with ED LOS for acute ethanol intoxication encounters. If modifiable factors could be identified, then community, hospital, and institutional changes could lead to greater control over LOS for intoxicated patients, and potentially improve care for this population.

2. Materials and methods

2.1. Study design and setting

This was a retrospective, multi-center, observational cohort study of patients presenting to the ED for acute ethanol intoxication (defined below) from January 2012 to December 2016. The population of interest for this study were ED encounters for acute ethanol intoxication, as opposed to encounters primarily for a medical or traumatic reason, where the patient was concomitantly intoxicated from ethanol as well. The institutional review board human subjects research committee for each hospital system approved this study.

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There were 6 study hospitals included in this analysis: hospital 1 is a county Level 1 trauma center, hospital 2 is an urban university medical center, hospital 3 is an urban university-affiliated medical center that receives significant referral for psychiatric care and chemical dependency, hospitals 4 and 5 are suburban community hospitals, and hospital 6 is an affiliated rural community hospital.

In all institutions, there are no required diagnostic workups, other than a complete set of vital signs, point of care glucose testing, and breath or blood ethanol concentration testing (which generally occurs immediately upon patient arrival). The rest of the workup is at the discretion of the treating physician. Discharge for these encounters occurs after patients achieve "clinical sobriety", and repeat ethanol concentration testing does not routinely occur (i.e. to be below the "legal limit").

2.2. Study protocol

To identify the study cohort, we queried the electronic medical record (EMR, Epic®, Verona, WI) for all patients greater than or equal to 18 years of age who presented to the ED for acute ethanol intoxication. The EMR search terms used to identify appropriate encounters had to vary slightly for each hospital system because there are institutional differences in the standard chief complaints utilized in the ED for ethanol intoxication encounters. In hospital 1, all ethanol intoxication encounters are placed in specific rooms within the ED. The purpose of these rooms is to focus resources and account for large volumes of such visits in that particular hospital. In hospital 1, all of these ethanol intoxication encounters are entered into the EMR using the chief complaint "Altered Mental Status". As such, the search query for hospital 1 was for a chief complaint of "Altered Mental Status" in one of these rooms (there are 16 rooms total). Hospitals 2 through 6 are all part of the same hospital system, and the institutional standards in these facilities is to enter ethanol intoxication encounters under the chief complaint of "Alcohol Intoxication" or "Alcohol Problem".

Patients were excluded if their ethanol concentration (breath or blood) was <80 mg/dL (to help ensure that the study encounters were in fact patients impaired from ethanol intoxication), or if it was missing. We also excluded repeat encounters (if a patient had more than one encounter during the study period) to maintain assumptions of independence for data analysis. The retained encounter was the first visit the patient had during the study period. Finally, we excluded encounters in which the patient was admitted to the hospital. The purpose of this exclusion criterion was to ensure that the only encounters being included were encounters *for* ethanol intoxication, as an admission to the hospital implies another concomitant active medical process ongoing other than just the intoxication.

This study was performed using standardized methods for chart review research [10]. All variables required for analyses were obtained directly from the EMR using structured query language (SQL) electronic abstraction, without any human abstraction. This was performed by a trained data analyst at each hospital system, who was blinded to the purpose of the study. The variables collected in this manner included age, gender, date of arrival, time of arrival, medical and psychiatric comorbidities, mode of arrival, ethanol concentration, parenteral sedation administered (haloperidol, olanzapine, droperidol, ketamine, or benzodiazepines), number of previous ethanol intoxication ED visits in the past 30 days, testing obtained during the encounter (laboratory or computed tomography [CT]), ED disposition, ED daily census, and ED LOS.

The primary outcome for this study was ED LOS in minutes. This was defined in the EMR as the elapsed interval between time of arrival and the time a discharge order was placed.

2.3. Data analysis

Baseline patient and encounter characteristics were analyzed descriptively including medians, interquartile ranges, and proportions where appropriate.

To investigate whether there were factors independently associated with ED LOS, we created a mixed-effects generalized linear model (GLM). The independent variables for the model were chosen based on their clinical plausibility rather than preliminary univariate analysis. The variables chosen for the model included age, gender, breath or blood ethanol concentration (BAC), whether a CT was obtained (yes/no), whether laboratory testing was obtained (yes/no), chemical sedation administered (yes/no), whether the patient was considered a "frequent user" (defined as >4 visits for ethanol intoxication in the previous 30 days), and whether the patient had a psychiatric disposition (admission to inpatient psychiatry or sent to acute psychiatric emergency services). A variable for ED volume was added to the model, which was included as a proportion equaling the ED daily census on the day of the patient's encounter divided by the maximum ED census identified during the study period.

We also included a variable for hour of arrival to the ED; the decision to include this variable was based on the investigator's clinical observation that vulnerable populations, such as intoxicated individuals, are sometimes kept in the ED until morning if they do not have a safe disposition (e.g. homeless shelters do not allow for late arrivals) or a safe way to get home (e.g. public transportation stops at night). The hour of arrival variable was imputed as an ordinal factor variable, with the index value as the hour of arrival with the shortest median LOS. Finally, a variable for the study hospital was included as a random effect term, to account for the non-independence of these clusters.

We considered three different structures for the GLM a priori; (1) a Gaussian distribution with log-transformed LOS as the outcome, (2) a Gaussian distribution with LOS as the outcome, and (3) a Gamma distribution with a logarithmic link function with LOS as the outcome. We elected not to use log-transformed LOS as the results of this model would yield exponentiated coefficients for multiplicative geometric means, which has limited utility in its practical interpretation. Therefore, we computed both of the latter two models (with identical independent/dependent variable structure), and the model presented in the results was selected after assessing model fit by comparison of each Akaike information criteria (AIC) and by comparing the deviance residuals. The confidence intervals presented for each coefficient were calculated with robust variance estimation. We did not perform any formal testing for collinearity, though CT and laboratory testing obtained were included as an interaction term.

A sensitivity analysis was performed to explore the relationship between hour of arrival and ED LOS. We hypothesized that hour of arrival would be independently associated with LOS for intoxicated individuals, and we felt that this relationship would be unique to intoxication encounters or other presentations that render a patient vulnerable for discharge during late night and early morning hours. As such, we analyzed LOS as it varied by hour of arrival for non-intoxicated patients presenting with a chief complaint of "abdominal pain", using a subgroup of data available from a previous study [11]. This analysis included data visualization, as well as a GLM with the outcome of LOS in minutes, and hour of arrival as the independent variable.

We did not perform any a priori sample size calculations. Interobserver agreement was not calculated as there was no human abstraction, but a random sample of 40 charts was reviewed to confirm the accuracy of the electronic abstraction (accuracy was 100%). Missing data were uncommon (missing for ethnicity in 3.8% of encounters, otherwise <1% for all other variables) and were therefore left as such without any imputation. All statistical analyses were conducted in Stata (Version 14.2, Stata Corporation, College Station, TX).

3. Results

The initial search query identified 45,153 encounters. There were 1007 encounters excluded for a breath or blood ethanol concentration of <80 mg/dL, and 315 encounter were excluded for a missing ethanol concentration (indicating consistent use of ethanol concentration testing at all institutions). Repeat encounters for ethanol intoxication

were common, resulting in the exclusion of 21,765 encounters (the retained observation was the initial visit). Finally, there were 3402 encounters excluded due to being admitted to the hospital. This left a final cohort of 18,664 unique patients for inclusion.

In the study cohort, the median age was 37, and 12,858 (69%) of patients were male. Median breath ethanol level was 213 mg/dL. Additional demographic and clinical data for the cohort are described in Table 1. The variables utilized for the GLM are described in Table 2, including stratification by each hospital for exploratory purposes. Table 2 highlights several demographic and practice pattern differences among the study hospitals, specifically among rates of CT and laboratory testing utilization. Table 2 does not include hour of arrival, which is instead depicted in Fig. 1. Fig. 2 describes ED LOS for the overall cohort, and ED LOS as it varies by hour of arrival is depicted in Fig. 3.

The GLM with the best model fit was that which utilized the Gamma distribution. The results of the GLM are shown in Table 3, which includes the exponentiated coefficients. These coefficients allow for interpretation of the arithmetic mean ratios on the original scale of minutes. Several variables were found to be associated with an increased LOS but the largest effect size was noted for the hour of arrival to the ED; specifically, LOS increased by as much as 86% if a patient arrived during the 19:00 h. Other variables that had a significant association with LOS included administration of parenteral sedation (coefficient = 0.30), and laboratory testing obtained (coefficient = 0.21).

The sensitivity analysis confirmed that this same relationship between hour of arrival and LOS did not exist for those patients who were not intoxicated presenting with abdominal pain. Supplemental Fig. 1 depicts LOS as it varies by time of arrival. The GLM performed on this sample demonstrated that the coefficients for each hour of arrival were all equal to 0 and therefore non-significant.

4. Discussion

In our multi-center cohort comprising 6 institutions, we identified several independent predictors of LOS among patients presenting to the ED for ethanol intoxication. Coinciding with existing literature on LOS in other ED patient populations [5,8], we identified that treatments (i.e. chemical sedation) and diagnostic testing (i.e. laboratory testing) increased LOS in this population. Interestingly, the use of head CT was not associated with an increase in ED LOS. The leads us to believe that some clinicians may use CT to rule out traumatic intracranial pathology in intoxicated individuals, rather than a period of observation. We are, however, unable to determine from these data if this decrease in LOS was confounded by the fact that those received a head CT happened to have a safe disposition more often compared to patients that did not receive a CT.

Table 1
Demographic and clinical data.

Variable	Value
Age	37 (27–50)
Gender (male)	12,858 (69%)
Ethnicity	
White	9823 (53%)
Black/African American	3965 (21%)
Native American	3092 (17%)
Hispanic/Latino	1159 (6%)
Asian	96 (0.5%)
Native Hawaiian/Pacific Islander	24 (0.1%)
Other/declined	505 (3%)
Mode of arrival	
EMS	13,634 (73%)
Police	3915 (21%)
Private vehicle	1115 (6%)
Comorbidities	
Liver disease	2430 (13%)
History of TBI	2126 (11%)
Bipolar disorder	1886 (10%)
Ischemic vascular disease	646 (3%)
Schizophrenia	497 (3%)
Dementia	229 (2%)
Survived to hospital discharge	18,664 (100%)

All data presented as median (IQR) or N (%).

Another finding in our study that is somewhat discrepant from previous reports was that the overall ED volume did not appear to be associated with LOS for ethanol intoxication encounters [4,12,13]. We did however utilize the daily census as our crowding metric, which we recognize is not the best measure to investigate this relationship [14]. It is possible however that for patient presentations in which the vast majority are discharged, ED volume and capacity may be a less powerful predictor of LOS.

We also explored potential variables influencing LOS that were relatively unique to ethanol intoxication encounters. First, we found that ethanol concentration had essentially no impact on LOS. This finding was not particularly unexpected given differences in ethanol tolerance, and that clinical symptoms of intoxication do not reliably correlate with ethanol concentration [15]. If providers are using the discharge criteria of "clinical sobriety" rather than serial ethanol concentration testing until below a certain cutoff, patients with higher tolerances to ethanol may be discharged sooner, despite having a high initial BAC; therefore, we believe that generalizing a relationship between ethanol concentration and LOS is not plausible and BAC values have to be considered on an individual patient basis.

Next, we explored variables related to the fact that patients who present to the ED for ethanol intoxication may be homeless, or otherwise vulnerable [16]. These variables were particularly important because these were the variables with the greatest potential to compel change within the community. Because providers may consider late night or early morning discharge unsafe, we hypothesized that time of ED arrival for intoxicated patients would correlate with LOS, such that patients arriving during evening hours would have a longer LOS. As predicted, patients that arrived to the ED during the evening hours (after 18:00), experienced up to an 86% LOS increase, presumably lengthening their ED encounter until morning. Interestingly, this association was not reproduced in our sensitivity analysis looking at patients with a chief complaint of "abdominal pain". We propose that these findings suggest that the relationship between time of arrival and LOS is at least partially due to safety concerns of the emergency physicians. Although this cannot be definitively proven, there is an intuitive basis for this notion, as these are the times at night in which public transportation ceases, homeless shelters do not allow late arrivals, and detoxification/sobering centers are often at capacity. It is still possible that other factors that may be confounding the association between arrival time and LOS, such as the volume of intoxication encounters (volume of intoxication encounters also increased starting around 6 pm, see Fig. 1), or that throughput may be slower at night (though to our knowledge there is no strong data to support this) [17,18].

If physician discomfort with vulnerable late night discharges in part explains the finding that LOS varies by time of arrival for ethanol intoxication encounters, there may be solutions to mitigate these concerns and impart change within the community. Specifically, if there were safe dispositions available for intoxicated patients who have been observed for an otherwise appropriate amount of time, discharging from the ED would be more plausible, even at late hours if those resources were accessible. For example, if detoxification centers consistently had available beds, or if there were sober transportation services or nighttime public transportation to get patients home or to local shelters, this could alleviate some of the barriers to safe discharge. Coordination and consultation with the community to implement such programs could help lessen the ED burden, while still providing quality care to this patient population.

ED observation units are becoming an increasingly popular entity [19-21], and many EDs have or will continue to develop observation protocols for acute intoxication accordingly. The Medicare Claims Processing Manual states that in order to bill for observation services, the encounter must span a minimum of 8 h (or cross midnight) [22]. Our

Table 2
Model variables and outcome data, overall cohort and stratified by hospital.

	Overall	1	2	3	4	5	6
Patients in cohort	18,664	10,234	981	3209	2815	1031	394
Model variables							
Age	37 (27–50)	35 (26–49)	24 (19–45)	41 (29–52)	41 (30–52)	37 (28–49)	38 (28–52)
Gender (% male)	12,858 (69%)	7300 (71%)	646 (66%)	2223 (69%)	1845 (65%)	618 (60%)	226 (57%)
BAC (mg/dL)	213 (156–273)	205 (156–257)	211 (150–278)	235 (167–295)	216 (150–277)	220 (150–290)	210 (150–280)
Psych disposition[a]	1280 (7%)	1002 (10%)	45 (5%)	160 (5%)	37 (1%)	24 (2%)	12 (2%)
Frequent user	1604 (8%)	872 (9%)	88 (9%)	353 (11%)	225 (8%)	52 (5%)	6 (2%)
Parenteral sedation[b]	4219 (22%)	3122 (30%)	98 (10%)	289 (9%)	394 (14%)	226 (22%)	90 (23%)
CT obtained[c]	1534 (8%)	709 (7%)	58 (6%)	121 (4%)	324 (11%)	224 (21%)	98 (24%)
Labs obtained[d]	4529 (24%)	719 (7%)	344 (35%)	986 (31%)	1415(50%)	777 (75%)	288 (73%)
Outcome variable							
ED length of stay (min)	348 (228–512)	393 (270–553)	300 (192–434)	346 (204–495)	317 (196–499)	250 (175–363)	245 (156–369)

All continuous variables presented as median (IQR), categorical variables presented as N (%).
[a] Psychiatric disposition could include admission to inpatient psychiatry unit or immediate subsequent evaluation in an emergency psychiatry setting.
[b] Parenteral sedation was given for acute psychomotor agitation and included: olanzapine (n = 3920), haloperidol (1720), droperidol (1187), benzodiazepines (498), and ketamine (26) – medication counts are higher than 4219 as some patients received more than one dose.
[c] CT includes imaging of any body cavity.
[d] Labs queried for included basic metabolic panel, liver function testing, complete blood count.

findings may provide useful information for those developing observation protocols by predicting appropriateness for observation status based on knowledge of those who may have a longer LOS. For example, those patients who received chemical sedation (LOS in this cohort increased by 34%) are quite likely to achieve this minimum required observation interval; while in contrast, breath ethanol level on arrival may be a less helpful predictor of appropriateness.

An important limitation of this study is its potential for selection bias as with any retrospective study design. It is possible with our search methods that certain ethanol intoxication encounters were missed, since for hospital 1 we only searched rooms dedicated to ethanol intoxication encounters (though this constitutes the vast majority of intoxication encounters in that hospital), and for the other hospitals it is possible that ethanol intoxication encounters were missed if the patients had been entered using other chief complaints. We do however believe that our search methodology was able to capture the majority of visits of interest within each hospital. It is also possible that bias was introduced by excluding encounters with missing ethanol levels, though this was a relatively small number of encounters. We also recognize that there may be other important predictor variables (such as homelessness) that were unable to be collected due to lack of systematic recording in the EMR.

Another potential limitation to this study is the possibility that some of encounters included were not encounters simply *for* ethanol intoxication, which was the goal of this investigation. We aimed to avoid this with our selection of search terminology (by using "Alcohol Intoxication" or "Altered Mental Status" as a chief complaint, rather than searching for medical/traumatic chief complaints plus an elevated ethanol concentration), as well as by excluding admitted encounters (where there were presumably more complicated issues present other than just ethanol intoxication). Despite this, it is possible that some encounters with concomitant minor trauma or simple medical issues were included. We do however believe that these are important encounters to include, as this reflects a more realistic spectrum of ethanol intoxication encounters seen in clinical practice.

Our decision to analyze length of stay with a GLM was based on previous work, but it is possible that other methodology could more appropriately model length of stay. We do however believe that our model fit

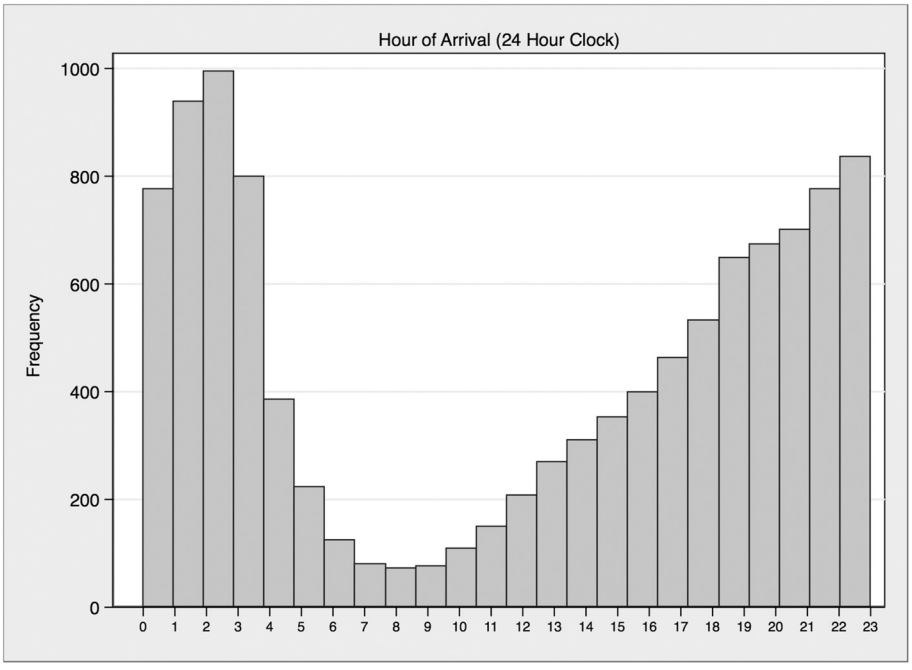

Fig. 1. Hour of arrival to the emergency department for ethanol intoxication encounters.

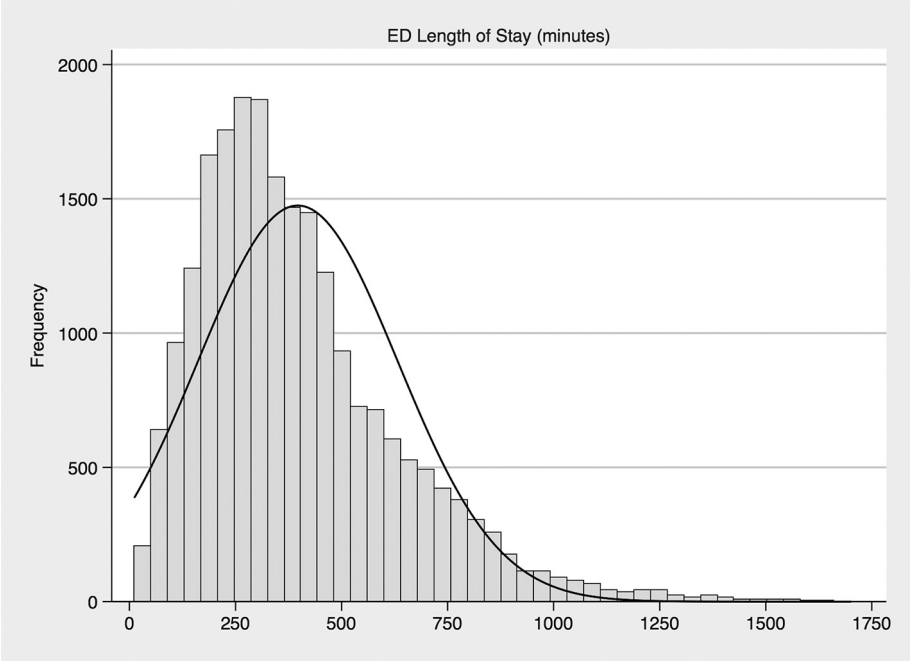

Fig. 2. Emergency department length of stay (in minutes).

assessments indicated good fit. Furthermore, the intent of this data was not necessarily to provide precise estimates of the number of minutes that LOS would increase for each variable, but rather identify important trends that could help inform emergency management. We also recognize that ED daily census is not considered the optimal way to model daily volume, but, again, the purpose of using this variable was to explore overall trends in this relationship.

5. Conclusions

In summary, we investigated factors associated with ED LOS for patients with acute ethanol intoxication in a large, multi-center, retrospective study. Our results indicate that increased LOS was associated with laboratory testing, administering chemical sedation, and patient arrivals to the ED during evening hours, most notably after 18:00. A better understanding of encounters for ethanol intoxication may help modify LOS and optimize care for this patient population.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ajem.2017.12.017.

Conflicts of interest

None.

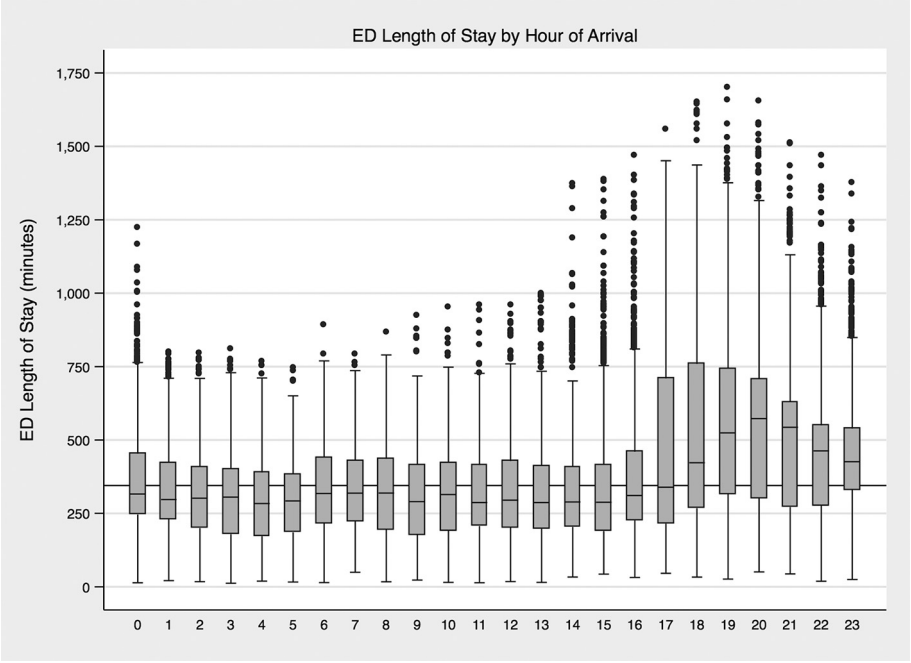

Fig. 3. Emergency department length of stay by hour of arrival for ethanol intoxication encounters.

Table 3
Results of the mixed-effects generalized linear model.

Model variables	Model outcome = LOS in minutes			
	Coefficient	95% CI	Exp (B)	% Increase LOS
Age	0.002	0–0.003	1.00	–
Gender (male)	0.01	0–0.03	1.01	1%
BAC (mg/dL)	0.001	0–0	1.00	–
Psychiatric disposition	0.005	−0.02 to 0.03	1.01	1%
Frequent user	0.06	0–0.10	1.06	6%
Parenteral sedation	0.30	0.29–0.32	1.34	34%
CT obtained	0.02	−0.01 to 0.04	1.02	2%
Labs obtained	0.21	0.18–0.23	1.23	23%
ED volume	0.001	−0.01 to 0.01	1.0	–
Hour of arrival				
0	0.14	−0.06 to 0.21	1.15	15%
1	0.10	−0.12 to 0.32	1.10	10%
2	0.05	−0.17 to 0.28	1.05	5%
3	0.05	−0.12 to 0.21	1.05	5%
4	0.01	−0.07 to 0.09	1.01	1%
5	0.01	−0.06 to 0.07	1.01	1%
6	0.09	−0.03 to 0.17	1.09	9%
7	0.10	−0.1 to 0.22	1.10	10%
8	0.08	−0.02 to 0.12	1.08	8%
9 [index]				
10	0.05	−0.05 to 0.12	1.05	5%
11	0.05	−0.04 to 0.12	1.05	5%
12	0.07	−0.02 to 0.11	1.07	7%
13	0.05	−0.04 to 0.10	1.05	5%
14	0.09	−0.03 to 0.14	1.09	9%
15	0.11	0.08–0.20	1.12	12%
16	0.26	0.18–0.34	1.29	29%
17	0.37	0.30–0.44	1.45	45%
18	0.52	0.45–0.60	1.68	68%
19	0.62	0.55–0.69	1.86	86%
20	0.58	0.51–0.65	1.79	79%
21	0.51	0.44–0.58	1.67	67%
22	0.40	0.34–0.47	1.49	49%
23	0.39	0.31–0.46	1.48	48%

Exp (B) is the exponentiated beta coefficient.

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None.

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