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Association between Operational Positive Depression Symptom Screen Scores on Hospital Admission and 30-Day Readmissions

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Abstract

BACKGROUND: Positive scores on inpatient depression symptom screens have been found to be associated with readmissions, yet most studies have used depression screens collected as part of research studies.

OBJECTIVE: We evaluated whether the relationship between depression severity and readmission persisted when depression screening data was obtained for operational purposes.

DESIGN: Retrospective analysis studying prospective use of PHQ data.

SETTING: Large academic medical center.

INTERVENTION: Ward nurses obtained depression screens from patients soon after admission. Patients who answered ‘yes’ to at least one Patient Health Questionnaire (PHQ)-2 question were screened using the PHQ-9.

MAIN OUTCOMES AND MEASURES: We examined the association between depression severity and 30-day readmissions using logistic regression, adjusting for known predictors of hospital readmission.

RESULTS: From July 2014-June 2016, 18,792 discharged adult medicine inpatients received an initial depression screen (PHQ-2) and 1,105 patients (5.90%) had at least one positive response. Of this group, 3,163 patients (6.32%) were readmitted within 30 days. 1,128 patients received the PHQ-9. Compared to patients with no depression, patients with moderately-severe depression had 3.03 higher odds (95%CI: 1.44-6.38) and patients with severe depression had 1.63 higher odds (95%CI: 0.70-3.78) of being readmitted, after adjusting for known predictors of hospital

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AUTHOR CONTRIBUTIONS

DL, RF, MK, JL, and JP contributed to study design. DL, MK, JL, and JP wrote and edited the manuscript. DL, RF, MK, JL, and JP contributed to data acquisition. RF contributed to statistical analysis. DL, RF, MK, and JP contributed to data analysis and interpretation.

admission. Adding PHQ-9 results did not significantly improve the predictive power of a readmissions model.

CONCLUSIONS: Our mixed results call into question whether PHQ data obtained for operational purposes may differ compared to data obtained for research purposes. Differences in training of screening staff or patient discomfort with discussing depression in the hospital could explain our findings.

INTRODUCTION

Depressive symptoms are linked to poor health outcomes and increased healthcare utilization, including hospital readmissions [1–12]. Patients with both mild and moderate-to-severe depressive symptomology may have a more difficult time managing chronic diseases such as diabetes, hypertension, congestive heart failure, and cardiovascular disease [2, 5, 7, 8, 11]. Depression is associated with less physical activity, a less healthy diet, and lower adherence to chronic disease medications such as hypoglycemics, antihypertensives, and lipid-lowering medications [9]. Depression has also been linked to higher healthcare utilization. A 2016 systematic review and meta-analysis found that depression symptoms are associated with higher rates of readmissions and mortality [6]. Several of the studies included in the meta-analysis observed patients with specific diagnosis such as heart failure, COPD, or diabetes [7–12]. One prior study in the meta-analysis looking at all adult inpatients discovered a dose-response relationship between depression severity and early hospital readmission [13].

In 2012, the Centers for Medicare and Medicaid Services (CMS) implemented the Hospital Readmission Reduction Program (HRRP) by penalizing hospitals with excess 30-day readmission rates [14–15]. In response, health systems have sought to identify risk factors for early hospital readmission [16–18]. Several risk factors have been studied and combined into readmission risk prediction models with moderate predictive capacity [19]. Unfortunately, many risk factors are not amenable to treatment (e.g. prior hospital admissions). Furthermore, others are difficult to obtain, especially early on during a hospital stay, during the time period when hospital personnel may be able to coordinate intervention (e.g. serum sodium level at discharge). Depression, however, is both a treatable risk factor and potentially identifiable at or soon after hospital admission [6].

We sought to understand if depressive symptoms could enhance the predictive power of an existing readmission prediction model. Most studies examining the association between a positive depression screen during hospitalization and readmissions have used depression screening scores obtained for research purposes [6]. We sought to learn whether routine, operations-based inpatient depression screening could predict 30-day readmissions, in contrast to prior studies that had collected depression screening scores as part of research protocols. In this analysis, we used depression screening data obtained for operational reasons at a large quaternary care medical center to test for a positive association between depression symptoms and hospital readmission within 30 days. We also add to the literature by examining whether combining depression screening data with an existing model of hospital readmission would enhance predictive capacity [19].

MATERIALS AND METHODS

Setting and Participants

This retrospective analysis studying prospective use of PHQ data used electronic health record data from a single institution: Cedars-Sinai Medical Center (CSMC), a large non-profit, quaternary care teaching hospital in Los Angeles, California. Our analysis included adult inpatients who were admitted to CSMC from July 1, 2014 to December 31, 2016. Out of 46,508 patients in the initial sample, 1555 patients were excluded from the analysis who died before discharge, were sent to organ procurement, were discharged to hospice, were discharged to a psychiatric hospital, or were under 18 years of age at the time of the encounter. An additional 1309 were excluded due to missing PHQ-2 data. As the HOSPITAL model was designed to work with medical inpatients, we also excluded 24,852 patients discharged from Ob-Gyn, surgical, or psychiatric services [19] (Figure 1). The CSMC Institutional Review Board reviewed and approved the study.

Depression Screening Measures

As part of an operational initiative, ward nurses were instructed to administer the Patient Health Questionnaire-2 (PHQ), a two-question validated depression screening instrument [20–21], to all adult inpatients (≥18 years old) soon after hospital admission. The PHQ-2 includes questions about the frequency of depressed mood and depression symptoms in the last two weeks. For patients who scored positive on the PHQ-2 question (cutoff ≥1), nurses were instructed to subsequently administer the PHQ-9, a nine-question screening instrument that can assess depression symptom severity and can be used to establish potential depressive disorder [22]. Nurses recorded patients' answers in the electronic health record (EHR). A two-step screening process was thought to enhance predictive capabilities as discovered in previous studies [23].

Hospital Readmission Measure

Our primary outcome measure was non-elective hospital readmissions within 30 days of discharge. Any patient re-hospitalized to CSMC via the Emergency Department was considered non-elective.

Covariates

We used descriptive statistics (means and frequencies) to describe the sample. For each patient included in the analysis, we extracted the covariates used in a previously published logistic regression model validated both in the U.S. and with an international cohort of patients [16]. The HOSPITAL model includes: last available Hemoglobin before discharge (positive if <12 g/dL), discharge from an Oncology service, last available Sodium level before discharge (positive if <135 mEq/L), any Procedure performed during the hospitalization (any International Classification of Disease [ICD-9] coded procedure), Index admission Type (non-elective), number of Admissions in the previous year, and Length of stay ≥5 days [19]. Other variables used included demographics, comorbid medical conditions (diabetes mellitus, heart failure, cancer, and kidney disease), previous health care utilization data (number of admissions in the previous year), and data from the index

admission (hemoglobin and sodium level before discharge, length of stay and index admission type). We extracted information about procedures performed during the hospitalization from billing data. Because many CSMC oncologists use hospitalists, we checked if patients had received consultation from an oncologist during the hospital stay to approximate this variable. To control for confounding variables, we adjusted the relationship between PHQ scores and readmission for the seven HOSPITAL factors found to be significant independent predictors of 30-day hospital readmission [19].

Statistical Analysis

We separated PHQ-2 data into two previously validated categories: negative (score of 0) and positive (score of 1 or more) [1]. We also separated PHQ-9 data into the six categories used previously: no depression (0), minimal depression (1-4), mild depression (5-9), moderate depression (10-14), moderately severe depression (15-19) and severe depression [19].

First, we examined the association between a cutoff of 1 on the PHQ-2 and having a 30-day readmission using Fisher's Exact Test. Second, we examined the association between depression severity as measured by the PHQ-9 and 30-day readmission using the Cochran-Armitage Trend Test.

Third, we examined the relationship between depression severity as measured on the PHQ-9 and hospital readmissions, adjusting for covariates in the HOSPITAL model. Finally, we examined whether adding the PHQ-9 data to the HOSPITAL model improved prediction accuracy. We used the *c*-statistic to evaluate prediction accuracy, where $c=1$ for a perfect model and $c=0.5$ for a model with no better than random classification. All reported tests were two-sided at a significance level of $\alpha=0.05$. Data were analysed using SAS statistical software (SAS Institute, Cary, NC).

RESULTS

Demographic and Clinical Characteristics of Study Patients

Out of 18,792 discharged adult medicine inpatients that received an initial depression screen (PHQ-2), 1,128 patients received the full depression screen (PHQ-9) (Figure 1).

Of the 18,792 patients who received a PHQ-2, the median age was 66 (standard deviation [SD]: 15) and the mean length of stay was 5 days (SD: 5). 68% of patients were categorized as White, 19% were Black, 5% were Asian/Pacific Islander, and fewer than 1% were American Indian, Other, or Unknown/Patient Refused. Most patients were Non-Hispanic (87%). Approximately 40% of patients were married, 28% were single, 17% were widowed, and 11% were divorced/legally separated. Most patients (39%) were retired, smaller proportions were employed full-time (14%), self-employed (9%), disabled (13%), not employed (14%), had never worked (7%), or were students (1%). At time of discharge, most patients were discharged to home (58%), to home with home health (27%), or to a skilled nursing facility (10%). With respect to chronic conditions, approximately 12% of patients had cancer at the time of the hospital visit or had been diagnosed with cancer during previous visits, 11% had diabetes, 26% had cardiovascular or cerebrovascular disease (including congestive heart failure), and 16% had kidney disease. With respect to the

variables within the HOSPITAL model, approximately 62% of adult inpatients had low hemoglobin <12g/dl at discharge, 13% had received an oncology consult, about 8% had low sodium levels at discharge (<135mEq/L), 48% had received a procedure during their hospital still, 80% had a nonelective admission, 36% had 1-5 hospital admission during previous year and 3% had >5 hospital admission during previous year, and 53% had a length of hospital stay ≥ 5 days.

(See supplemental Table 1–2 for demographic and clinical characteristics of adult medicine patients discharged who received PHQ-9 vs. those that did not).

Positive PHQ-2 Screen and Readmissions

Out of the 18,792 patients who received the PHQ-2, 1,105 patients (5.88%) had at least one positive response. Patients who had at least one positive answer to the PHQ-2 depression screen had a 30-day readmission rate of 18.10%, compared with a readmission rate of 16.75% among patients with a negative PHQ-2 (p = 0.25, Fisher's Exact Test) (Table 2).

Depression Severity as Measured by the PHQ-9 and Readmissions

Of the 1,128 patients administered the PHQ-9, 107 had scores of no depression (9.49%), 240 had minimal depression (21.28%), 344 had mild depression (30.50%), 193 had moderate depression (17.11%), 145 had moderately severe depression (12.85%), and 99 had severe depression (8.78%) (Table 3). Figure 2 shows the unadjusted 30-day hospital readmission rates according to depression severity, as measured by the PHQ-9. Among patients who had the PHQ-9 screen, we did not see a significant trend between increasing levels of depression severity and higher hospital readmissions (Z=−1.48, p= 0.07, Cochran-Armitage Trend Test). (See supplemental Table 3 for demographic and clinical characteristics of adult medicine patients discharged who received PHQ-9 and were readmitted within 30 days).

Adding Depression Severity to the HOSPITAL Model

We present odds ratios, 95% confidence intervals and p-values for each depression severity level as measured by the PHQ-9 after adjusting for covariates in HOSPITAL model (Table 4). Compared to patients with no depression, patients with minimal depression (PHQ-9 score 1-4), mild depression (PHQ-9 score 5-9), moderate depression (PHQ-9 score 10-14), moderately severe depression (PHQ-9 15-19), and severe depression (PHQ-9 score 20-29) all had higher odds of readmission, although not all were statistically significant. Most notably, compared to patients with no depression, patients with minimal depression had adjusted 2.06-fold higher odds of admission (95% CI: 1.00-4.46) and moderately severe depression had adjusted 3.03-fold higher odds of admission (95% CI: 1.44-6.48, p= 0.04).

We found that adding the PHQ-9 data to the HOSPITAL model increased the c-statistic from 0.699 at baseline to 0.709, but logistic regression modeling did not meet our *a priori* alpha of 0.05 (p=0.07).

DISCUSSION

We found some evidence that depression severity was associated with 30-day readmissions, most notably for patients with minimal depression and moderately severe depression. Interestingly, we did not find that patients with severe depression were significantly more likely to be readmitted compared to patients with no depression, although these findings could be a result of small sample size in the severe depression category (n=99). Additionally, we did not find that adding depression screening results from the PHQ-9 substantially improved the predictive power of the previously published HOSPITAL model. We also did not find an appreciable increase in hospital readmission at higher levels of depression severity.

Our mixed results call into question whether PHQ data obtained for operational purposes may be different than PHQ data obtained for research purposes. There could be a number of reasons for this discrepancy, including differences in how nursing staff administer the PHQ-2 or PHQ-9 compared to trained clinical research staff, or whether patients are less likely to answer honestly in a clinical setting given the potential stigma associated with depression4 and other mental illness [24–26]. Previous studies have found that patients are reticent to discuss depression with their primary care physicians – clinicians with whom they likely have a trusted relationship [27–28]. Patients may be even more unforthcoming about discussing depression symptoms with hospital-based nursing staff whom they do not know, particularly as they may face stigmatizing conditions in the acute hospital setting [24]. Patients may also be reticent to discuss depression symptoms given the type of treatment options often available in the hospital setting.

Moreover, other studies have found that the majority of patients diagnosed with depression in the inpatient setting are not prescribed antidepressants [24]. As depression is often a chronic disease, inpatient clinicians may be less willing to start medications that are mostly managed in the outpatient setting. Future applications of the PHQ in hospital settings should provide more information regarding how the PHQ-2 and PHQ-9 are presented, including how much time is spent on the screening test and which services are available to respond to abnormal scores.

Strengths of our study include using a prespecified published model [19] of readmission risk to adjust for known predictors of readmission. Our sample size using the HOSPITAL model (N=1,128) is substantially larger than other studies [6] examining the relationship between depression as measured by the PHQ-2 and PHQ-9 and readmissions, so if a clear relationship existed, we should have had adequate power to detect this association. Another strength is the use of a two-step screen of a PHQ-2 followed by a PHQ-9. A recent meta-analysis shows that a combination of PHQ-2 (with cutoff ≥2) followed by PHQ-9 (with cutoff ≥10) had similar sensitivity but higher specificity compared with PHQ-9 cutoff scores of 10 or greater alone [23]. Moreover, our study uses data captured in an operational setting, making the results more generalizable than studies which use data captured in a research setting. Our study is an excellent example of how associations may not be as strong in real-world implementation settings as compared to high-quality research studies [6]. Finally, we

used a pre-existing model of factors known to influence hospital readmissions [19]; other studies may have had residual confounding due to the omission of critical covariates.

Our study also has several limitations. Operational deployment of the depression screening tests may have missed many cases of depression. We found a 6% prevalence of depression in this study vs. 30% prevalence in prior studies [6]. Reasons for the lower prevalence rate could be explained by stigma surrounding mental illness, leading to underreporting of severity of PHQ in clinical settings. Moreover, the manner in which the survey was administered could affect the way PHQ was documented. Consequently, the lack of association between depression and readmission can be explained by the misclassification by missing patients who may have atypical symptoms of depression on admission, leading to a less robust association.

We also cannot exclude the possibility that differences in readmission rates could have been due to unmeasured variables that are important predictors of hospital readmission, such as health literacy, medication adherence, and social support. Moreover, depression is often found to be comorbid in a number of conditions, such as COPD, older age and inflammatory bowel disease, that are not controlled for in our model [29–30]. Interestingly, we found that patients diagnosed with cancer and kidney disease in our model had a higher chance of readmission than patients who did not (supplemental table 3).

Moreover, we used an existing predictive model of hospital readmission that uses prior hospital readmissions as one of its adjusting criteria. Thus, adjusting for previous hospital readmissions may have attenuated the true correlation between depression and hospital readmissions. [31–32].

Last, some efforts may have been made to reduce depression severity. (e.g., antidepressants might have been started based on a high PHQ-9 score). Improvement in symptoms often occur between 10-14 days after treatment, which would therefore attenuate the relationship between depression severity and hospital readmission. However, patients may be lost to follow-up after discharge as outpatient psychiatry appointments are often difficult to schedule, which may lead to poor medication adherence [33–34].

In conclusion, we found mixed evidence that depression severity as measured by PHQ-9 scores obtained for operational reasons was associated with 30-day hospital readmission rates. Notably, we did not find a clear association between increasing depression severity and increased likelihood of 30-day readmissions. Our finding reduces the likelihood that operational depression screening could be reliably used as a method of targeting anti-depression interventions to reduce 30-day readmission rates.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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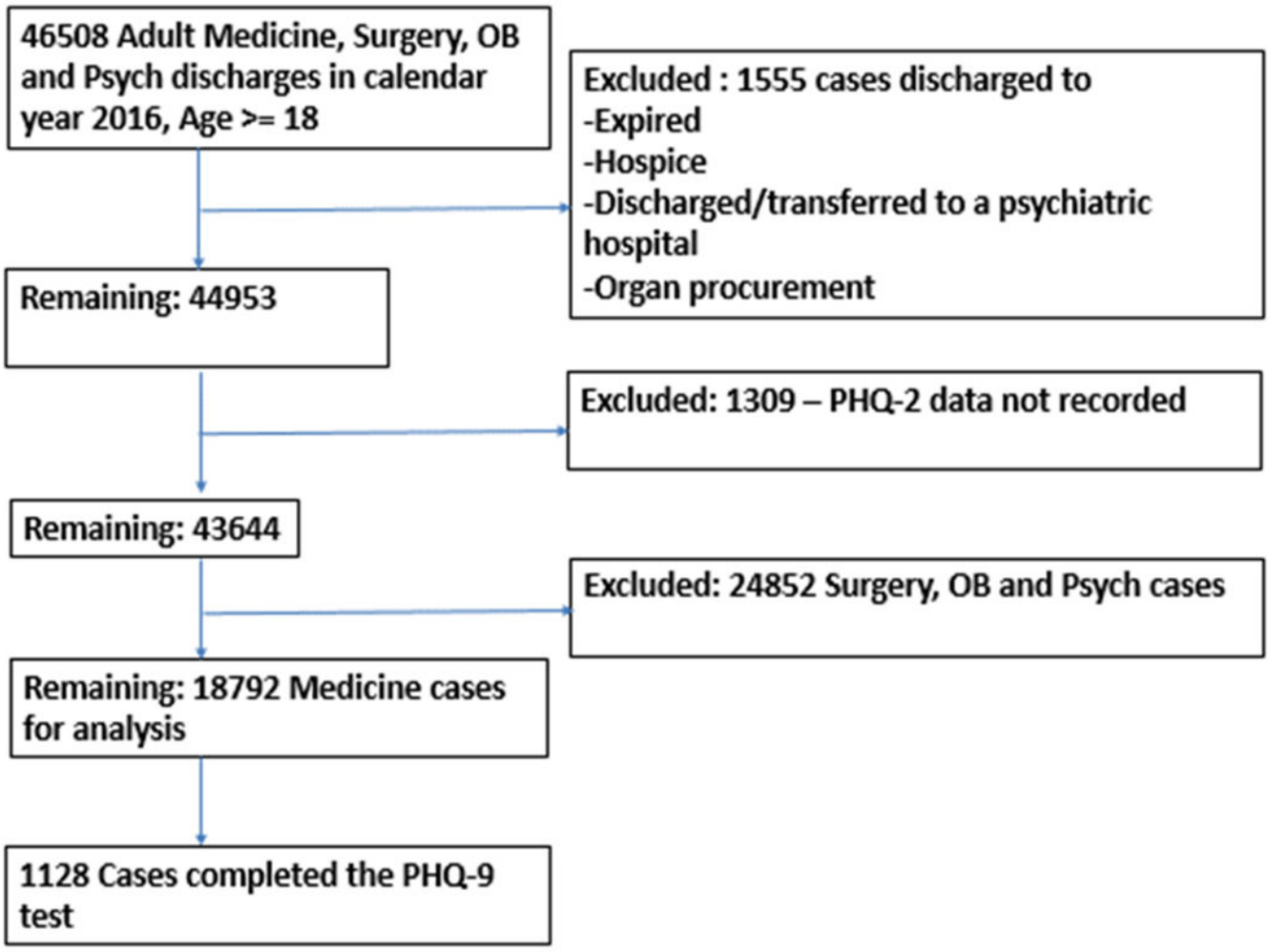

Figure 1.
Study data flow diagram illustrating patients who received the PHQ-9 and were included in the HOSPITAL regression model

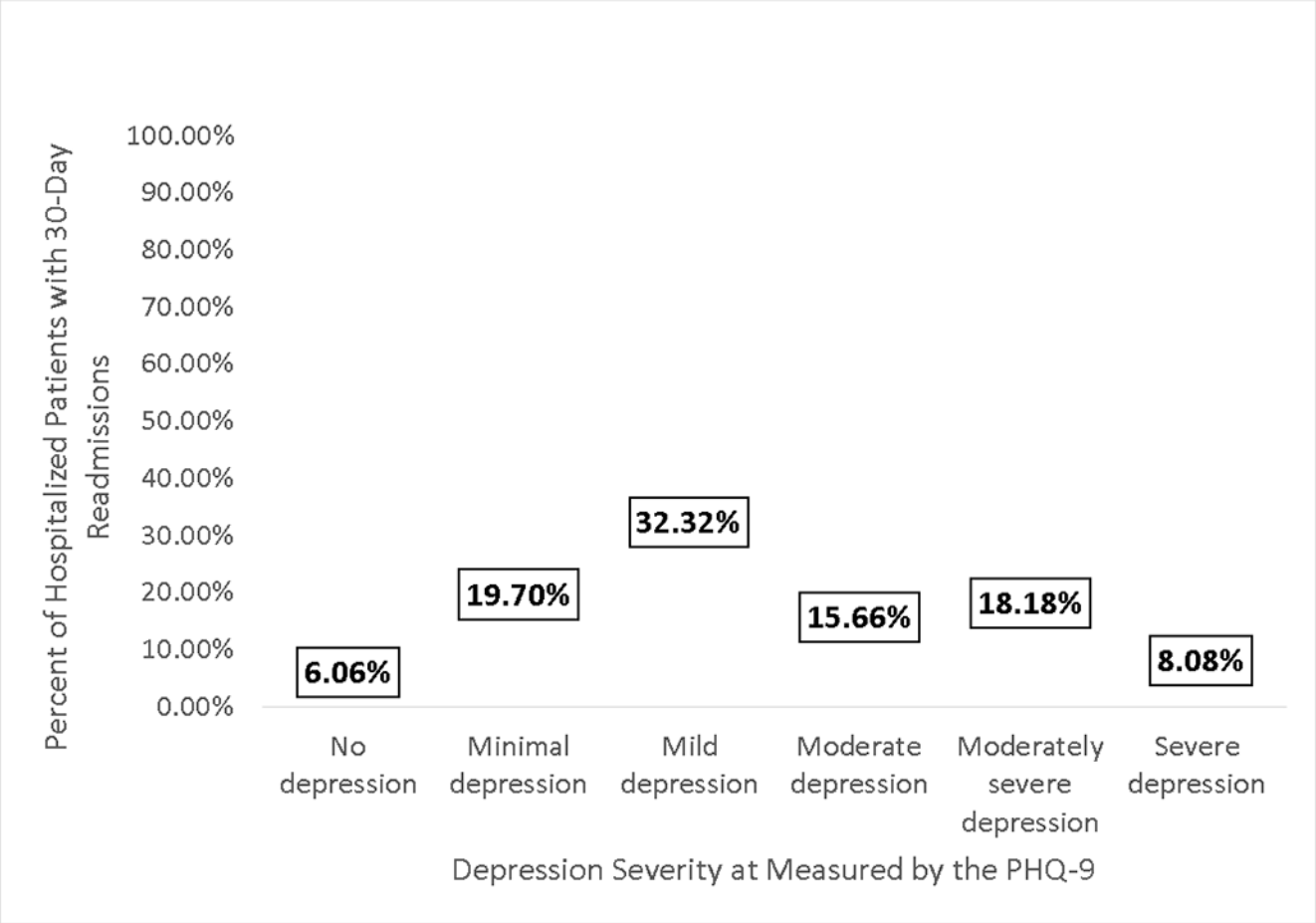

Figure 2.
Percent of patients with 30-day readmissions is varying levels of depression severity as measured by the PQH-19

Table 1.

Demographic and clinical characteristics of adult medicine patients discharged during calendar year 2016 from Cedars-Sinai Medical Center tested with PHQ-2, N=18,792

Variable	Overall (N=18792)
AGE, median (Q1, Q3)	66.0 (51.0, 79.0)
FEMALE, n (%)	9214 (49.0%)
EMPLOYMENT, n (%)	
. Disabled	2414 (12.9%)
. Full Time	2698 (14.4%)
. Never Worked	1346 (7.2%)
. Not Employed	2614 (13.9%)
. On Active Military Duty	1 (0.0%)
. Part Time	247 (1.3%)
. Retired	7404 (39.4%)
. Self Employed	1683 (9.0%)
. Student - Full Time	192 (1.0%)
. Student - Part Time	30 (0.2%)
. Unknown	151 (0.8%)
ETHNIC GROUP, n (%)	
. Hispanic	2431 (12.9%)
. Non-Hispanic	16259 (86.5%)
. Patient Refused	11 (0.1%)
. Unknown	91 (0.5%)
RACE, n (%)	
. American Indian or Alaska Native	41 (0.2%)
. Asian	934 (5.0%)
. Black or African American	3610 (19.2%)
. Native Hawaiian or Other Pacific Islander	40 (0.2%)
. Other	1333 (7.1%)
. Patient Refused	4 (0.0%)
. Unknown	75 (0.4%)
. White	12755 (67.9%)
MARITAL STATUS, n (%)	
. Divorced	1824 (9.7%)
. Domestic Partner	186 (1.0%)
. Legally Separated	229 (1.2%)
. Married	7361 (39.2%)
. Significant Other	622 (3.3%)
. Single	5344 (28.4%)
. Unknown	110 (0.6%)
. Widowed	3115 (16.6%)
HOSPITAL VARIABLES, n (%)	

Variable	Overall (N=18792)
Low hemoglobin at discharge (<12 g/dL)	11576 (61.6%)
Oncology consult	2424 (12.9%)
Low sodium level at discharge (<135 mEq/L)	1454 (7.7%)
Procedure during hospital stay	8929 (47.5%)
Index admission type: nonelective	15075 (80.2%)
1-5 hospital admissions during previous year	6758 (36.0%)
>5 hospital admission during previous year	552 (2.9%)
Length of hospital stay ≥ 5 days	9960 (53%)
DISCHARGE DISPOSITION, n (%)	
. Against Medical Advice (AMA)	316 (1.7%)
. Home	11016 (58.6%)
. Home with home health	5072 (27.0%)
. Hospice- Inpatient Respite/Facility	6 (0.0%)
. Inpatient Acute Care- Another Hospital	102 (0.5%)
. Inpatient Acute Care – At CSMC	36 (0.2%)
. Inpatient Rehab - CSMC	89 (0.5%)
. Inpatient Rehab - OTHER	62 (0.3%)
. Medicare Certified Nursing Facility (SNF)	1902 (10.1%)
. Residential Care Facility	33 (0.2%)
MEDICAL VARIABLES, n (%)	
Cancer, n (%)	2272 (12.1%)
Diabetes, n (%)	2095 (11.1%)
Cardiovascular, n (%)	4944 (26.3%)
Kidney, n (%)	2987 (15.9%)

Table 2.

Positive depression screen as measured by the PHQ-2 and 30-day readmissions

	No 30-day readmission		30-day readmission		Total
PHQ-2 Score	**N**	**%**	**N**	**%**	
No depression (score = 0)	14,724	94.21%	2963	93.68%	17,688
Probably depression (≥ 1 positive answer)	905	5.79%	200	6.32%	1,105
Total	15,629		3,163		18,792

Table 3.

Depression severity as measured by the PHQ-9 and 30-day readmissions

	No 30-day readmission		30-day readmission		Total
PHQ-9 Score	**N**	**%**	**N**	**%**	
No depression (score = 0)	95	10.22%	12	6.06%	107
Minimal depression (score = 1-4)	201	21.61%	39	19.70%	240
Mild depression (score = 5-9)	280	30.11%	64	32.32%	344
Moderate depression (score = 10-14)	162	17.42%	31	15.66%	193
Moderately severe depression (score = 15-19)	109	11.72%	36	18.18%	145
Severe depression (score = 20-29)	83	8.92%	16	8.08%	99
Total	930		198		1128

Table 4.

Adjusted odds ratios measuring the association between depression severity and 30-day readmissions using the HOSPITAL Model (N=1,128)

	Odds Ratio	95% Confidence Intervals		p-value
Depression severity				
No depression (score = 0)	Reference	--	--	--
Minimal depression (score = 1-4)	2.06	1.00	4.26	0.05
Mild depression (score = 5-9)	1.97	1.00	3.93	0.05
Moderate depression (score = 10-14)	1.64	0.77	3.46	0.20
Moderately severe depression (score = 15-19)	3.03	1.44	6.38	0.00
Severe depression (score = 20-29)	1.63	0.70	3.78	0.26
Hemoglobin below discharge (positive if <12 g/dL)	1.27	0.89	1.81	0.20
Discharge from an Oncology service	1.65	1.05	2.61	0.03
Last available Sodium level before discharge (positive if <135 mEq/L)	1.55	0.90	2.69	0.12
Procedure performed during the hospitalization	1.47	1.05	2.06	0.03
Index admission Type (non-elective)	1.01	0.63	1.61	0.98
Number of Admissions in the previous year	2.37	1.68	3.34	<.0001
Length of stay ≥5 days	1.52	1.06	2.19	0.02