Depression in Emergency Department Patients and Association with Healthcare Utilization

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Abstract

Background—Depression is one of the most common illnesses in the U.S., with increased prevalence among people with lower socioeconomic status and chronic mental illness who often seek care in the Emergency Department (ED). We sought to estimate the rate and severity of major depressive disorder (MDD) in a non-psychiatric emergency department (ED) population and its association with subsequent ED visits and hospitalizations.

Methods—This prospective cohort study enrolled a convenience sample of English-speaking adults presenting to an urban academic medical center ED without psychiatric complaints between January 1, 2015 and September 21, 2015. Patients completed a computerized adaptive depression diagnostic screen (CAD-MDD) and dimensional depression severity measurement test (CAT-DI) via tablet computer. Primary outcomes included number of ED visits and hospitalizations assessed from index visit until January 1, 2016. Negative binomial regression modeling was performed to assess associations between depression, depression severity, clinical covariates, and utilization outcomes.

Results—Of 999 enrolled patients, 27% screened positive for MDD. The presence of MDD conveyed a 61% increase in the rate of ED visits (IRR=1.61, 95% CI: 1.27–2.03) and a 49% increase in the rate of hospitalizations (IRR=1.49, 95% CI: 1.06–2.09). For each 10% increase in...
MDD severity, there was a 10% increase in the relative rate of subsequent ED visits (incident rate ratio, IRR=1.10, 95% CI: 1.04–1.16) and hospitalizations (IRR=1.10, 95% CI: 1.02–1.18). Across the range of the severity scale there was over a 2.5-fold increase in the rate of ED visits and hospitalization rates.

**Conclusions**—Rates of depression were high among a convenience sample of English-speaking adult ED patients presenting with non-psychiatric complaints and independently associated with increased risk of subsequent ED utilization and hospitalization. Standardized assessment tools that provide rapid, accurate and precise classification of MDD severity have the potential to play an important role in identifying ED patients in need of urgent psychiatric resource referral.

**Keywords**
depression; healthcare utilization; behavioral health; computer adaptive testing

**INTRODUCTION**

**Background**
Major depressive disorder (MDD) is a significant public health problem, affecting 16.2 million adults in the United States (6.7%) per year\(^1\) and is the leading cause of disability among adults in high-income countries.\(^2\) MDD can have significant negative impact on physical, mental, and social well-being, and is major multiplier of healthcare costs.\(^3-5\) The burden of MDD is disproportionately experienced by patients with low socioeconomic status, Medicaid recipients, the elderly, and those with chronic medical conditions.\(^6-9\) This same population is also less likely to receive primary care and more likely to access the emergency department (ED) for both urgent and ambulatory-care sensitive conditions.\(^10-14\)

**Importance**
Early detection and appropriate treatment of MDD increases the likelihood of achieving remission, preventing relapse, and decreasing overall healthcare costs.\(^15,16\) Yet MDD remains under-detected and under-treated with barely half of Americans and only 40% of African Americans with MDD receiving treatment.\(^17,18\) Recognizing this gap in care, the United States Preventive Services Task Force (USPSTF) recently recommended routine depression screening in adult primary care settings.\(^19\) Given the ED’s role as a primary safety net provider and the risk profiles of its patients, several have asked whether or not MDD screening should be extended to the general adult ED population.\(^20-22\) Yet more research is needed regarding the scope of the problem, implementation of screening, and potential impacts before such secondary prevention efforts are broadly adopted in the ED.\(^21\)

Little is known about the prevalence, spectrum of severity, and outcomes (e.g., patterns of health care utilization) of MDD in the adult ED population. A few small to moderately sized studies utilized single-question,\(^23\) paper short-form\(^22,24-26\) or self-administered computer-based short-form\(^27\) screening instruments, resulting in MDD prevalence estimates of 16% to 32%. One large study of 5641 adult emergency department patients utilizing the Patient Health Questionnaire (PHQ-9)\(^28\) classified approximately 23% of ED patients as moderately to severely depressed.\(^29\) Overall, the bulk of the evidence suggests that MDD may be more
prevalent in the ED as compared to the 12.5% estimated prevalence in the primary care setting. None of these reports have addressed the spectrum of MDD symptom severity for those patients who screen positive. Also, only one small study has documented the link between depression severity and ED visits in the general adult population. Consequently, there is significant uncertainty regarding the true burden of MDD in the ED population.

MDD screening programs should utilize standardized screening tools and be implemented with “adequate systems in place” to appropriately diagnose, assess disease severity, and refer patients who screen positive to an appropriate level of care. Implementation of such a program within the ED poses several challenges given time and resource constraints. Existing short-form MDD screening instruments such as the Patient Health Questionnaire (PHQ-9), which are commonly implemented in the primary care setting, address the need for brevity in the ED, yet concerns have been raised regarding their sensitivity and their limited ability to provide accurate severity assessment across the full range of depressive symptoms. Indeed, there is a need for MDD tools that not only detect depression but also provide accurate severity assessment in order to assist providers in the triage of patients to the appropriate intensity of services. Advanced survey methodologies, such as computer adaptive testing and diagnosis, address this need for increased precision and accuracy while reducing the burden of mental health assessment.

**Goals of This Investigation**

This study represents a first attempt at estimating the scope of the problem of depression in the ED and the needed capacity for mental health referral resources for future ED-based screening programs. Specifically, the goals of this study were to 1) estimate the rate of MDD and spectrum of severity of symptoms in a non-psychiatric adult ED population, 2) examine the health service implications of depression (diagnosis and severity) through the metric of ED and hospital utilization in this sample, and 3) cross-validate a computerized adaptive test for depression severity (CAT-DI) in this population.

**METHODS**

**Study Design and Setting**

This was a prospective observational study conducted between January 1, 2015 to September 21, 2015 of patients over the age of 18 years old presenting with non-psychiatric chief complaints to the ED of an urban academic medical center with a triage patient volume of 41,373 during that period. The Institutional Review Board of the University of Chicago approved this study.

**Selection of Participants**

Adult ED patients were recruited during weekdays and weekends between the hours of 8:00 am and 12:00 am based on research assistant availability. In order to avoid potential issues of incapacity around informed consent, patients with acute psychiatric complaints at triage were not approached. In addition, patients triaged with an Emergency Severity Index (ESI) of 1 (requiring immediate life-saving intervention) or 2 (high risk of deterioration) were deemed ineligible in order to avoid the potential for interference with acute patient care.
delivery. Patients were also excluded if they declined participation, were unable to consent, or did not speak English. Patients were recruited by a group of 9 volunteer research assistants and a paid research coordinator, who were all trained to screen patients, enroll participants, and operate a tablet computer used to deliver the depression instruments. The majority of recruitment sessions occurred during the hours of 1 pm and 11 pm, which corresponds to the peak census of our ED. Recruitment sessions were uniformly distributed across the days of the week.

While the overall design of the study was nonrandom, efforts were made to reduce sampling bias by randomizing the screening process. Patients were randomly selected for screening during each recruitment session using the following strategy. At the start of each session, the current ED census was printed. A reduced list of patients was developed for potential screening by matching the last digit of a patient’s age with a randomly selected number between 0 and 9. Patients on the reduced list were then screened for eligibility and approached using a standardized script if eligible. Once all eligible patients were either approached or removed from the ED tracking board, either the recruitment session ended or an updated census was printed and the process repeated. Patients could only be approached once for the study. Written informed consent was obtained for all study participants.

MDD Screening and Severity Scoring

The self-administered Computerized Adaptive Diagnostic Test for Major Depressive Disorder (CAD-MDD)\textsuperscript{32} and Computerized Adaptive Test-Depression Inventory (CAT-DI)\textsuperscript{36} were used to obtain rapid diagnostic depression screens and severity estimates. Once enrolled, patients were handed a tablet computer that they used to complete the CAD-MDD and CAT-DI. Patients were given the option of text or text plus audio administration. Test administration process measures, including time for completion in seconds and number of administered questions, were recorded to track test administration burden.

The CAD-MDD\textsuperscript{32} is a computerized adaptive depression screening tool based on a random forest\textsuperscript{37} machine learning algorithm that adapts to patient responses to questions about depression by asking the most diagnostically informative question from a bank of 88 items. The CAD-MDD item bank was created based on a review of over 500 items from 73 commonly used depression tools. Items were then filtered by an expert panel to include only those that closely aligned with 9 DSM-IV criteria for MDD diagnosis: depressed mood, loss of interest or pleasure in activities, loss or gain of weight, insomnia or hypersomnia, agitation or slowed behavior, fatigue, thoughts of worthlessness or guilt, inability to think or concentrate, and suicidality. The final item bank included only those items in the public domain.\textsuperscript{32}

A prior study showed that the CAD-MDD was on average shorter than the PHQ-9 (an average of 4 items vs. 9 items), and that overall sensitivity and specificity for the CAD-MDD was 0.95 and 0.87, respectively, compared to 0.70 and 0.91 for the PHQ-9, as compared to the Structured Clinical Interview for DSM-IV (SCID) criterion standard.\textsuperscript{32} An independent validation study including patients presenting to an outpatient mental health clinic and healthy controls showed similar test performance.\textsuperscript{38} We have also recently
validated the CAD-MDD within our institution’s primary care population with comparable results. The CAT-DI is a computerized adaptive dimensional severity measure for depression that utilizes a bank of 389 depression items whose response patterns are fitted to a multidimensional item response theory model. The CAT-DI produces a continuous depressive severity estimate on a 0–100 point scale with 5 points of precision. Prior work has shown that an average of 12 items and a median administration time of 137 seconds had a correlation of r=0.95 with the 389 total item bank score. In terms of diagnostic validity, using the continuous CAT-DI depressive severity scale scores as a linear predictor of DSM-IV MDD diagnoses, there was a 24-fold increase in the probability of MDD across the range of the CAT-DI scale (odds ratio = 24.19; 95% CI, 10.51–55.67). Gibbons et al. have also shown that using an empirically derived threshold based on a normal mixture distribution, the CAT-DI has a sensitivity of 0.92 and specificity of 0.88 for predicting of MDD based on a SCID. We cross-validated the CAT-DI by comparing responses of our adult ED sample to those of the original psychiatric outpatient base sample to test for the presence of differential item functioning (DIF). DIF occurs when people from different subgroups with the same underlying level of a latent trait, in this case depression, have different likelihoods of endorsing certain survey items about depression. A description of these cross-validation methods and results can be found in the Supplementary Materials.

Chart Review

Descriptive statistics were used to summarize CAD-MDD depression screening and CAT-DI depression severity results. Sociodemographic, healthcare-related, and utilization covariates and outcome variables were abstracted from the hospital’s electronic medical record (EMR, Epic Systems, Verona, WI) following procedures outlined in a coding manual created by study team members. Sociodemographic covariates included patient sex, age, insurance status, and race/ethnicity. Comorbid diagnoses were obtained from EMR data within the History, Problem List, and Emergency Department Clinical Impression fields and recorded using the 9th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-9). Additional diagnoses recorded in the free text of all ED provider EMR notes were also scanned. In order to reduce variability, all records were reviewed by one research assistant, who was blinded to depression testing results. Inconsistencies were adjudicated by the principal investigator (DGB) who was also blinded to depression testing results.

Outcomes

Utilization outcomes included the number of subsequent ED visits and hospital admissions at the study institution for one year following the index ED visit.

Statistical Analysis

Summary statistics were presented as frequencies (with percentages), means (with standard deviations (SD)), or medians (with interquartile ranges (IQR)), as appropriate. We performed multivariable analyses using 4 models that assessed associations between depression and utilization outcomes, one for each unique pair of depression and utilization.
measures. Use of a Poisson model for count outcomes requires the variance of the dependent variable to be equal to the mean (no over-dispersion). In the case of both outcomes, ED visits and admissions, over-dispersion was detected through a deviance or Pearson chi-squared value substantially exceeding 1.0, and therefore, negative binomial models were estimated controlling for demographics, comorbidity burden, having a primary care provider, and current use of illicit drugs, alcohol, and tobacco. Likelihood ratio chi-square tests were used to assess final model fit by comparing the likelihoods of the intercept-only and full (all covariates included) model. The full model fit the data better than the null model ($p < 0.0001$ for both outcome measures).

Primary covariates of interest included depression screen status (positive/negative) and symptom severity (severity percentile decile on a 0 – 100 scale) as measured by the CAD-MDD and CAT-DI respectively. These measures were included in separate models. The same covariates were used to control for confounding in modeling both count outcomes of hospital admissions and ED visits. Demographic variables included patient sex, age, insurance status, and race/ethnicity. Age was modeled as a continuous covariate, while sex (male/female), insurance status (commercial/Medicaid/Medicare/uninsured/miscellaneous), race (white/black/other) and ethnicity (Hispanic/not Hispanic) were included in models as categorical covariates. Healthcare-related dichotomous covariates included having a primary care provider and current use of illicit drugs, alcohol, and tobacco. Comorbidity burden was quantified using the enhanced version of the validated Charlson–Deyo comorbidity index (CCI) for administrative data, which weights 17 selected comorbidities, where higher scores are associated with greater burden of comorbid disease. The CCI was included in models as a continuous covariate.

The incidence rate ratio (IRR), a ratio of two incidence rates, was used as relative measure of the effect of depression on utilization. We defined the incidence rate as the number of events (i.e., ED visits or hospitalizations) divided by the person-time at risk in person-years. All IRRs are presented with 95% CIs. All analyses were performed using SAS software version 9.4 (SAS Institute, Cary, North Carolina).

An enrollment goal of 1000 patients was established based on an a priori power analysis to provide a margin of error in rate of MDD of 2% based on a conservative estimated base-rate of 15%, which yields a 95% confidence and a population of 10,000 ED patients during the recruitment period.

**RESULTS**

**Descriptive Statistics**

During the study period, a total of 1000 patients were enrolled (Figure 1). Of those enrolled, 1 patient had a missing CAD-MDD test score leaving 999 patients for analysis. The median time to complete the CAD-MDD was 62 sec (IQR = 41 sec), with a median number of 4 items (IQR = 1). Median time for completion of the CAT-DI was 101 sec (IQR = 62 sec), with a median number of 9 items (IQR = 4). Among enrollees, 26.5% screened positive for MDD by the CAD-MDD. Patients who screened positive for MDD (Table 1) were
predominantly female (65.4% vs. 57.7%), used illicit drugs (14.7% vs. 9.4%), and currently smoked (25.2% vs. 15.4%).

**Utilization**

Patients who screened positive for MDD were more likely to re-visit the ED and to be admitted to the hospital during follow-up compared to those with a negative screen (ED: 3.51 vs. 2.15 events per person-year; hospitalization: 1.50 vs. 1.10 events per person-year). In adjusted analyses, a positive MDD screen was associated with a 61% increase in subsequent ED utilization and a 49% increase in subsequent hospital admissions, see Table 2. In terms of depressive severity (deciles), the relative rate of subsequent ED visits and hospitalizations increased by 10% for every 10% increase in MDD severity (10 points on the 100 point scale). Across the entire range of the scale (from lowest to highest severity) the rate of ED visits increased and the rate of hospitalizations increased more than 2.5-fold. Full model results can be found in supplementary tables S1 and S2.

**DISCUSSION**

This study presents one of the largest prospective reports of major depression screening in a general adult ED population. We describe for the first time the distribution of depression severity in the adult ED and its association with future healthcare utilization.

Our ED sample had a rate of MDD of 26.5% among patients without psychiatric complaints who present during daytime hours. This rate is consistent with the published ED literature. Consistent with suggestions by Booth et al., such high rates of depression may reflect the impact of low socioeconomic status on MDD as approximately 29% of the population within the University of Chicago Medical Center catchment area live below the Federal Poverty Level and the 40% of rate of Medicaid coverage in our sample. Also, it may represent the under treatment and under diagnosis in our catchment area due to a documented local shortage of primary care and mental health professionals. Similar shortages have been documented nationally and are projected to worsen over the next decade.

We also found that a positive MDD screen was associated with increased subsequent healthcare utilization during the one-year follow-up period. While associations between depression and healthcare utilization have been previously reported in the primary care clinic, specialty clinic, and elderly ED patient populations, and adult ED patients with abdominal pain, our study represents one of the first reports specific to the general adult ED population.

Severity of depression had an even stronger association with utilization: 2.55-fold increase across the continuum from the least to the most severe for ED visits, and 2.53-fold increase for the rate of hospitalizations. To our knowledge, we are among the first to report the correlation between depression severity and ED utilization. In one small study of homebound elderly patients, self-reported ED visit frequency during the preceding 6 months...
was positively associated with scores from the 24-item Hamilton Rating Scale for Depression (HAMD) during baseline interviews. In addition, ED visit frequency at 12 and 24 week follow-up intervals were associated with changes in HAMD scores from baseline.

In one prior report in the general adult ED population, patients with moderate or severe depression reported a median of 2 ED visits in the past 6 months while those who screened negative for depression reported 1 visit. Notably, that study also documented strong correlations between mental health scores for depression and anxiety and perceived barriers to care.

In order to integrate MDD screening into the busy ED clinical workflow, it is essential that screening and diagnostic instruments be convenient, brief, and accurate. Our results demonstrate that computer adaptive CAD-MDD and CAT-DI assessments can be delivered to ED patients using a minimal amount of patient burden, though the feasibility of integrating this approach into the clinical workflow without the use of research assistants has yet to be demonstrated. Others have reported on the feasibility, advantages, and challenges of deploying technology-based behavioral health intervention, screening, and referral programs in the ED (see Choo et al. for review). There is also evidence to suggest that self-administered screening has high patient acceptability and may increase disclosure rates by at-risk individuals. In many examples, computers enable the delivery of kiosk-based self-administered assessments with automated scoring and little to no staff intervention. We envision integrating a variety of patient-facing adaptive screening instruments such as the CAD-MDD and CAT-DI into the ED workflow via tablet computers or in-room television-based patient response system in a manner that minimizes clinical provider time and interfaces with the electronic medical record.

An optimal ED-based screening program must include provisions for those who screen positive to provide appropriate diagnosis, initial treatment, and evidence-based care or referral to a proper care setting. ED implementation of traditional screening and referral programs based on standard MDD short-form screening instruments with binary, i.e., positive or negative, outcomes would quickly overwhelm the existing psychiatric resources of most health systems. Our study, by documenting the full spectrum of MDD disease severity in an ED population, provides a refined estimate of the demand for psychiatric referral services. Specifically, we can apply empirically-derived thresholds established for the CAT-DI in an outpatient psychiatric population to estimate that approximately 7% of our ED sample were experiencing moderate to severe depression symptoms and thus might require urgent referral for psychiatric services. Assuming a representative sample of our entire ED census, this result implies the need for approximately 11 urgent psychiatric referrals from the ED per day. This number of additional urgent referrals would quickly saturate available psychiatry consultation and clinic capacity at our institution.

In the past, we have addressed the needed for additional follow-up clinic capacity, e.g., primary care, by developing referral networks with unaffiliated community physician providers. However, given the aforementioned shortages of mental health providers in our city and nationally, it is vital that we consider more innovative strategies for addressing this gap in care. Several care models from primary care may provide useful guidance in this regard. For example, Project ECHO utilizes expert-led video conferences...
to provide advanced training of primary care providers in mental health treatment. Integrated behavioral health care models embed mental health providers of various levels directly into the primary care clinic environment. Alternatively, stepped-care models align referral resource intensity (e.g., primary care, social work, or psychiatry) with depression symptom severity (mild, moderate, or severe). In addition, at our institution, we have adopted a primary care-behavioral health model, have educated our primary care providers to provide primary psychiatric care, and have community mental health partnerships.

Finally, digital technology, including telepsychiatry, web- and mobile-based applications may help extend the capacity of the existing mental health workforce. While each of these approaches requires the dedication of significant resources to improve proper care coordination, the adaptation of such emerging models to emergency care would be reasonable next steps for addressing the high need for mental health services in the ED population.

LIMITATIONS

The use of a convenience sample in this study introduces the potential for bias from several important sources. By excluding patients with primary psychiatric complaints, acute life-threatening illness, cognitive impairment, and those who decline to participate, we may have excluded patients at higher risk for depression or with greater depression severity and thus, underestimated the rate of MDD in a general adult ED population. Patients presenting overnight between 12 am and 8 am were also not included in the sample. While patients presenting overnight represented only approximately 10% of our patient volume, there is the potential that patients with MDD might not present uniformly throughout the day and thus impact our estimate of MDD rate in this population. For example, one report suggests that patients with psychiatric issues are more likely to present to a psychiatric emergency service facility during day, rather than night, shifts. If this were true in our population, it could lead to an overestimate of the rate of MDD.

Another limitation of our study is that patient follow-up data were only available for a single hospital site. Since the primary service area of our hospital overlaps with those of other institutions with emergency departments, it is likely that we have undercounted recidivism rates in both the MDD positive and MDD negative groups. In addition, we did not account for patient mortality. It is difficult to predict how incomplete utilization and mortality data might bias the observed association between depression severity and utilization.

The interpretation of this study’s utilization findings is also limited by our reliance on chart review methods for capturing clinical and demographic data. Also, our study did not control for a variety of social determinants of health which have both been shown to have associations with depression and healthcare utilization. Not accounting for these additional covariates in our model may have biased our estimates, leading to overestimation of the effects. Finally, while the CAD-MDD has been previously validated against the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID) in an outpatient psychiatric population, this validation step has yet to be performed in the ED and will be the subject of future work.
CONCLUSIONS

This work documents the high rate of depression and its range of severity within a population of adult patients presenting to an urban ED with non-psychiatric complaints. It also describes the positive association between depression and depression severity and future ED visits and hospitalizations in this selected population. Given the potential for increased ED utilization under Medicaid expansion, the ED may be ideally positioned to interrupt the vicious cycle of depression, poor medical outcomes, and high utilization. Together these results lend support to the idea of a future trial testing the impact of depression screening and treatment on ED utilization and hospital readmissions. Additional research is necessary to demonstrate the feasibility, effectiveness, and cost savings associated with MDD screening, diagnosis, and severity classification tools as part of an ED-based tiered psychiatric referral and follow-up pathway.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Figure 1.
Study enrollment flowchart.
Table 1:
Sociodemographic and Healthcare-Related Characteristics\textsuperscript{a}

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>CAD-MDD Screening\textsuperscript{b}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negative (n=733)</td>
</tr>
<tr>
<td></td>
<td>(n=733)</td>
</tr>
<tr>
<td><strong>Sociodemographic</strong></td>
<td></td>
</tr>
<tr>
<td>Age, mean (SD), y</td>
<td>47.0 (18.2)</td>
</tr>
<tr>
<td>Female</td>
<td>423 (57.7)</td>
</tr>
<tr>
<td><strong>Race</strong></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>108 (14.7)</td>
</tr>
<tr>
<td>Black/African American</td>
<td>599 (81.7)</td>
</tr>
<tr>
<td>Other</td>
<td>26 (3.6)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>25 (3.4)</td>
</tr>
<tr>
<td><strong>Insurance Type</strong></td>
<td></td>
</tr>
<tr>
<td>Commercial</td>
<td>204 (27.8)</td>
</tr>
<tr>
<td>Medicare</td>
<td>218 (29.7)</td>
</tr>
<tr>
<td>Medicaid</td>
<td>267 (36.4)</td>
</tr>
<tr>
<td>Uninsured</td>
<td>40 (5.5)</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>4 (0.6)</td>
</tr>
<tr>
<td><strong>Charlson Index Score, median (IQR)</strong></td>
<td>0 (0 – 1)</td>
</tr>
<tr>
<td><strong>Healthcare-Related</strong></td>
<td></td>
</tr>
<tr>
<td>Has primary care provider</td>
<td>426 (58.1)</td>
</tr>
<tr>
<td>Any illicit drug use</td>
<td>69 (9.4)</td>
</tr>
<tr>
<td>Any alcohol use</td>
<td>222 (30.3)</td>
</tr>
<tr>
<td>Current smoker</td>
<td>113 (15.4)</td>
</tr>
<tr>
<td><strong>Emergency Department Utilization</strong></td>
<td></td>
</tr>
<tr>
<td>Proportion with ≥ 1 ED Visit</td>
<td>353 (48.2)</td>
</tr>
<tr>
<td>Number of ED Visits among those with ≥ 1 ED Visit, median (IQR)</td>
<td>2 (1–3)</td>
</tr>
<tr>
<td>Time-to-first re-visit to the ED, mean (SD), days</td>
<td>101.2 (100.1)</td>
</tr>
<tr>
<td><strong>Inpatient Utilization</strong></td>
<td></td>
</tr>
<tr>
<td>Proportion with ≥ 1 Hospitalization</td>
<td>158 (21.6)</td>
</tr>
<tr>
<td>Number of Hospitalizations among those with ≥ 1 Hospitalization, median (IQR)</td>
<td>1 (1–3)</td>
</tr>
<tr>
<td>Time-to-first re-hospitalization, mean (SD), days</td>
<td>98.0 (97.9)</td>
</tr>
<tr>
<td><strong>Depression Severity (CAT-DI), mean (SD)\textsuperscript{c}</strong></td>
<td>23.6 (13.4)</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Data are presented as number (percentage) of patients, unless stated otherwise

\textsuperscript{b}Computerized Adaptive Diagnostic-Major Depressive Disorder

\textsuperscript{c}Continuous depression severity estimate on a 0–100 scale

SD = Standard Deviation
IQR = Interquartile Range
Table 2.

Incident Rate Ratios (95% CIs) for ED Utilization and Hospitalizations by Measure of Depression

<table>
<thead>
<tr>
<th>Depression Measure</th>
<th>Number of ED Visits IRR (95% CI)</th>
<th>P-Value</th>
<th>Number of Admissions IRR (95% CI)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAD-MDDb</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>Ref</td>
<td></td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>1.61 (1.27–2.03)</td>
<td>&lt;0.0001</td>
<td>1.49 (1.06–2.09)</td>
<td>0.02</td>
</tr>
<tr>
<td>CAT-DIc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per increase in level of depression severity</td>
<td>1.10 (1.04–1.17)</td>
<td>&lt;0.001</td>
<td>1.10 (1.02–1.18)</td>
<td>0.02</td>
</tr>
</tbody>
</table>

a Adjusted for sociodemographic and healthcare-related covariates
b CAT-MDD: Computerized Adaptive Diagnostic Test for Major Depressive Disorder
c CAT-DI: Computerized Adaptive Testing-Depression Inventory (severity classifier)