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Delirium Risk Prediction, Health Care Utilization and Mortality of Elderly Emergency Department Patients

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Abstract

Background/Objectives—Delirium is common and under-diagnosed in elderly Emergency Department (ED) patients. The primary aim of this study is to create a risk prediction rule for ED delirium. The secondary aim is to compare the mortality rates and resource utilization of delirious versus non-delirious elderly ED patients.

Design—Prospective observational study.

Setting—An urban tertiary care emergency department.

Participants—700 patients 65 years of age or older and presenting for ED care.

Measurements—A trained research assistant performed a structured mental status assessment and attention tests, after which delirium was determined using the Confusion Assessment Method. We collected data on patient demographics, comorbidities, medications and ED course, hospital and Intensive Care Unit (ICU) admission, length of stay, hospital charges, and 30-day re-hospitalization and mortality.

Results—Nine percent of elderly study participants were delirious. Using logistic regression, we created a delirium prediction rule consisting of older age, prior stroke or transient ischemic attack, dementia, suspected infection and acute intracranial hemorrhage with good predictive accuracy (AUC=0.77). Among admitted patients, those with ED delirium had longer median lengths of stay (4 versus 2 days), and were more likely to require ICU admission (13% versus 6%) and to be discharged to a new long-term care facility (37% versus 9%). Among all patients, ED delirium was associated with higher 30-day mortality (6% vs. 1%) and 30-day readmissions (27% vs. 13%).

Conclusion—Our risk prediction rule may help identify a group of high risk ED patients that should undergo screening for delirium, but requires external validation. Identification of delirium in the ED may enable physicians to implement strategies to decrease delirium duration and avoid inappropriate discharge of acutely delirious patients, thereby improving patient outcomes.

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Keywords

Delirium; Emergency Medicine; Geriatrics

INTRODUCTION

Delirium, an acute confusional state characterized by an alteration in cognition and attention, is common among older patients, associated with increased morbidity and mortality¹⁻³, and annually accounts for between \$38 billion and \$152 billion dollars in health-related costs in the United States⁴. Previous studies have demonstrated that approximately 7 to 10% of elderly Emergency Department (ED) patients have delirium, yet ED physicians diagnosed delirium in only one out of six of delirious ED patients⁵⁻¹². The lack of ED physician recognition of delirium may result in delay to diagnosis and implementation of delirium modifying interventions, or the inappropriate discharge of an acutely delirious patient from the ED. Delirium may interfere with a patient's ability to understand the discharge planning and compliance with medications; furthermore unrecognized ED delirium may result in higher mortality rates^{7, 8, 13}.

Given the seriousness of unrecognized delirium, the Society for Academic Emergency Medicine's Geriatric Task Force has selected cognitive assessment of older patients to be one of three quality measures by which care given to older patients in the ED may be measured¹⁴. As standard screening tests for delirium take a minimum of 15 minutes, it would not be feasible to formally screen all elderly ED patients for delirium². Accordingly, a more judicious approach may be to identify a subset of elderly ED patients at greatest risk for being delirious. There are many studies in the inpatient setting that describe risk factors for the development of delirium after hospital admission or surgery; however, many of these studies exclude patients who are acutely delirious in the ED¹⁵⁻²⁶. While there has been ED based research into risk prediction of ED delirium²⁷, this study included activities of daily living (ADLs) which are not routinely obtained by practicing ED physicians. The primary aim of this study is to identify patient risk factors associated with and develop a risk prediction rule for ED delirium using data obtained by a physician during a patient's ED course. The secondary aim is to report the mortality rates and resource utilization of delirious elderly ED patients in comparison to non-delirious elderly ED patients.

METHODS

Study Design, Setting and Selection of Participants

We conducted a prospective, observational cohort study of a convenience sample of patients aged 65 or older presenting to the ED between September 2009 and April 2011 at a single tertiary care university hospital with approximately 55,000 annual ED visits. The study was approved by our Institutional Review Board. Subjects were eligible for study inclusion if they met the following criteria: age 65 or older; informed consent obtained from patient or surrogate; and ability to complete a structured delirium assessment tool in English. Subjects were excluded if, per the treating physician, study participation would adversely interfere with timely medical care; if they had been in the ED greater than 4 hours prior to enrollment; or, if they were non-English speaking. A single trained research assistant was available to enroll subjects 3 days a week, 8 hours per day. Enrollment typically occurred on weekdays and during the hours of noon to 8 pm. During enrollment shifts, consecutive patients over the age of 65 were evaluated for eligibility and approached for study participation. Research assistant training consisted of the review of a written manual detailing the administration and scoring of the cognitive and delirium assessments, review of previously videotaped interviews with sample patients, and conduct of supervised interviews

with delirious and non-delirious patients in the ED. For the videotaped and supervised patient interviews the research assistant completed and scored the cognitive tests detailed below and determined whether the patient had delirium using the Confusion Assessment Method (CAM)²; his responses were reviewed by clinicians and researchers with prior experience in the evaluation of delirious patients.

Delirium Measurement

Delirium, our primary outcome, was assessed using the CAM², in conjunction with a structured cognitive assessment. After obtaining informed consent, a trained research assistant performed a structured mental status examination which has been described in detail previously²⁸. Briefly, the Mini-Mental State Examination (MMSE), Delirium Symptom Interview, and the Memorial Delirium Assessment Scale were completed. Attention was assessed via digit span and reciting the days-of-the-week and months-of-the-year backwards. A minimum interview consisting of the MMSE and attention tests had to be completed for a subject to be included in the study. Following this structured assessment, the research assistant determined whether the patient had delirium using the CAM diagnostic algorithm. The CAM is the most commonly used validated tool for diagnosing delirium, has excellent sensitivity (94–100%) and specificity (90–95%)²⁹ and has been specifically evaluated in the ED setting¹⁰; accordingly, it was used as our gold standard. A subject was determined to have probable delirium if they had 1) an acute change in mental status or fluctuating course and 2) inattention, and either 3) disorganized thinking or 4) altered level of consciousness. The use of either an acute change in mental status or a fluctuating course for item 1 is currently recommended in the CAM training manual³⁰ and has been utilized previously in the ED setting⁹ where length of stay is often not long enough to observe fluctuations in a patient's mental status.

Other Measures

We collected data on patient demographics, comorbid illnesses, home medications, presenting illness, severity of illness and initial laboratory results. With respect to the presenting illness, we obtained initial vital signs and the medical diagnosis from the physician's chart. Clinically suspected infection was defined as physician chart diagnosis of infection and antibiotics administered in the ED. Severity of illness was determined by calculating the Acute Physiological and Chronic Health Evaluation II (APACHE II) score for each patient. Patients were followed through their ED and hospital stays, and by telephone at 30 days.

To evaluate differential resource utilization among delirious and non-delirious ED patients, data was collected on hospital and Intensive Care Unit (ICU) admissions, length of hospitalization, hospital charges, discharge to a new long term care or rehabilitation facility, and 30-day mortality. ED observations were not considered hospital admissions unless a patient was subsequently admitted to a hospital ward after ED observation. To be defined as discharged to a new long term care facility or rehabilitation center, subjects could not reside in such a facility at the time of their ED visit. We also recorded 30-day re-hospitalization rates; patients who were initially admitted from the ED, and discharged and re-hospitalized within a 30 day time period were included in this outcome, as were patients who were discharged from the ED but subsequently hospitalized within the following 30 days. Thirty-day re-hospitalization, 30-day mortality, and discharge to a new long term care facility or rehabilitation center were determined through a combination of follow up telephone calls to subjects and/or their caregivers and reviewing subjects' online medical records at our hospital.

Data Analysis

Because our primary aim was the development of a risk prediction rule for ED delirium, we based our target sample size on the number needed to create a robust risk prediction model based on the rule that 10 outcomes are required to support each independent risk factor. A sample size of 700 and an expected rate of delirium of 10% would result in 70 delirious subjects, allowing the inclusion of 7 variables in our delirium risk model.

The patient population was characterized using descriptive statistics. Proportions were reported for nominal data and compared using Fishers Exact Tests. Means with standard deviations (SD) and medians with 25–75% interquartile ranges (IQR) were reported for continuous data; normally distributed data were compared using a t-test whereas the Wilcoxon rank test was used to compare non-normal variables.

To create the optimal independent risk profile, we performed a univariate analysis and considered variables with a p value ≤ 0.1 for inclusion in a multivariable logistic regression model with the presence of ED delirium as the outcome. Continuous variables, including respiratory rate, laboratory values, and APACHE II score, were dichotomized before entering into the multivariable model. Forward selection was used to create a final model of significant risk factors with a p-value ≤ 0.05 . In sensitivity analyses, we repeated model building using stepwise and backward selection, and obtained similar results (not shown). To avoid model overfitting we allowed 1 covariate per 10 outcomes (delirious patients). Odds ratios (ORs) with 95% confidence intervals (95% CI) were calculated for variables in the final model. Model accuracy was assessed by the c-statistic with 95% confidence intervals (95% CI) and Hosmer-Lemeshow tests. The beta coefficient for each covariate was used to assigned integer point values to each covariate in the final model to calculate a delirium risk score, which was also evaluated with a c-statistic and Hosmer-Lemeshow tests. We used bootstrap resampling to internally validate the scoring system, and report the mean C-statistic with 95% CI for 1000 bootstrap samples. A risk prediction rule was created to identify subjects at low, moderate and high risk of ED delirium based on their total risk score. We calculated the total number and proportion of subjects in each risk group, and the proportion of subjects in each risk group who were delirious.

For our secondary aim, hospitalization, ICU admissions, discharge to a new long-term care facility, 30-day mortality and 30-day re-hospitalization were reported as proportions for subjects with and without delirium and compared using Fishers Exact Tests. Median hospital charges and length of stay in those admitted to the hospital with and without ED delirium were reported and compared using the Wilcoxon rank test. Hospital charges and length of stay were log-transformed to achieve normality and controlled for APACHE II score, dementia and nursing home residence.

RESULTS

Study Population

From September 2009 to April 2011, 2140 subjects were screened for study participation of which 1146 met inclusion and exclusion criteria and were approached to participate in the study (Figure 1). The most common reasons for exclusion were non-English speaking, patient inability to provide informed consent and non-availability of surrogate for informed consent, or exclusion by the ED physician due to high acuity of illness (Figure 1). Of the 1110 patients who were eligible for enrollment, 446 (39% of eligible patients) were further excluded after the patient or his/her surrogate declined to consent to study participation, resulting in 700 subjects who consented to study participation and were enrolled. Compared to subjects who were enrolled in the study, patients who were excluded were older (mean age 82 years old (SD ± 9); $p < 0.001$), more likely to be female (59% of excluded subjects;

$p=0.004$), and more likely to be African American (17% of excluded subjects; $p=0.002$), Asian (7% excluded subjects; $p<0.001$) or Latino (11% of excluded subjects vs. 1% of included subjects; $p<0.001$).

Of the enrolled subjects, five subjects were withdrawn after enrollment due to incomplete cognitive testing: four withdrew consent either before or during cognitive testing and one subject had a seizure before completing cognitive testing. Of the remaining 695 subjects who completed the minimum cognitive assessment, 63 (9%) were delirious, 613 subjects (88%) were not delirious, and 19 subjects (3%) were unable to be classified (Figure 1). The unclassified group demonstrated inattention and disorganized thinking or altered level of consciousness, but had no fluctuation in their cognitive status or level of consciousness during our interview, nor collateral to help establish an acute onset or fluctuating course. Data on subject demographics, comorbidities, illness severity, vital signs, ED diagnoses and laboratory results are presented in Table 1.

Emergency Department Risk Factors for Delirium and Delirium Risk Prediction Rule

Univariate analysis results are presented in Table 1. Predisposing risk factors for ED delirium that were included in the multivariable analysis included older age, non-independent living situation, history of anxiety, depression, dementia, prior stroke or transient ischemia attack, higher Charlson Comorbidity Index score, and taking an antipsychotic medication at home. Precipitating risk factors for delirium that were included in the multivariable analysis included: APACHE II score, tachypnea, acute intracranial hemorrhage (ICH), hip fracture, suspected infection, lower hemoglobin level and lower chloride. In a univariate analysis of dichotomized laboratory values, serum bicarbonate level greater than 30 and serum glucose greater than 300 were also significantly associated with delirium (p -value 0.01 and 0.02, respectively).

As we only had 63 delirious subjects, we limited our model to six covariates. For our final model, we included the three strongest covariates and excluded the APACHE II score as it is too cumbersome for routine clinical use, then sequentially evaluated different models, selecting a final model which minimized the Akaike information criterion and maximized the c-statistic. Our final model consists of: age; history of dementia; history of transient ischemic attack (TIA) or ischemic stroke; tachypnea; suspected infection; and acute ICH (Table 2). This model had a c-statistic of 0.79 (95% CI 0.73 to 0.84) and p -value for the HosmerLemeshow goodness of fit of 0.3. The following covariates were significant on multivariable analysis, however were not included when we restricted the model to 6 covariates: history of anxiety, elevated serum bicarbonate, elevated serum glucose and APACHE II score greater than 15. Models which included the APACHE II score had only minimally better model statistics than our model, supporting our decision to exclude it from the final model. In sensitivity analyses where unclassified subjects were reassigned as either all delirious or all non-delirious, odds ratios and model statistics were minimally affected.

To create a risk prediction rule, points were assigned proportionately to each covariate of the multivariable model of ED delirium (Table 2) and summated to create a delirium risk score. The C-statistic for our delirium risk score was 0.77 (95% CI=0.71 – 0.83) and the Hosmer-Lemeshow p -value was 0.3. In a bootstrap analysis performed to internally validate our results, our delirium risk score retained its robustness (mean c-statistic 0.77; 95% CI=0.77–0.78). In our risk prediction rule, scores of 2 points, 3 or 4 points and 5 points were used to identify subjects at low, moderate and high risk groups for delirium, respectively (Figure 2).

Outcomes and Healthcare Utilization of Patients with and without ED delirium

Delirious patients were much more likely to be admitted to the hospital than non-delirious subjects and of the patients admitted to the hospital, those with ED delirium had longer lengths of stay, were more likely to require ICU admission, were four times more likely to be discharged to a new long-term care facility, and had significantly greater hospital charges than subjects without ED delirium (Table 3). Thirty day follow up data was completed for 94% of all subjects. Patients with ED delirium were twice as likely to be re-hospitalized within 30 days and had greater 30 day mortality than subjects without ED delirium (Table 3). After log-transforming the outcomes of hospital charges and length of stay, admitted patients with ED delirium 27% higher hospital charges and had 44% longer lengths of stay than those without ED delirium, controlling for age, APACHE II score, dementia and nursing home residence ($p=0.01$ and $p=0.001$, respectively). The relationship between greater hospital charges and ED delirium dissipated when adjusted for length of stay, suggesting the higher charges were primarily due to increased length of stay.

DISCUSSION

In our study of 695 elderly ED patients, 9% were found to be delirious, consistent with other ED-based studies of delirium^{5, 7-12}. Our multivariable prediction rule for ED delirium demonstrated good discrimination and calibration for identifying elderly ED patients at increased risk of being delirious and our risk prediction rule successfully identified those at low, moderate and high risk of delirium. Our risk prediction rule, if externally validated, could help identify a subset of patients at such high risk for delirium that a formal assessment for delirium should be undertaken prior to ED disposition, as well as a low risk group of patients where delirium assessment may not be needed. The appropriate approach to the moderate risk group is not as obvious; perhaps this group would most benefit from the implementation of a shortened delirium screening tool that helps identify which patients should undergo a full delirium assessment, several of which are currently being researched in the clinical setting^{31, 32}. The strengths of our rule include its simplicity and application in the ED setting to identify patients at risk for delirium. Additionally, we demonstrated that patients with established delirium had increased adverse health outcomes and increased utilization. This rule could be applied by any care provider in the ED, or could even be automated in certain electronic medical record environments after an initial physician evaluation and before the patient's disposition is determined. A limitation of this rule is that two elements of the rule (suspected infection and ICH) rely on adequate physician suspicion and laboratory or radiologic testing. While an ideal delirium risk prediction rule would require no medical testing, in our study the best models consisted of a combination of predisposing and precipitating risk factors for delirium. Points should only be assigned for ICH or suspected infection if the ED physician has a suspicion for, performs a workup of and treats a patient for infection or ICH, as was done in our study. The model was examined with and without inclusion of ICH but performs better when ICH is included.

Another ED-based study assessed for risk factors of prevalent delirium using the CAM-ICU, which awaits validation in the ED setting. They found that older age, dementia, Systemic Inflammatory Response Syndrome (SIRS) criteria and suspected infection were also predictive of delirium; however their final multivariable model included only dementia, ADLs and hearing impairment as independent predictors²⁷. We did not test ADLs or hearing impairment in our study, as they are not routinely assessed or consistently recorded in our ED, so we are unable to validate their rule or make a direct comparison. The individual elements of our risk profile have been associated with delirium in prior studies of hospitalized elderly patients, including dementia^{18, 20, 24, 25}, older age^{22, 25, 26}, and infection^{18, 25}. Prior studies of hospitalized patients have demonstrated an association between both acute ischemic and hemorrhagic stroke and delirium^{33, 34} whereas in our study

a prior history of ischemic stroke or TIA and acute ICH were associated with ED delirium, but acute ischemic stroke or TIA was not. Our lack of a statistically significant relationship between acute stroke and delirium in our study may be reflective of the small number of subjects enrolled with acute stroke, due to physician exclusion of stroke patients to prevent delays in obtaining critical imaging studies or administering tissue plasminogen activator (tPA), or reflect a physiologic delay between the onset of stroke and post-stroke delirium. While higher severity of illness was associated with delirium in our study and studies of admitted patients^{18, 20, 24}, in another ED-based study triage severity score, a less robust measure of illness severity than APACHE II, was not associated with delirium²⁷.

In the secondary aim of our study, we found delirium is associated with increased length of hospitalization, however, our length of stays were shorter in both delirious and non-delirious patients than in other studies^{18, 25, 35–37}. The reason for the shorter length of stay in our study may reflect variation in study populations such as acuity, or temporal trends toward decreasing length of hospitalizations. Additionally, while our assessment for delirium occurred in the ED, in studies of admitted patients the initial delirium assessment was typically conducted within the first 48 hours of admission, which may have resulted in a selection bias against patients with shorter lengths of stay. Admitted patients with ED delirium were four times more likely to be admitted to a rehabilitation or nursing home in our study, consistent with prior studies^{18, 36, 37}. Though other ED-based studies also report an association between delirium and higher mortality^{8, 9, 38}, our mortality rates were lower than these studies, likely reflecting the shorter duration of follow-up and possibly differences in acuity.

It is worth noting that in our study 19 patients (3%) were not able to be classified as being either delirious or non-delirious by the CAM algorithm. This highlights the challenge of diagnosing delirium in the busy ED setting when there is limited collateral information available on a patient's baseline cognitive function. Our primary analysis excluded these patients, but we performed a sensitivity analysis and our risk profile was robust to any potential misclassification of these patients.

Limitations of our study include that it was performed at a single study site, which is a tertiary referral center, hence the findings may not be generalizable to other ED facilities. For instance, as our hospital is a level one trauma center, we see a larger number of patients with ICH, therefore this element of the risk prediction rule may not perform as well in a community setting. Additional issues include selection bias introduced by our inclusion criteria and consent requirements. Indeed subjects who were excluded were older and more likely to be Latino or of non-white race. Exclusion of subjects of high acuity and of those for whom consent could not be obtained may result in an under-reporting of the prevalence of delirium among elderly ED patients. Another study limitation is that we used a convenience sample of patients in that we conducted our study predominantly during weekdays in the afternoon and evening hours. Therefore our results may not be generalizable to subjects presenting to the ED on weekend or night shifts. For instance, subjects presenting on night shifts may be more likely to have higher acuity of illness or be delirious. Additionally, neither ED-administered medications nor ADLs were included in our models. ADLs were also not included in our adjusted models of health care utilization; accordingly there may be residual confounding. With respect to our delirium diagnosis, we only assessed delirium at a single time-point in the ED; a second evaluation several hours later may have allowed us to identify fluctuations in mental status and enabled us to better detect delirium. Patients were classified as having dementia if it was documented in either the emergency physician's chart or the online medical record, which may have resulted in under-detection. This misclassification, however, would have likely biased the association of dementia and delirium toward the null and we found a highly significant association. Lastly, as we

evaluated for prevalent delirium, we can only report associations between the risk factors identified and delirium and cannot infer causality. Nonetheless, a risk profile of patients who are mostly likely to have ED delirium might improve detection and treatment of delirious ED patients.

In conclusion, we found 9% of elderly patients enrolled in our study were delirious and delirious ED patients had greater resource utilization and higher mortality. We created a risk prediction rule, consisting of older age, prior stroke or TIA, dementia, suspected infection, tachypnea, and acute intracranial hemorrhage, which accurately identified patients at low, moderate and high risk for ED delirium. Given the frequency with which physicians do not recognize delirium in ED patients, our risk prediction model, if externally validated, could help identify a narrower group of patients that should be evaluated for delirium. Further research is needed into streamlined delirium screening for use in screening patients at moderate risk of delirium. Early identification of delirium may enable physicians to implement strategies to decrease the duration of delirium, or avoid inappropriate discharge of acutely delirious patients from the ED, which could improve patient outcomes.

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Figure 1.
Summary of Subject Enrollment

Delirium Risk Group (Score)	Low Risk (≤ 2 point)	Moderate Risk (3-4 points)	High Risk (≥ 5 points)
Subjects with Delirium, n (%)	15 (4%)	18 (12%)	30 (29%)
Total Subjects, n (%)	416 (62%)	156 (23%)	104 (15%)

Figure 2.
Performance Characteristics of Delirium Prediction Rule

Table 1

Univariate Analysis of Demographics, Past Medical History, and Presenting Illness Covariates for Delirious and Non-Delirious Subjects.

	All N=676	Non-Delirious N=613	Delirious N=63	P-value [†]
Demographics:				
Age, Mean (±SD)	77 (±8)	77 (±8)	81 (±8)	<0.001
Male, n (%)	328 (49)	302 (49)	26 (41)	0.2
Race/Ethnicity				0.6
Caucasian, n (%)	593 (88)	536 (87)	57 (90)	
African American, n (%)	69 (10)	64 (10)	5 (8)	
Other, n (%)	14 (2)	13 (2)	1 (2)	
Independent Living, n (%)	589 (88)	544 (89)	45 (74)	0.001
Comorbid Illness				
Anxiety, n (%)	65 (10)	54 (9)	11 (17)	0.04
Atrial Fibrillation or Flutter, n (%)	168 (25)	147 (24)	21 (33)	0.1
Chronic Lung Disease, n (%)	149 (22)	134 (22)	15 (24)	0.7
Coronary Artery Disease, n (%)	264 (39)	239 (39)	25 (40)	1.0
Dementia, n (%)	67 (10)	47 (8)	20 (32)	<0.001
Depression, n (%)	142 (21)	122 (20)	20 (32)	0.03
Diabetes Mellitus, n (%)	188 (28)	170 (28)	18 (29)	0.9
Seizure disorder, n (%)	18 (3)	14 (2)	4 (6)	0.08
CVA or TIA, n (%)	95 (14)	76 (12)	19 (30)	<0.001
Charlson Comorbidity Index, Mean (±SD)	2.3 (±2.1)	2.2 (±2.0)	2.9 (±2.2)	0.007
Outpatient Medications				
Number of Medications, Mean (±SD)	9 (±5)	9 (±5)	10 (±3)	0.2
Antidepressant, n (%)	159 (24)	140 (23)	19 (30)	0.2
Opioid, n (%)	123 (18)	109 (18)	14 (22)	0.4
Antipsychotic, n (%)	25 (4)	19 (3)	6 (9)	0.02
Sedatives, n (%)	148 (22)	133 (22)	15 (24)	0.7
Triage Vital Signs				
Temperature, Mean (±SD)	98.0 (±1.0)	98.0 (±0.9)	98.1 (±1.8)	0.6
HR, Mean (±SD)	78 (±17)	78 (±17)	78 (±16)	0.4
SBP, Mean (±SD)	138 (±25)	139 (±25)	135 (±24)	0.3
RR, Mean (±SD)	17.7 (±2.7)	17.7 (±2.7)	18.5 (±2.5)	0.03
O2 Sat, Mean (±SD)	98 (±2.5)	98 (±2.5)	98 (±2.2)	0.5
Emergency Department Laboratory Results				
WBC, Mean (±SD)	8.5 (±3.5)	8.3 (±3.4)	9.6 (±4.3)	0.05
Hemoglobin, Mean (±SD)	12.2 (±1.9)	12.3 (±1.9)	11.5 (±2.1)	<0.001
Sodium, Mean (±SD)	138 (±3.8)	139 (±3.5)	138 (±5.0)	0.3
Potassium, Mean (±SD)	4.3 (±0.6)	4.3 (±0.6)	4.2 (±0.6)	0.14
Chloride, Mean (±SD)	102 (±4)	102 (±5)	100 (±6)	0.02
Bicarbonate, Mean (±SD)	26.4 (±3.8)	26.3 (±3.6)	27.2 (±5.0)	0.06

	All N=676	Non-Delirious N=613	Delirious N=63	P-value [†]
BUN, Mean (±SD)	26 (±17)	26 (±18)	23 (±11)	0.6
Creatinine, Mean (±SD)	1.4 (±1.1)	1.3 (±1.1)	1.4 (±1.1)	0.4
Glucose, Mean (±SD)	127 (±54)	124 (±48)	143 (±90)	0.2
Patient Diagnosis by Emergency Physician				
Chest Pain, n (%)	83 (12)	79 (13)	4 (6)	0.2
Congestion Heart Failure, n (%)	34 (5)	32 (5)	2 (3)	0.8
Fall, n (%)	64 (9)	59 (10)	5 (8)	0.8
Gastrointestinal Hemorrhage, n (%)	36 (5)	32 (5)	4 (6)	0.8
Hip Fracture, n (%)	3 (0.4)	1 (0.2)	2 (3)	0.02
Intracranial Hemorrhage, n (%)	10 (1)	7 (1)	3 (5)	0.06
CVA or TIA, n (%)	24 (4)	20 (3)	4 (6)	0.3
Any Infection, n (%)	153 (23)	131 (21)	22 (35)	0.02
Pneumonia, n (%)	46 (7)	37 (6)	9 (14)	0.03
Urinary Tract Infection, n (%)	44 (6)	33 (5)	11 (17)	0.001
Seizure, n (%)	4 (0.6)	4 (0.6)	0 (0)	1.0
Emergency Department Severity of Illness				
APACHE II Score, Mean (±SD)	9.3 (±3.6)	9.0 (±3.5)	11.3 (±4.4)	<0.001

Non-independent living scenarios include nursing homes, assisted living, and rehabilitation centers.

SD=Standard Deviation. CVA=Cerebrovascular Accident. TIA=Transient Ischemic Attack. HR=Heart Rate. SBP=Systolic Blood Pressure. RR=Respiratory Rate. O2 Sat= Oxygen saturation. WBC=White Blood Cell. BUN=Blood urea nitrogen. APACHE II =Acute Physiology and Chronic Health Evaluation II.

[†]P-value compares delirious and non-delirious subjects.

Table 2

Final Multivariable Model of Risk Factors Predicting Delirium Among Emergency Department Patients.

Covariate Entered in Model	Odds Ratio (95% CI)	Points Assigned For Risk Prediction Rule
Decades > 65 [*]	1.6 (1.1 – 2.3)	65–69: 0 points 70–79: 1 point 80–89: 2 points 90+: 3 points
History of Dementia	4.3 (2.2 – 8.5)	3 points
History of TIA or ischemic stroke	3.3 (1.7 – 6.2)	2 points
Respiratory rate >20	2.8 (1.2 – 6.1)	2 points
Suspected Infection ^{**}	3.2 (1.7 – 6.0)	2 points
ED diagnosis of intracranial hemorrhage	8.4 (1.8 – 40)	5 points

C-statistic for multivariable model 0.79 (95%CI=0.73 – 0.84). C-statistic for risk prediction rule 0.77 (95% CI=0.71 – 0.83).

CI=Confidence Interval. TIA=Transient Ischemic Attack. ED=Emergency Department. UTI=Urinary Tract Infection).

^{*} Age was used as a continuous variable but the odds ratio is reported for each decade over 65 years of age; for example, a 75 year old ED patient has a 1.7 times greater odds of having delirium than a 65 year old patient.

^{**} Suspected infection is defined as physician chart diagnosis of infection, such as pneumonia or UTI, and antibiotics administered in the ED.

Table 3

Mortality and Healthcare Utilization among Delirious and Non-Delirious Emergency Department Patients.

Outcome	Non-Delirious, N=613	Delirious, N=63	p-value
Admission from the ED, n (%)	388 (63)	56 (89)	<0.001
30-day mortality, n (%)	7 (1)	4 (6)	0.01
30-day Re-hospitalization, n (%)	82 (13)	17 (27)	0.008
Admitted Patients Only:			
Admission to the ICU, n (%)	35 (6)	8 (13)	0.05
Length of Stay, Days, Median (25–75% IQR)	2 (1–4)	4 (2–6)	<0.001
Mean (±SD)	3.3 (±3.5)	4.6 (±3.6)	
Hospital Charges, \$, Median (25–75% IQR)	\$13,381 (\$9,051–\$19,968)	\$16,788 (\$11,533–\$31,785)	0.01
Mean (±SD)	\$18,577 (±\$18,913)	\$23,715 (±\$18,530)	
Discharge to New Rehabilitation or Chronic Care Facility, n (%)	56 (9)	23 (37)	<0.001

ED = Emergency Department. ICU = Intensive Care Unit. IQR = 25–75% Interquartile Range. SD= Standard Deviation