Depression in Emergency Department Patients and Association With Health Care Utilization

David G. Beiser, MD[1], Charlotte E. Ward, MPH[2], Milkie Vu, MA[3], Neda Laiteerapong, MD[4], and Robert D. Gibbons, PhD[5]

ABSTRACT

Background: Depression is one of the most common illnesses in the United States, 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 nonpsychiatric 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 (incidence rate ratio [IRR] = 1.61, 95% confidence interval [CI] = 1.27 to 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 (IRR = 1.10, 95% CI = 1.04 to 1.16) and hospitalizations (IRR = 1.10, 95% CI = 1.02 to 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 nonpsychiatric 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.

From the [1]Section of Emergency Medicine, the [3]Section of Emergency Medicine, Department of Medicine, the [4]Section of General Internal Medicine, and the [5]Center for Health Statistics, Departments of Medicine and Public Health Sciences, University of Chicago, Chicago, IL; and the [2]Center for Healthcare Studies, Northwestern University Feinberg School of Medicine, Chicago, IL. Ms. Vu is currently at Rollins School of Public Health, Emory University, Atlanta, GA.
Received November 13, 2018; revision received March 7, 2019; accepted March 12, 2019.
Presented at the Society for Academic Emergency Medicine Annual Meeting, New Orleans, LA, May 12, 2016 and the Academy Health Annual Research Meeting, June 27, 2016.
The authors have no relevant financial information or potential conflicts to disclose.
RDG was supported by R01-MH66302 from the National Institute of Mental Health. NL was funded by K23 DK092783 from the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). CEW was supported by 4T32HS000084-18 from the Agency for Healthcare Research and Quality (AHRQ). RDG is a founder of Adaptive Testing Technologies, which distributes the CAT-MDD and CAT-DI instruments.
Author contributions: DGB, RDG, and NL conceived of the study and designed the protocol; DGB supervised the overall conduct of the study and data quality control; MV coordinated the patient recruitment workforce and managed the data; CEW, RDG, and DGB provided statistical advice on study design and analyzed the data; DGB drafted the manuscript; all authors contributed substantially to its revision; and DGB takes responsibility for the paper as a whole.
Supervising Editor: Damon R. Kuehl, MD.
Address for correspondence and reprints: David G. Beiser; e-mail: dbeiser@uchicago.edu.
ACADEMIC EMERGENCY MEDICINE 2019;00:1–11.

doi: 10.1111/acem.13726
ISSN 1553-2712

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 health care 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 health care costs.[15,16] Yet MDD remains underdetected and undertreated 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 5,641 adult ED 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 compared to the 12.5% estimated prevalence in the primary care setting.[30] 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.[26] Consequently, there is significant uncertainty regarding the true burden of MDD in the ED population.

Major depressive disorder 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.[19] 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,[19] 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.[31,32] Indeed, there is a need for MDD tools that not only detect depression but also provide accurate severity assessment to assist providers in the triage of patients to the appropriate intensity of services.[19,21,33] 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.[34]

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 nonpsychiatric 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 nonpsychiatric 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. 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[35] of 1 (requiring immediate lifesaving intervention) or 2 (high risk of deterioration) were deemed ineligible 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 nine 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)[32] and Computerized Adaptive Test-Depression Inventory (CAT-DI)[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[32] is a computerized adaptive depression screening tool based on a random forest[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 nine 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.[32]

A prior study showed that the CAD-MDD was on average shorter than the PHQ-9 (an average of four items versus nine 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, compared to the Structured Clinical Interview for DSM-IV (SCID) criterion standard.[32] An independent validation study including patients presenting to an outpatient mental health clinic and healthy controls showed similar test performance.[38] We have also recently validated the CAD-MDD within our institution's primary care population with comparable results.[39]

The CAT-DI[36] 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.[40,41] The CAT-DI produces a continuous depressive severity estimate on a 0 to 100 point scale with 5 points of precision.[36] 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.[36] 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 to 55.67).[36] Gibbons et al.[36] 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[36] 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 Data Supplement S1 (available as supporting information in the online version of this paper, which is available at http://onlinelibrary.wiley.com/doi/10.1111/acem.13726/full).

Chart Review

Descriptive statistics were used to summarize CAD-MDD depression screening and CAT-DI depression severity results. Sociodemographic, health care–related, and utilization covariates and outcome variables were abstracted from the hospital's electronic medical record (EMR; Epic Systems) 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 ED clinical impression fields and recorded using 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. 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 1 year following the index ED visit.

Statistical Analysis

Summary statistics were presented as frequencies (with percentages), means (with standard deviations [SDs]), or medians (with interquartile ranges [IQRs]), as appropriate. We performed multivariable analyses using four 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 overdispersion). In the case of both outcomes, ED visits and admissions, overdispersion was detected through a deviance or Pearson chi-squared value substantially exceeding 1.0, and therefore, negative binomial models[42] 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,[43–45] 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.

An enrollment goal of 1,000 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%,[22–25,27,29,46,47] 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 1,000 patients were enrolled (Figure 1). Of those enrolled, one patient had a missing CAD-MDD test score leaving 999 patients for analysis. The median time to complete the CAD-MDD was 62 seconds (IQR = 41 seconds), with a median number of four items (IQR = 1 item). Median time for completion of the CAT-DI was 101 seconds (IQR = 62 seconds), with a median number of nine items (IQR = 4 items). 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 revisit 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 Data Supplement S1, 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 health care utilization.

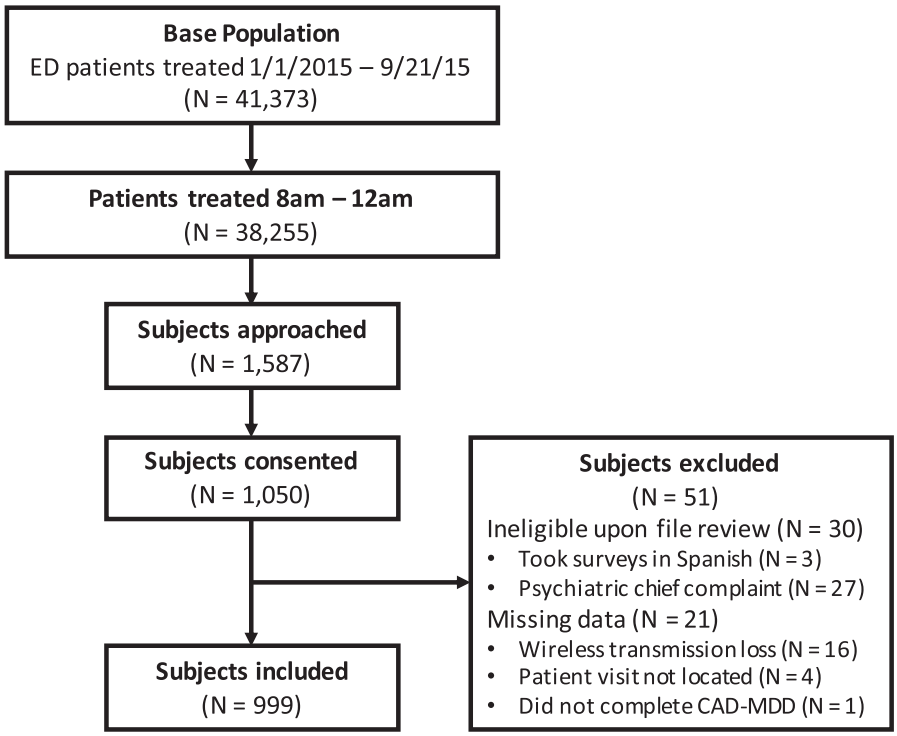

Figure 1. Study enrollment flowchart.

Table 1
Sociodemographic and Health Care–related Characteristics*

Characteristic	CAD-MDD Screening	
	Negative (*n* = 733)	Positive (*n* = 266)
Sociodemographic		
Age (years), mean (±SD)	47.0 (±18.2)	46.9 (±17.9)
Female	423 (57.7)	174 (65.4)
Race		
White	108 (14.7)	26 (9.8)
Black/African American	599 (81.7)	234 (88.0)
Other	26 (3.6)	6 (2.3)
Hispanic	25 (3.4)	8 (3.0)
Insurance type		
Commercial	204 (27.8)	42 (15.8)
Medicare	218 (29.7)	76 (28.6)
Medicaid	267 (36.4)	136 (51.1)
Uninsured	40 (5.5)	9 (3.4)
Miscellaneous	4 (0.6)	3 (1.1)
Charlson Index Score, median (IQR)	0 (0–1)	0 (0–1)
Health care-related		
Has primary care provider	426 (58.1)	149 (56.0)
Any illicit drug use	69 (9.4)	39 (14.7)
Any alcohol use	222 (30.3)	82 (30.8)
Current smoker	113 (15.4)	67 (25.2)
ED utilization		
Proportion with ≥ 1 ED visit	353 (48.2)	153 (57.5)
Number of ED visits among those with ≥ 1 ED visit, median (IQR)	2 (1–3)	2 (1–5)
Time to first revisit to the ED (days), mean (±SD)	101.2 (±100.1)	97.5 (±99.3)
Inpatient utilization		
Proportion with ≥ 1 hospitalization	158 (21.6)	73 (27.4)
Number of hospitalizations among those with ≥ 1 hospitalization, median (IQR)	1 (1–3)	2 (1–3)
Time to first rehospitalization (days), mean (±SD)	98.0 (±97.9)	96.7 (±99.5)
Depression severity (CAT-DI), mean (±SD)†	23.6 (±13.4)	57.7 (±13.2)

CAD-MDD = Computerized Adaptive Diagnostic-Major Depressive Disorder; CAT-DI = Computerized Adaptive Testing-Depression Inventory (severity classifier); IQR = interquartile range.
*Data are presented as number (%) of patients, unless stated otherwise.
†Continuous depression severity estimate on a 0–100 scale.

Table 2
IRRs (95% CIs) for ED Utilization and Hospitalizations by Measure of Depression*

Depression Measure	Number of ED Visits (95% CI)	p-value	Number of Admissions (95% CI)	p-value
CAD-MDD				
Negative	Ref		Ref	
Positive	1.61 (1.27–2.03)	<0.0001	1.49 (1.06–2.09)	0.02
CAT-DI				
Per increase in level of depression severity	1.10 (1.04–1.17)	<0.001	1.10 (1.02–1.18)	0.02

CAT-MDD = Computerized Adaptive Diagnostic Test for Major Depressive Disorder; CAT-DI = Computerized Adaptive Testing-Depression Inventory (severity classifier); IRR = incident rate ratio.
*Adjusted for sociodemographic and health care–related covariates.

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.[23–25,29,46,47] The rate of MDD in our ED sample is also more than double of the 12.5% estimated prevalence of MDD for adult primary care patients in the United States.[48] Consistent with suggestions by Booth et al.,[29] such high rates of depression may reflect the impact of low socioeconomic status on MDD[6–9] 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.[49] Similar shortages have been documented nationally and are projected to worsen over the next decade.[50,51]

We also found that a positive MDD screen was associated with increased subsequent health care utilization during the 1-year follow-up period. While associations between depression and health care utilization have been previously reported in the primary care clinic,[3] specialty clinic,[52,53] elderly ED patient populations,[54–56] and adult ED patients with abdominal pain,[57] our study represents one of the first reports specific to the general adult ED population.[26]

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.[58] In addition, ED visit frequency at 12- and 24-week

follow-up intervals were associated with changes in HAMD scores from baseline.[58] In one prior report in the general adult ED population, patients with moderate or severe depression reported a median of two ED visits in the past 6 months while those who screened negative for depression reported one visit.[26] Notably, that study also documented strong correlations between mental health scores for depression and anxiety and perceived barriers to care.[26]

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, although 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.[59] 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.[39,60,61] In many examples, computers enable the delivery of kiosk-based self-administered assessments with automated scoring and little to no staff intervention.[27,60–63] 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 EMR.

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.[19] 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[36] 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[49] and nationally,[50,51] 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[64] 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.[65] Alternatively, stepped-care models align referral resource intensity (e.g., primary care, social work, or psychiatry) with depression symptom severity (mild, moderate, or severe).[30,66,67] 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.[68]

Finally, digital technology, including telepsychiatry, Web- and mobile-based applications may help extend the capacity of the existing mental health workforce.[69–71] 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.[72] 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 EDs, it is likely that we have undercounted recidivism rates in both the MDD-positive and the 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.[73–75] 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 health care 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,[32] 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 nonpsychiatric 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,[76,77] 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.

The authors acknowledge the volunteer data collection efforts of Jenifer Goldberg, BA, as well as the following individuals affiliated with the University of Chicago: Maha Ahmad, BA; Alexandra Berthiaume; Cody Davis; Ali Fadhil, MBChB; Annie Hao; Ellen Harris; Davina Moossazadeh; Ivy Sandquist; and Anna Shin, BA.

References

1. Ahrnsbrak R, Bose J, Hedden SL, Lipari RN, Park-Lee E. Key Substance Use and Mental Health Indicators in the United States: Results from the 2016 National Survey on Drug Use and Health. Rockville (MD): Substance Abuse and Mental Health Services Administration, 2017.
2. Vos T, Barber RM, Bell B, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet 2015;386:743–800.
3. Bock JO, Luppa M, Brettschneider C, et al. Impact of depression on health care utilization and costs among multimorbid patients–from the MultiCare Cohort Study. PLoS One 2014;9:e91973.
4. Katon WJ, Lin E, Russo J, Unutzer J. Increased medical costs of a population-based sample of depressed elderly patients. Arch Gen Psychiatry 2003;60:897–903.
5. Simon GE, VonKorff M, Barlow W. Health care costs of primary care patients with recognized depression. Arch Gen Psychiatry 1995;52:850–6.
6. Lorant V. Socioeconomic inequalities in depression: a meta-analysis. Am J Epidemiol 2003;157:98–112.
7. Noël PH, Williams JW, Unützer J, et al. Depression and comorbid illness in elderly primary care patients: impact on multiple domains of health status and well-being. Ann Fam Med 2004;2:555–62.
8. Moussavi S, Chatterji S, Verdes E, Tandon A, Patel V, Ustun B. Depression, chronic diseases, and decrements in health: results from the World Health Surveys. Lancet 2007;370:851–8.
9. Harman JS, Mulsant BH, Kelleher KJ, Schulberg HC, Kupfer DJ, Reynolds CF. Narrowing the gap in treatment of depression. Int J Psychiatry Med 2001;31:239–53.
10. Mitchell AJ, Malone D, Doebbeling CC. Quality of medical care for people with and without comorbid mental illness and substance misuse: systematic review of comparative studies. Br J Psychiatry 2009;194:491–9.

11. Katon WJ. Clinical and health services relationships between major depression, depressive symptoms, and general medical illness. Biol Psychiatry 2003;54:216–26.
12. DiMatteo MR, Lepper HS, Croghan TW. Depression is a risk factor for noncompliance with medical treatment: meta-analysis of the effects of anxiety and depression on patient adherence. Arch Intern Med 2000;160:2101–7.
13. Hunt KA, Weber EJ, Showstack JA, Colby DC, Callaham ML. Characteristics of frequent users of emergency departments. Ann Emerg Med 2006;48:1–8.
14. Garcia TC, Bernstein AB, Bush MA. Emergency department visitors and visits: who used the emergency room in 2007? NCHS Data Brief 2010;38:1–8.
15. Halfin A. Depression: the benefits of early and appropriate treatment. Am J Manag Care 2007;(4 Suppl):S92–7.
16. Le HN, Boyd RC. Prevention of major depression: early detection and early intervention in the general population. Clin Neuropsychiatry 2006;3:6–22.
17. Kessler RC, Berglund P, Demler O, et al. The epidemiology of major depressive disorder. JAMA Psychiatry 2003;289:3095–105.
18. Gonzalez HM, Vega WA, Williams DR, Tarraf W, West BT, Neighbors HW. Depression care in the United States: too little for too few. Arch Gen Psychiatry 2010;67:37.
19. Siu AL; The US Preventative Services Task Force (USPSTF), Bibbins-Domingo K, et al. Screening for depression in adults: US Preventive Services Task Force recommendation statement. JAMA 2016;315:380–7.
20. Rhodes KV. Mood disorders in the emergency department: the challenge of linking patients to appropriate services. Gen Hosp Psychiatry 2008;30:1–3.
21. Kowalenko T. Should we screen for depression in the emergency department? Acad Emerg Med 2004;11:177–8.
22. Boudreaux ED, Clark S, Camargo CA. Mood disorder screening among adult emergency department patients: a multicenter study of prevalence, associations and interest in treatment. Gen Hosp Psychiatry 2008;30:4–13.
23. Kumar A, Clark S, Boudreaux ED, Camargo CA. A multicenter study of depression among emergency department patients. Acad Emerg Med 2004;11:1284–9.
24. Hoyer D, David E. Screening for depression in emergency department patients. J Emerg Med 2012;43:786–9.
25. Boudreaux ED, Cagande C, Kilgannon H, Kumar A, Camargo CA. A prospective study of depression among adult patients in an urban emergency department. Prim Care Companion J Clin Psychiatry 2006;8:66–70.
26. Abar B, Holub A, Lee J, DeRienzo V, Nobay F. Depression and anxiety among emergency department patients: utilization and barriers to care. Acad Emerg Med 2017;24:1286–9.
27. Schriger DL, Gibbons PS, Langone CA, Lee S, Altshuler LL. Enabling the diagnosis of occult psychiatric illness in the emergency department: a randomized, controlled trial of the computerized, self-administered PRIME-MD diagnostic system. Ann Emerg Med 2001;37:132–40.
28. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med 2001;16:606–13.
29. Booth BM, Walton MA, Barry KL, Cunningham RM, Chermack ST, Blow FC. Substance use, depression, and mental health functioning in patients seeking acute medical care in an inner-city ED. J Behav Health Serv Res 2011;38:358–72.
30. O'Connor E, Rossom RC, Henninger M, et al. Screening for depression in adults: an updated systematic evidence review for the U.S. preventive services task force [Internet]. Rockville, MD: Agency for Healthcare Research and Quality, 2016. Evidence Syntheses, No. 128. Available at: https://www.ncbi.nlm.nih.gov/books/NBK349027/. Accessed March 31, 2019.
31. Mitchell AJ, Yadegarfar M, Gill J, Stubbs B. Case finding and screening clinical utility of the Patient Health Questionnaire (PHQ-9 and PHQ-2) for depression in primary care: a diagnostic meta-analysis of 40 studies. Br J Psychiatry Open 2016;2:127–38.
32. Gibbons RD, Hooker G, Finkelman MD, et al. The computerized adaptive diagnostic test for major depressive disorder (CAD-MDD): a screening tool for depression. J Clin Psychiatry 2013;74:669–74.
33. Larkin GL, Beautrais AL, Spirito A, Kirrane BM, Lippmann MJ, Milzman DP. Mental health and emergency medicine: a research agenda. Acad Emerg Med 2009;16:1110–9.
34. Gibbons RD, Weiss DJ, Kupfer DJ, et al. Using computerized adaptive testing to reduce the burden of mental health assessment. Psychiatr Serv 2008;59:361–8.
35. Wuerz RC, Milne LW, Eitel DR, Travers D, Gilboy N. Reliability and validity of a new five-level triage instrument. Acad Emerg Med 2000;7:236–42.
36. Gibbons RD, Weiss DJ, Pilkonis PA, et al. Development of a computerized adaptive test for depression. Arch Gen Psychiatry 2012;69:1104–12.
37. Breiman L. Random forests. Mach Learn 2001;45:5–32.
38. Achtyes ED, Halstead S, Smart L, et al. Validation of computerized adaptive testing in an outpatient non-academic setting: the VOCATIONS trial. Psychiatr Serv 2015;66:1091–6.
39. Graham AK, Minc A, Staab E, Beiser DG, Gibbons RD, Laiteerapong N. Validation of the computerized adaptive test for mental health in primary care. Ann Fam Med 2019;17:23–30.
40. Gibbons RD, Bock RD, Hedeker D, et al. Full-information item bifactor analysis of graded response data. Appl Psychol Meas 2007;31:4–19.
41. Gibbons RD, Hedeker DR. Full-information item bi-factor analysis. Psychometrika 1992;57:423–36.

42. Hedeker DR, Gibbons RD. Longitudinal data analysis. In: Longitudinal Data Analysis. Hoboken: John Wiley & Sons, Inc., 2006. p. 239–56.
43. Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. Med Care 2005;43:1130–9.
44. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol 1992;45:613–9.
45. Charlson ME, Pompei P, Ales KL. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987;40:373–83.
46. Marchesi C, Brusamonti E, Borghi C, et al. Anxiety and depressive disorders in an emergency department ward of a general hospital: a control study. Emerg Med J 2004;21:175–9.
47. Downey LA, Zun LS, Burke T. Undiagnosed mental illness in the emergency department. J Emerg Med 2012;43:876–82.
48. Mitchell AJ, Rao S, Vaze A. International comparison of clinicians' ability to identify depression in primary care: meta-analysis and meta-regression of predictors. Br J Gen Pract 2011;61:72–80.
49. Health Resources & Services Administration (HRSA) Data Warehouse [Internet]. Available at: https://data.hrsa.gov/topics/health-workforce/shortage-areas. Accessed June 9, 2017.
50. National Projections of Supply and Demand for Selected Behavioral Health Practitioners: 2013–2025. Washington, DC: US Department of Health and Human Services, 2016.
51. Health Workforce Projections: Mental Health Counselors. Rockville, MD: Health Resources & Services Administration, 2016.
52. Rutledge T, Reis VA, Linke SE, Greenberg BH, Mills PJ. Depression in heart failure. a meta-analytic review of prevalence, intervention effects, and associations with clinical outcomes. J Am Coll Cardiol 2006;48:1527–37.
53. Tavallaii SA, Ebrahimnia M, Shamspour N, Assari S. Effect of depression on health care utilization in patients with end-stage renal disease treated with hemodialysis. Eur J Intern Med 2009;20:411–4.
54. Naughton C, Drennan J, Treacy P, et al. The role of health and non-health-related factors in repeat emergency department visits in an elderly urban population. Emerg Med J 2010;27:683–7.
55. McCusker J, Cardin S, Bellavance F, Belzile É. Return to the emergency department among elders: patterns and predictors. Acad Emerg Med 2000;7:249–59.
56. Himelhoch S, Weller WE, Wu AW, Anderson GF, Cooper LA. Chronic medical illness, depression, and use of acute medical services among medicare beneficiaries. Med Care 2004;42:512–21.
57. Meltzer AC, Bregman B, Blanchard J. Depression is associated with repeat emergency department visits in patients with non-specific abdominal pain. West J Emerg Med 2014;15:325–8.
58. Choi NG, Marti CN, Bruce ML, Kunik ME. Relationship between depressive symptom severity and emergency department use among low-income, depressed homebound older adults aged 50 years and older. BMC Psychiatry 2012;12:233.
59. Choo EK, Ranney ML, Aggarwal N, Boudreaux ED. A systematic review of emergency department technology-based behavioral health interventions. Acad Emerg Med 2012;19:318–28.
60. Rhodes KV, Lauderdale DS, Stocking CB, Howes DS, Roizen MF, Levinson W. Better health while you wait: a controlled trial of a computer-based intervention for screening and health promotion in the emergency department. Ann Emerg Med 2001;37:284–91.
61. Rhodes KV, Lauderdale DS, He T, Howes DS, Levinson W. "Between me and the computer": increased detection of intimate partner violence using a computer questionnaire. Ann Emerg Med 2002;40:476–84.
62. Fein JA, Pailler ME, Barg FK, et al. Feasibility and effects of a web-based adolescent psychiatric assessment administered by clinical staff in the pediatric emergency department. Arch Pediatr Adolesc Med 2010;164:1112–7.
63. Houry D, Kaslow NJ, Kemball RS, et al. Does screening in the emergency department hurt or help victims of intimate partner violence? Ann Emerg Med 2008;51:433–42.
64. Sockalingam S, Arena A, Serhal E, Mohri L, Alloo J, Crawford A. Building provincial mental health capacity in primary care: an evaluation of a Project ECHO Mental Health Program. Acad Psychiatry 2018;42:451–7.
65. Vogel ME, Kanzler KE, Aikens JE, Goodie JL. Integration of behavioral health and primary care: current knowledge and future directions. J Behav Med 2017;40:69–84.
66. Cross SP, Hickie I. Transdiagnostic stepped care in mental health. Public Health Res Pract 2017;27. pii: 2721712.
67. Gjerdingen D, Crow S, McGovern P, Miner M, Center B. Stepped care treatment of postpartum depression: impact on treatment, health, and work outcomes. J Am Board Fam Med 2009;22:473–82.
68. Staab EM, Terras M, Dave P, et al. Measuring perceived level of integration during the process of primary care behavioral health implementation. Am J Med Qual 2018;33:253–61.
69. Butterfield A. Telepsychiatric evaluation and consultation in emergency care settings. Child Adolesc Psychiatr Clin N Am 2018;27:467–78.

70. Hilty DM, Ferrer DC, Parish MB, Johnston B, Callahan EJ, Yellowlees PM. The effectiveness of telemental health: a 2013 review. Telemed e-Health 2013;19:444–54.
71. Tal A, Torous J. The digital mental health revolution: opportunities and risks. Psychiatr Rehabil J 2017;40:263–5.
72. Breslow RE, Klinger BI, Erickson BJ. Time study of psychiatric service evaluations emergency. Gen Hosp Psychiatry 1997;19:1–4.
73. Kaji AH, Schriger D, Green S. Looking through the retrospectoscope: reducing bias in emergency medicine chart review studies. Ann Emerg Med 2014;64:292–8.
74. Lowenstein SR. Medical record reviews in emergency medicine: the blessing and the curse. Ann Emerg Med 2005;45:452–5.
75. Gilbert EH, Lowenstein SR, Koziol-McLain J, Barta DC, Steiner J. Chart reviews in emergency medicine research: where are the methods? Ann Emerg Med 1996;27:305–8.
76. Baicker K, Taubman SL, Allen HL, et al. The Oregon Experiment–effects of Medicaid on clinical outcomes. N Engl J Med 2013;368:1713–22.
77. Medford-Davis LN, Eswaran V, Shah RM, Dark C. The Patient Protection and Affordable Care Act's effect on emergency medicine: a synthesis of the data. Ann Emerg Med 2015;66:496–506.

Supporting Information

The following supporting information is available in the online version of this paper available at http://onlinelibrary.wiley.com/doi/10.1111/acem.13726/full

Data Supplement S1. Supplemental material.