ORIGINAL RESEARCH

Treatment Differences in Primary and Specialty Settings in Veterans with Major Depression

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Introduction: The Veterans Health Administration (VHA) supports the nation's largest primary care–mental health integration (PC-MHI) collaborative care model to increase treatment of mild to moderate common mental disorders in primary care (PC) and refer more severe-complex cases to specialty mental health (SMH) settings. It is unclear how this treatment assignment works in practice.

Methods: Patients (n = 2610) who sought incident episode VHA treatment for depression completed a baseline self-report questionnaire about depression severity-complexity. Administrative data were used to determine settings and types of treatment during the next 30 days.

Results: Thirty-four percent (34.2%) of depressed patients received treatment in PC settings, 65.8% in SMH settings. PC patients had less severe and fewer comorbid depressive episodes. Patients with lowest severity and/or complexity were most likely to receive PC antidepressant medication treatment; those with highest severity and/or complexity were most likely to receive combined treatment in SMH settings. Assignment of patients across settings and types of treatment was stronger than found in previous civilian studies but less pronounced than expected (cross-validated AUC = 0.50-0.68).

Discussion: By expanding access to evidence-based treatments, VHA's PC-MHI increases consistency of treatment assignment. Reasons for assignment being less pronounced than expected and implications for treatment response will require continued study. (J Am Board Fam Med 2021;34:268–290.)

Keywords: Comorbidity, Depression, Integrated Health Care Systems, Mental Health Services, Military Medicine, Primary Health Care, Psychotherapy, Self-Report, Veterans Health

Introduction

Depressive disorders are more prevalent among US veterans[1–3] than civilians.[4–6] The Veterans Health Administration (VHA) has initiated a system of primary care–mental health integration (PC-MHI) to address this high prevalence and that of other common mental disorders by including psychologists, psychiatrists, nurses, and social workers on primary care (PC) teams to collaborate in evaluation and treatment.[7] PC-MHI is the country's largest implementation of a collaborative care model for treatment of common mental disorders

and consequently represents a unique opportunity to study implications of team-based treatment. The model has proven effective and efficient in treating mild and moderate depression[7–11] while referring more severe and refractory cases to specialty care[11] based on VHA clinical practice guidelines.[12] However, setting and type of treatment may differ from guidelines because of differences in patient preferences and experiences, differences in comfort levels of PC clinicians in treating depression, and geographic differences in access to services. Whether these factors influence treatment decisions regarding setting and type of treatment, in turn, might have implications for treatment quality and outcomes.[13–20]

Previous research in civilian samples comparing patients in PC versus specialty mental health (SMH) settings has found mixed evidence for differences in depression severity and complexity.[21–23] We would expect assignment to be more distinct in VHA given the existence of PC-MHI and VHA treatment guidelines calling for less complex cases to be treated in integrated PC and more complex cases to be referred to SMH. However, it is unknown whether this is the case. In addition, unknown is what other factors may affect assignment, including patient factors (eg, preferences, comorbidities, sociodemographics, treatment adherence), provider factors (eg, preferences, willingness to treat, time constraints), and system factors (eg, referral resources, incentives). Evidence suggests that prescriber specialty and place of treatment are important factors in determining outcomes.[24,25] As a result, understanding the drivers of patient assignment to a given setting and treatment can help improve care quality, predict successful treatment, and potentially lower health care costs. The current report's goal is to present national data on these issues as part of an observational study of baseline predictors of differential treatment assignment across VHA settings and treatment types among patients with new diagnoses of depression.

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Methods

Sample

Patients were recruited in weekly samples between December 2018 and June 2020. Eligible patients were defined as those identified from VHA electronic medical records (EMRs) as making an outpatient visit at either a PC or SMH clinic for treatment of major depression in the prior week and either receiving a prescription for antidepressant medication (ADM) or referral to psychotherapy. Patients were recruited regardless of whether depression was the primary complaint. As we were interested in analyzing patients with a new diagnosis, past 365 days' exclusions included any VHA visit with a diagnosis of major depression or any ADM prescription. We also excluded patients with a suicide plan in the past 2 weeks or lifetime severe mental disorders (ie, any VHA visit with a diagnosis of bipolar disorder, psychosis, dementia, intellectual disabilities, autism, Tourette's disorder, stereotyped movement disorders, borderline intellectual functioning, or prescription of either antimanic or antipsychotic medication; see Appendix 1 for ICD-9/10-CM codes). In addition, excluded after completing the baseline survey were patients who did not report in the survey that depression was a primary or secondary visit reason.

Recruitment began with a weekly mailing of a letter to a probability sample of eligible patients from VHA records in the conterminous United States who had an initial outpatient visit in the past week, inviting them to participate in a study of depression treatment that would require completing a self-report web or phone-based baseline questionnaire averaging 45 minutes with a $50 incentive and a 3-month self-report follow-up averaging 20 minutes with a $25 incentive. Given the substantial proportion of VHA depressed patients treated with ADM only, we undersampled patients having a record indicating a PC-MHI contact with ADM but not psychotherapy. This allowed a larger proportion of patients treated with psychotherapy to be included in the sample for purposes of comparing psychotherapy between primary and specialty settings. The recruit letter included an 800 number for questions or to opt out. We then made up to 3 recruitment calls at different times over the next week. Cases not reached within the 3 calls were closed out. We focus in the current report on baseline results of the 2610 respondents who passed all

study inclusion and exclusion criteria. The Institutional Review Board of Syracuse VA Medical Center, Syracuse, New York, approved these procedures.

Measures
Administrative Variables Comparing the Analysis Sample with the Population
Information was abstracted from the VHA EMR for patients to whom we mailed invitations (n = 55,106) about sociodemographics (age, sex, race/ethnicity, marital status) and location of home address, whether the incident visit was at a community-based or hospital-based clinic, if depression was the primary or secondary diagnosis and, if secondary, whether the primary diagnosis was another mental disorder or a physical disorder; and if the patient was seen on the day of initial treatment by a primary care clinician (PCP), was prescribed ADM, was referred to psychotherapy, or received a code indicating a PC-MHI contact. Prior mental health history was also abstracted from EMR.

Treatment Setting and Type
Administrative data from the initial visit and following 30 days were used to distinguish patients whose treatment occurred exclusively in PC versus SMH. Patients who began treatment in PC and then moved to SMH were coded as SMH. Treatment type was coded as psychotherapy (patients who were referred to psychotherapy), ADM (patients who received an ADM prescription), or combined (referral to psychotherapy and an ADM prescription). Patients who only had initial visit data were included in the analysis.

Depression and Psychiatric Comorbidity
Depression symptom severity in the 2 weeks before seeking treatment was assessed in the baseline survey with the 16-item Quick Inventory of Depressive Symptomatology Self-Report Scale (QIDS-SR).[26] Total scores were transformed into Hamilton Rating Scale for Depression (HRSD) severity levels of none, mild, moderate, severe, and very severe using published transformation guidelines.[27] Additional questions from diverse instruments were used to enrich the assessment of depressive features to search for dimensions that might distinguish patients across settings and predict treatment response, all using the same 2-week recall period. Depression persistence was defined using questions from the Composite

International Diagnostic Interview[28] to obtain retrospective assessments of depression age of onset, number of years with depression, and length of current depressive episode. Patients were also asked about other presenting mental health problems, asked which were primary versus secondary, and were administered brief dimensional screening scales for comorbid disorders of special interest: post-traumatic stress disorder (PTSD), alcohol/substance disorder, and somatic symptoms disorder. (See Appendix 2 for an overview.)

Analysis Procedures
A comparison of administrative variables between baseline survey respondents and nonrespondents in the sample of 55,106 was conducted using logistic regression. The R program sbw[29] was then used to implement a stable weight balancing procedure[30] to adjust for significant differences between respondents and the full sample. The depression symptom measures were then subjected to exploratory factor analysis in the weighted respondent sample. Factor-based scales were constructed with equal weighting across items with standardized partial regression coefficients of at least 0.40 after assigning means to item-missing score values. The resulting scales were then standardized in the weighted sample to a mean of 0 and variance of 1.0 to facilitate interpretation.

One-way analysis of variance was used to compare patients across settings and types of treatment on standardized (mean of 0, variance of 1.0) administrative variables, depression symptom scales, and comorbidity measures. Similar to prior studies of depression-related outcomes between PC and SMH settings,[22,24] the analyses adjusted for age, sex, race and ethnicity, marital status, census region, urbanicity, percentage of population below 1.5 of poverty line, history of previously diagnosed mental disorders, number of previously diagnosed mental disorders, current depression treatment, and treatment location, setting, and type. Estimates were adjusted for the false discovery rate using the Benjamini–Yekutieli method.[31] Ensemble machine learning[32] was then used to assess distinctiveness of predictor profiles of patients in each setting-type of treatment. This method used a series of different classifiers (Appendix 3) to capture nonlinearities and interactions among predictors to obtain the best 10-fold externally cross-validated prediction of treatment setting-type. Strength of associations was quantified with AUC predicting individual setting-type combinations in the total sample.

Table 1. Distributions and Associations of Administrative Variables with Survey Completion (n = 55,106)†

	Prevalence		Univariate		Multivariate	
	%	(S.E.)	OR	(95% CI)	OR	(95% CI)
Age						
18-34	27.61	(0.19)	0.76*	(0.69-0.83)	0.75*	(0.68-0.82)
35-49	26.91	(0.19)	0.95	(0.87-1.03)	0.94	(0.86-1.03)
50-59	17.06	(0.16)	1.15*	(1.05-1.26)	1.17*	(1.07-1.29)
60+	28.42	(0.19)	1.00	Ref	1.00	Ref
χ^2_3			72.65*		76.83*	
Sex						
Male	82.67	(0.16)	0.77*	(0.72-0.84)	0.69*	(0.63-0.75)
Race/ethnicity						
Non-Hispanic White	60.84	(0.21)	1.00	Ref	1.00	Ref
Non-Hispanic Black	25.12	(0.18)	0.66*	(0.61-0.71)	0.66*	(0.60-0.72)
Hispanic	10.30	(0.13)	0.63*	(0.56-0.72)	0.67*	(0.59-0.76)
Other	3.74	(0.08)	0.58*	(0.47-0.71)	0.59*	(0.48-0.72)
χ^2_3			154.23*		128.88*	
Marital status						
Currently married	48.60	(0.21)	1.00	Ref	1.00	Ref
Divorced	21.87	(0.18)	0.83*	(0.77-0.91)	0.82*	(0.75-0.89)
Separated	4.70	(0.09)	0.90	(0.77-1.05)	0.99	(0.84-1.15)
Widowed	2.14	(0.06)	0.76*	(0.60-0.97)	0.69*	(0.54-0.89)
Never married	22.69	(0.18)	0.78*	(0.72-0.85)	0.90*	(0.82-0.98)
χ^2_4			42.34*		28.52*	
Census region						
Northeast	10.77	(0.13)	1.02	(0.91-1.15)	0.98	(0.86-1.10)
Midwest	17.67	(0.16)	1.10	(0.99-1.21)	1.01	(0.91-1.13)
South	50.64	(0.21)	0.98	(0.90-1.07)	0.97	(0.89-1.06)
West	20.92	(0.17)	1.00	Ref	1.00	Ref
χ^2_3			6.65		1.11	
Urbanicity						
Major metro	85.87	(0.15)	1.00	Ref	1.00	Ref
Urban	12.73	(0.14)	1.19*	(1.09-1.31)	1.10	(1.00-1.21)
Rural	1.40	(0.05)	1.21	(0.94-1.56)	1.10	(0.85-1.42)
χ^2_2			15.83*		3.73	
% of population below 1.5 of poverty line						
1st quartile (low % with low income)	25.00	(0.18)	1.00	Ref	1.00	Ref
2nd quartile	25.00	(0.18)	1.10	(1.00-1.20)	1.02	(0.93-1.12)
3rd quartile	25.00	(0.18)	1.15*	(1.05-1.26)	1.06	(0.96-1.16)
4th quartile (high % with low income)	25.00	(0.18)	1.19*	(1.08-1.30)	1.10	(1.00-1.21)
χ^2_3			14.97*		4.15	
History of previously diagnosed mental disorders						
Depression	47.99	(0.21)	0.86*	(0.81-0.92)	0.89	(0.79-1.01)
Anxiety	28.27	(0.19)	0.92*	(0.86-0.99)	1.00	(0.83-1.21)
PTSD	24.28	(0.18)	0.83*	(0.77-0.90)	0.87	(0.71-1.06)
Adjustment disorder	16.10	(0.16)	0.98	(0.89-1.07)	1.11	(0.90-1.37)
Other reactions to stress	6.40	(0.10)	0.98	(0.86-1.12)	1.25	(0.77-2.05)
Substance	17.62	(0.16)	0.77*	(0.70-0.84)	0.89	(0.70-1.14)
Other disorders	18.84	(0.17)	1.03	(0.95-1.12)	1.08	(0.87-1.33)

Continued

Table 1. Continued

	Prevalence		Univariate		Multivariate	
	%	(S.E.)	OR	(95% CI)	OR	(95% CI)
Number of previously diagnosed mental disorders						
0	30.29	(0.20)	1.00	Ref	1.00	Ref
1	22.00	(0.18)	0.94	(0.86-1.03)	—	—
2	21.34	(0.17)	0.85*	(0.77-0.93)	0.85*	(0.78-0.94)
3+	26.38	(0.19)	0.82*	(0.76-0.90)	0.85*	(0.78-0.93)
$\chi^2{}_3$				25.46*		
Current depression treatment						
Primary	58.16	(0.21)	0.89*	(0.82-0.96)	0.86	(0.80-0.93)
Secondary with primary physical	16.96	(0.16)	1.11*	(1.01-1.22)	1.02	(0.91-1.14)
Secondary with primary other mental	24.88	(0.18)	1.00	Ref	1.00	Ref
$\chi^2{}_2$				30.07*		19.69*
Treatment location, setting, and type						
Seen in community-based clinic	57.15	(0.21)	1.18*	(1.10-1.26)	1.15*	(1.07-1.23)
Seen by primary care clinician	39.64	(0.21)	1.09*	(1.11-1.16)	1.02	(0.94-1.11)
Received psychotherapy‡	89.29	(0.13)	0.92	(0.83-1.01)	1.10	(0.97-1.25)
Received medication	31.81	(0.20)	1.05	(0.98-1.13)	1.04	(0.96-1.14)
Received PC-MHI treatment	35.95	(0.20)	0.96	(0.89-1.02)	0.99	(0.92-1.07)

CI, confidence interval; OR, odds ratio; PC-MHI, primary care–mental health integration; PTSD, post-traumatic stress disorder; S.E., standard error.
*Significant at the 0.05 level, 2-sided test.
†Weighted to represent treatment distribution in population.
‡Either saw a mental health specialist or referred to mental health treatment.

Results

Comparison of Analysis Sample with the Full Original Sample

Of the 55,106 patients we attempted to contact, 17,000 were reached by telephone. The others either were not reached after 3 calls (n = 27,603), their phone numbers no longer worked (n = 6,828), or they moved without forwarding information (n = 3,675) (Appendix 4). Of the 17,000, 6,298 patients agreed to participate, and 4,164 completed the baseline questionnaire (24.4% cooperation rate). We subsequently excluded 1,554 respondents because they had a history of bipolar disorder not found in VHA records (n = 728), reported current suicidality (n = 84), said depression was not a primary or secondary presenting problem (n = 471), or reported no depression severity in the 2 weeks before baseline assessment (n = 271). Analysis focuses on the remaining 2,610 patients, most of whom were young (54.5% aged 49 years or less), male (82.7%), non-Hispanic White (60.8%), married (48.6%), living in the south (50.6%), and living in major metro areas (85.9%). About half reported a prior history of depression (48.0%). Most had 1 or more mental comorbidities (69.7%). Most reported that depression was their main reason to seek care (58.2%) (Table 1). Most patients were referred to psychotherapy (89.3%), while less than one third were prescribed an ADM (31.8%).

Patients who completed the questionnaire were, on average, somewhat older than nonrespondents and more likely to be female, non-Hispanic White, and currently married, with reduced odds among the under-represented categories in the range OR = 0.58-0.83. Although these characteristics were related significantly to participation ($\chi^2{}_{35} = 401.2$, $P < .001$), the multivariate association of predictors with participation was weak (AUC = 0.59). We nonetheless weighted the sample of survey respondents to adjust for these small differences.[30]

Exploratory Factor Analysis of Depression Symptom Severity Measures

Sixteen percent (16.4%) of patients who completed the questionnaire and were eligible had one or more missing items (10.9% missing only 1 item, 2.2% 2, 1.5% 3, and 1.7% 4+, 0.6% overall item

missing response rate). Exploratory factor analysis among respondents with complete data found 7 factors that, after promax rotation, were labeled depression symptom severity (14 items; Cronbach's α = 0.92), positive mental health (19 items; α = 0.81), anhedonia (5 items; α = 0.86), cognitive difficulties (7 items; α = 0.20), rumination (5 items; α = 0.72), dissociation (4 items; α = 0.89), and mixed features (6 items; α = 0.78) (Appendix 5). Correlations among factors were between 0.53 (depression symptom severity and low positive mental health) and 0.09 (cognitive difficulties and mixed features) (Appendix 6).

Distribution and Administrative Correlates of Treatment Setting and Type

Thirty-four percent (34.2%) of depressed patients were treated in integrated PC and 65.8% in SMH during the initial visit and following 30 days. Patients with PC-MHI encounters receiving only ADM made up 32.4% of the weighted PC sample compared with 18.2% of the SMH sample. Patients with psychotherapy made up 46.9% of the PC sample and 51.7% of SMH. Patients with combined treatment made up the remaining 20.8% of PC and 30.2% of SMH samples.

Patients in PC differed only modestly from those in SMH in terms of sociodemographics and geographic variables. More consistent, albeit relatively modest, differences were found in history of prior mental disorders, which were all less common among PC than SMH patients, with PC standardized mean estimates (Est) ranging between −0.05 and −0.18 (Table 2). PC patients were somewhat less likely than SMH patients to have presented with depression secondary to another mental disorder (Est = -0.15) and less likely to receive a psychotherapy referral on the first visit (Est = -0.35). PC patients were more likely than SMH patients, in comparison, to have presented with depression secondary to a physical disorder and to receive an ADM prescription (Est = 0.14-0.16). PC patients were more likely than SMH patients to have received a PC-MHI encounter during their first visit (Est = 0.70).

Administrative variables were also associated with treatment type within and between settings. Sociodemographics were generally weak predictors, although the oldest patients (ages 60+) were less likely than others to receive combined treatment in both settings (Est = −0.13 to −0.18). Six out of 11 measures of prior mental disorders were predictors of treatment setting-type (F_5 = 3.4-9.9, P = .005-<0.001), with increases in SMH and especially SMH combined treatment (Est = 0.13-0.18) strongest for prior PTSD, substance disorder, and 3+ prior diagnoses compared with other treatment types. Presenting problems were also predictors, with primary depression more likely to be treated with PC psychotherapy (Est = 0.27), depression secondary to a physical disorder with PC ADM (Est = 0.78), and depression secondary to another mental disorder with SMH ADM or combined treatment (Est = 0.16-0.18).

Patients seen initially by a PCP were more likely than others to end up in PC ADM (Est = 0.78) or combined (Est = 0.35) treatment, whereas patients receiving ADM on their initial visit were more likely than others to end up in ADM treatment either in PC or SMH (Est = 1.03-0.79). Patients receiving psychotherapy or a psychotherapy referral on their first visit were more likely than others to end up in psychotherapy either in PC (Est = 0.34) or SMH (Est = 0.35). Patients with a PC-MHI encounter on their first visit were more likely than others to end up in PC psychotherapy (Est = 1.25) or PC combined treatment (Est = 0.87).

Depression Symptom Correlates of Treatment Setting and Type

The proportion of cases classified severe or very severe depression on the QIDS-SR/HRSD and 6 of the 7 depression symptom factors were all elevated among patients in SMH compared with PC (F_1 = 7.7-19.1, P = .006-<0.001), but with relatively modest standardized associations (Est = 0.04-0.05) (Table 3). Treatment types within and between settings show 2 noticeable associations: very severe cases more likely to receive SMH combined treatment (Est = 0.17) and less likely to receive ADM treatment in PC (Est = -0.14); patients with anhedonia, were less likely to receive PC psychotherapy (Est = -0.12), and more likely to receive SMH combined treatment (Est = 0.14).

Comorbidity Correlates of Treatment Setting and Type

The results for self-reported comorbidity showed differences between settings on 5 of 10 measures (F_1 = 7.5-30.7, P = .006-<0.001), mostly due to modestly higher comorbidities among SMH than PC patients (Est = 0.04-0.08) and associations for

Table 2. Associations of Administrative Variables with Setting and Type of Treatment (n = 2610)†

| | Target | | Primary Care | | | | | | | | Specialty Mental Health | | | | | | | | | | |
| | | | Psychotherapy‡ (n = 290) | | ADM (n = 439) | | Combined (n = 219) | | Total (n = 948) | | Psychotherapy‡ (n = 697) | | ADM (n = 373) | | Combined (n = 592) | | Total (n = 1662) | | F_5 | F_1 |
	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)		
Age																				
18 to 34	27.61	(0.19)	−0.08	(0.06)	−0.03	(0.05)	0.07	(0.07)	−0.03	(0.03)	−0.01	(0.04)	0.06	(0.05)	0.03	(0.04)	0.02	(0.02)	1.2	1.6
35 to 49	26.91	(0.19)	−0.04	(0.06)	−0.02	(0.05)	−0.07	(0.07)	−0.04	(0.03)	−0.07	(0.04)	0.08	(0.05)	0.13	(0.04)	0.02	(0.02)	3.2	2.0
50 to 59	17.06	(0.16)	−0.07	(0.06)	−0.03	(0.05)	0.15	(0.07)	−0.01	(0.03)	0.01	(0.04)	−0.02	(0.05)	0.01	(0.04)	0.00	(0.02)	1.3	0.1
60+	28.42	(0.19)	0.18	(0.06)	0.08	(0.05)	−0.13	(0.06)	0.08	(0.03)	0.07	(0.04)	−0.12	(0.05)	−0.18*	(0.04)	−0.04	(0.02)	8.6*	8.7*
Sex																				
Male	82.67	(0.16)	0.09	(0.06)	−0.09	(0.05)	−0.03	(0.07)	0.01	(0.03)	0.06	(0.04)	−0.05	(0.05)	−0.09	(0.04)	0.00	(0.02)	2.9	0.1
Race/ethnicity																				
Non-Hispanic white	60.84	(0.21)	−0.08	(0.06)	0.03	(0.05)	−0.10	(0.07)	−0.05	(0.03)	0.05	(0.04)	−0.02	(0.05)	0.01	(0.04)	0.03	(0.02)	1.6	3.3
Non-Hispanic black	25.12	(0.18)	0.12	(0.06)	−0.05	(0.05)	0.07	(0.07)	0.05	(0.03)	−0.04	(0.04)	−0.01	(0.05)	−0.02	(0.04)	−0.03	(0.02)	1.8	3.9
Hispanic	10.30	(0.13)	−0.05	(0.05)	0.01	(0.05)	0.07	(0.07)	−0.01	(0.03)	−0.02	(0.04)	0.06	(0.06)	0.01	(0.04)	0.00	(0.02)	0.8	0.1
Other	3.74	(0.08)	0.04	(0.06)	0.01	(0.05)	0.00	(0.07)	0.02	(0.03)	−0.02	(0.04)	−0.02	(0.05)	0.00	(0.04)	−0.01	(0.02)	0.2	0.6
Marital status																				
Currently married	48.60	(0.21)	0.04	(0.06)	0.05	(0.05)	0.00	(0.07)	0.04	(0.03)	−0.03	(0.04)	0.07	(0.05)	−0.06	(0.04)	−0.02	(0.02)	1.1	1.7
Divorced	21.87	(0.18)	−0.04	(0.06)	−0.02	(0.05)	0.00	(0.07)	−0.03	(0.03)	0.02	(0.04)	−0.16*	(0.04)	0.11	(0.04)	0.01	(0.02)	3.2	1.0
Separated	4.70	(0.09)	−0.07	(0.05)	−0.07	(0.04)	−0.09	(0.05)	−0.07	(0.03)	0.02	(0.04)	0.05	(0.06)	0.06	(0.05)	0.04	(0.03)	1.6	7.6
Widowed	2.14	(0.06)	0.05	(0.07)	0.06	(0.06)	0.02	(0.07)	0.05	(0.04)	0.00	(0.04)	−0.03	(0.05)	−0.06	(0.03)	−0.02	(0.02)	0.8	2.8
Never married	22.69	(0.18)	0.01	(0.06)	−0.01	(0.05)	0.04	(0.07)	0.01	(0.03)	0.00	(0.04)	0.05	(0.05)	−0.05	(0.04)	0.00	(0.02)	0.5	0.1
Census region																				
Northeast	10.77	(0.13)	−0.09	(0.05)	−0.15*	(0.04)	−0.20*	(0.04)	−0.13*	(0.03)	0.11	(0.04)	0.01	(0.05)	0.02	(0.04)	0.07	(0.03)	5.9*	23.3*
Midwest	17.67	(0.16)	−0.07	(0.06)	−0.03	(0.05)	0.00	(0.07)	−0.04	(0.03)	0.06	(0.04)	−0.03	(0.05)	0.00	(0.04)	0.02	(0.02)	1.1	2.4
South	50.64	(0.21)	0.12	(0.06)	0.07	(0.05)	0.14	(0.07)	0.11*	(0.03)	−0.13*	(0.04)	0.08	(0.05)	−0.01	(0.04)	−0.06	(0.02)	5.6*	15.6*
West	20.92	(0.17)	−0.01	(0.06)	0.05	(0.05)	−0.02	(0.07)	0.01	(0.03)	0.02	(0.04)	−0.07	(0.05)	0.00	(0.04)	0.00	(0.02)	0.5	0.1
Urbanicity																				
Major metro	85.87	(0.15)	0.13	(0.05)	−0.04	(0.05)	0.18*	(0.05)	0.09	(0.03)	−0.15*	(0.04)	0.01	(0.05)	0.10	(0.04)	−0.04	(0.03)	7.7*	10.0*
Urban	12.73	(0.14)	−0.14	(0.05)	0.06	(0.05)	−0.18*	(0.05)	−0.08	(0.03)	0.15*	(0.04)	−0.01	(0.05)	−0.10	(0.04)	0.04	(0.03)	8.0*	9.8*
Rural	1.40	(0.05)	0.01	(0.06)	−0.05	(0.04)	0.00	(0.07)	−0.01	(0.03)	0.02	(0.04)	0.01	(0.05)	−0.01	(0.04)	0.01	(0.03)	0.2	0.3
% of population below 1.5 of poverty line																				

Continued

Table 2. Continued

			Primary Care								Specialty Mental Health									
	Target		Psychotherapy‡ (n = 290)		ADM (n = 439)		Combined (n = 219)		Total (n = 948)		Psychotherapy‡ (n = 697)		ADM (n = 373)		Combined (n = 592)		Total (n = 1662)		F_S	F_I
	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)		
1st quartile (low % with low income)	25.00	(0.18)	−0.08	(0.06)	−0.06	(0.05)	0.13	(0.07)	−0.03	(0.03)	0.04	(0.04)	−0.06	(0.05)	0.02	(0.04)	0.02	(0.02)	2.0	1.3
2nd quartile	25.00	(0.18)	−0.01	(0.06)	0.07	(0.05)	0.03	(0.07)	0.02	(0.03)	0.00	(0.04)	0.00	(0.05)	−0.05	(0.04)	−0.01	(0.02)	0.5	0.7
3rd quartile	25.00	(0.18)	0.00	(0.06)	0.04	(0.05)	−0.10	(0.06)	−0.01	(0.03)	−0.01	(0.04)	0.06	(0.05)	0.00	(0.04)	0.00	(0.02)	0.7	0.1
4th quartile (high % with low income)	25.00	(0.18)	0.09	(0.06)	−0.05	(0.05)	−0.06	(0.07)	0.01	(0.03)	−0.03	(0.04)	0.00	(0.05)	0.03	(0.04)	−0.01	(0.02)	1.2	0.2
History of previously diagnosed mental disorders																				
Depression	47.99	(0.21)	0.00	(0.06)	−0.09	(0.05)	−0.09	(0.07)	−0.05	(0.03)	0.02	(0.04)	0.03	(0.05)	0.03	(0.04)	0.03	(0.02)	1.0	3.3
Anxiety	28.27	(0.19)	−0.04	(0.06)	−0.19*	(0.04)	0.00	(0.07)	−0.08	(0.03)	0.01	(0.04)	0.10	(0.05)	0.06	(0.04)	0.04	(0.03)	3.2	8.8*
PTSD	24.28	(0.18)	−0.12	(0.05)	−0.24*	(0.04)	−0.20*	(0.06)	−0.18*	(0.03)	0.07	(0.04)	0.09	(0.05)	0.13	(0.04)	0.09*	(0.03)	9.3*	43.0*
Adjustment disorder	16.10	(0.16)	−0.05	(0.06)	−0.20*	(0.04)	0.00	(0.07)	−0.09	(0.03)	0.05	(0.04)	0.03	(0.05)	0.06	(0.04)	0.05	(0.03)	3.4*	11.0*
Other reactions to stress	6.40	(0.10)	−0.04	(0.05)	−0.12	(0.04)	−0.05	(0.06)	−0.07	(0.03)	−0.01	(0.04)	0.09	(0.06)	0.08	(0.05)	0.04	(0.03)	2.2	6.3
Substance	17.62	(0.16)	−0.12	(0.05)	−0.17*	(0.04)	−0.13	(0.06)	−0.14*	(0.03)	0.03	(0.04)	0.00	(0.05)	0.18*	(0.05)	0.07	(0.03)	7.0*	25.8*
Other disorders	18.84	(0.17)	−0.12	(0.05)	−0.21*	(0.04)	−0.01	(0.07)	−0.13*	(0.03)	0.04	(0.04)	0.07	(0.05)	0.11	(0.04)	0.07	(0.03)	5.8*	22.6*
Number of previously diagnosed mental disorders																				
0	30.29	(0.20)	0.07	(0.06)	0.28*	(0.05)	0.11	(0.07)	0.15*	(0.03)	−0.07	(0.04)	−0.09	(0.05)	−0.08	(0.04)	−0.08*	(0.02)	7.6*	29.9*
1	22.00	(0.18)	0.09	(0.06)	0.03	(0.05)	−0.04	(0.07)	0.04	(0.03)	0.00	(0.04)	0.01	(0.05)	−0.09	(0.04)	−0.02	(0.02)	1.7	2.6
2	21.34	(0.17)	−0.06	(0.06)	−0.09	(0.04)	0.10	(0.07)	−0.04	(0.03)	0.02	(0.04)	0.02	(0.05)	0.02	(0.04)	0.02	(0.02)	1.3	1.8
3+	26.38	(0.19)	−0.12	(0.05)	−0.26*	(0.04)	−0.17	(0.06)	−0.17*	(0.03)	0.05	(0.04)	0.07	(0.05)	0.16*	(0.04)	0.09*	(0.03)	9.9*	41.7*
Current depression treatment																				
Primary	58.16	(0.21)	0.27*	(0.05)	−0.38*	(0.05)	0.07	(0.07)	0.02	(0.03)	−0.04	(0.04)	0.04	(0.05)	0.02	(0.04)	−0.01	(0.02)	15.6*	0.3
Secondary with primary physical	16.96	(0.16)	−0.24*	(0.04)	0.78*	(0.06)	0.02	(0.07)	0.14*	(0.04)	0.06	(0.04)	−0.22*	(0.04)	−0.22*	(0.03)	−0.07*	(0.02)	53.9*	28.1*
Secondary with primary other mental	24.88	(0.18)	−0.09	(0.05)	−0.27*	(0.04)	−0.11	(0.06)	−0.15*	(0.03)	−0.01	(0.04)	0.16	(0.06)	0.18*	(0.05)	0.08	(0.03)	10.3*	31.8*
Treatment location, setting, and type																				
Seen in community-based clinic	57.15	(0.21)	0.01	(0.06)	−0.02	(0.05)	−0.04	(0.07)	−0.01	(0.03)	0.13*	(0.04)	−0.11	(0.05)	−0.14*	(0.04)	0.00	(0.02)	5.7*	0.1

Continued

Table 2. Continued

| | Target | | Primary Care | | | | | | | | | | Specialty Mental Health | | | | | | | | | | |
| | | | Psychotherapy‡ (n = 290) | | ADM (n = 439) | | Combined (n = 219) | | Total (n = 948) | | Psychotherapy‡ (n = 697) | | ADM (n = 373) | | Combined (n = 592) | | Total (n = 1662) | | F_5 | F_1 |
	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)		
Seen by primary care clinician	39.64	(0.21)	−0.35*	(0.05)	0.78*	(0.03)	0.35*	(0.07)	0.16*	(0.03)	−0.16*	(0.04)	−0.05	(0.05)	0.03	(0.04)	−0.08*	(0.02)	60.5*	34.9*
Received psychotherapy‡	89.29	(0.20)	0.34*	(0.01)	−1.44*	(0.08)	−0.21	(0.08)	−0.35*	(0.04)	0.35*	(0.00)	−0.03	(0.05)	0.02	(0.04)	0.18*	(0.02)	217.4*	179.1*
Received medication	31.81	(0.13)	−0.72*	(0.02)	1.03*	(0.03)	0.74*	(0.06)	0.15*	(0.03)	−0.74*	(0.01)	0.79*	(0.05)	0.53*	(0.04)	−0.08*	(0.02)	656.1*	31.8*
Received PC–MHI treatment	35.95	(0.20)	1.25*	(0.03)	−0.23*	(0.04)	0.87*	(0.06)	0.70*	(0.03)	−0.36*	(0.03)	−0.65*	(0.02)	−0.19*	(0.04)	−0.36*	(0.02)	367.4*	878.2*

ADM, antidepressant medication; Est, standardized mean estimates; PC-MHI, primary care–mental health integration; PTSD, post-traumatic stress disorder; S.E., standard error.
*Significant at the 0.05 level, 2-sided test, adjusted for false discovery rate.
†Weighted to represent treatment distribution in population; estimates in the target column are in true metrics of the scales, whereas estimates in the other columns are based on standardized values of the row variables, with mean of 0 and variables of 1.0.
‡Either saw a mental health specialist or referred to mental health treatment.

setting-type combinations (Table 4). Comorbidity was elevated for 3 measures among patients in SMH combined treatment (Est = 0.14-0.15; PTSD, other anxiety, and substance disorders) and for 1 measure among patients in SMH ADM treatment (Est = 0.17, other anxiety). Comorbidity was reduced, in comparison, for PTSD among patients in PC ADM treatment (Est = -0.25) and for anxiety disorder among patients in PC psychotherapy (Est = -0.13). Comorbidity prevalence estimates were much higher when based on EMR data than on self-reported data. Despite the higher prevalence, comorbidity patterns were similar between PC and SMH patients, with only 5 of 10 comorbidity measures showing significant differences (F_1 = 9.2.1-32.0, P = .002-<0.001). Comorbid PTSD was high among SMH patients on ADM (Est = 0.15) or combined treatment (Est = 0.18) and reduced among PC patients with psychotherapy (Est = -0.16) or ADM (Est = -0.12). Comorbid substance use disorder patients were more likely to receive combined treatment in SMH (Est = 0.21) than in a PC setting (Est = -0.19).

Joint Predictive Associations
As many of the statistically significant associations in Tables 2-4 were relatively modest in substantive terms, we estimated a series of ensemble machine learning models to quantify the joint predictive associations of all baseline variables with treatment setting-type (Appendix 7). Cross-validated AUC for integrated PC versus SMH was 0.64, for specific types of PC treatment in the range 0.53-0.68, and for specific types of SMH treatment in the range 0.50-.60. The highest AUC (0.68) was for PC ADM, the treatment type consistently associated with the lowest depression severity-complexity.

Discussion
This analysis is among the first national studies of depression among VHA patients that linked administrative data with patient-reported symptoms. Three important findings emerged. First, depressed veterans seen in integrated PC have less severe and comorbid episodes on average than those seen in SMH. This finding contrasts with studies in other health care systems, which found mixed evidence for whether depression severity and psychiatric comorbidity were higher among SMH than PC patients.[21–23,33,34] Second, within-setting analyses showed that these broad patterns are due largely to

Table 3. Associations of Depression Severity with Setting and Type of Treatment (n = 2610)†

| | Target | | Primary Care | | | | | | | | Specialty Mental Health | | | | | | | | | | |
| | | | Psychotherapy‡ (n = 290) | | ADM (n = 439) | | Combined (n = 219) | | Total (n = 948) | | Psychotherapy‡ (n = 697) | | ADM (n = 373) | | Combined (n = 592) | | Total (n = 1662) | | F₅ | F₁ |
	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)		
QIDS-SR	13.12	(0.08)	0.02	(0.06)	−0.18*	(0.05)	−0.06	(0.07)	−0.06	(0.03)	−0.09	(0.04)	0.06	(0.05)	0.22*	(0.04)	0.03	(0.02)	8.6*	4.6
HRSD (%)																				
Mild	29.54	(0.89)	0.00	(0.06)	0.09	(0.05)	−0.01	(0.07)	0.02	(0.03)	0.08	(0.04)	−0.06	(0.05)	−0.14*	(0.04)	−0.01	(0.02)	3.8*	0.8
Moderate	33.80	(0.93)	0.03	(0.06)	0.10	(0.05)	0.03	(0.07)	0.05	(0.03)	−0.02	(0.04)	−0.02	(0.05)	−0.05	(0.04)	−0.03	(0.02)	1.0	3.7
Severe	20.81	(0.79)	−0.10	(0.05)	−0.09	(0.04)	−0.02	(0.07)	−0.08	(0.03)	0.00	(0.04)	0.10	(0.06)	0.06	(0.04)	0.04	(0.03)	2.3	8.3*
Very severe	15.85	(0.71)	0.07	(0.06)	−0.14*	(0.04)	0.00	(0.07)	−0.01	(0.03)	−0.08	(0.03)	−0.02	(0.05)	0.17*	(0.05)	0.01	(0.02)	5.7*	0.2
Years with depression (mean)	9.74	(0.22)	0.06	(0.07)	−0.07	(0.04)	−0.08	(0.06)	−0.01	(0.03)	0.06	(0.04)	−0.09	(0.05)	−0.03	(0.04)	0.01	(0.02)	2.1	0.2
Depression persistence (%)	50.93	(0.67)	−0.08	(0.06)	−0.12	(0.05)	0.04	(0.07)	−0.06*	(0.03)	0.01	(0.04)	0.00	(0.05)	0.10	(0.04)	0.03	(0.02)	2.3	5.7
Depression factors																				
Depression severity	0.00	(0.02)	−0.07	(0.06)	−0.20*	(0.05)	0.02	(0.07)	−0.09*	(0.03)	−0.07	(0.04)	0.11	(0.05)	0.22*	(0.04)	0.05	(0.02)	9.7*	11.8*
Positive mental health	0.00	(0.02)	0.11	(0.06)	0.18*	(0.05)	0.04	(0.06)	0.12	(0.03)	0.04	(0.04)	−0.10	(0.05)	−0.21*	(0.04)	−0.06	(0.02)	8.8*	19.1*
Anhedonia	0.00	(0.02)	−0.12	(0.06)	−0.09	(0.05)	0.04	(0.07)	−0.08	(0.03)	−0.03	(0.04)	0.07	(0.05)	0.14*	(0.04)	0.04	(0.02)	4.2*	7.8*
Cognitive difficulties	0.00	(0.02)	−0.05	(0.06)	−0.16	(0.05)	−0.02	(0.07)	−0.08	(0.03)	−0.03	(0.04)	0.07	(0.05)	0.14	(0.04)	0.04	(0.02)	4.1*	8.6*
Rumination	0.00	(0.02)	−0.06	(0.05)	−0.13	(0.05)	−0.09	(0.07)	−0.09	(0.03)	0.00	(0.04)	0.03	(0.05)	0.14	(0.04)	0.05	(0.02)	3.6*	10.5*
Dissociation	0.00	(0.02)	−0.08	(0.06)	−0.13	(0.05)	0.02	(0.07)	−0.07	(0.03)	−0.02	(0.04)	0.06	(0.05)	0.13	(0.04)	0.04	(0.02)	3.4*	7.7*
Mixed episodes	0.00	(0.02)	−0.01	(0.06)	−0.12	(0.05)	0.14	(0.07)	−0.02	(0.03)	0.00	(0.04)	0.01	(0.05)	0.01	(0.04)	0.01	(0.02)	1.7	0.4

ADM, antidepressant medication; Est, standardized mean estimates; HRSD, Hamilton Rating Scale for Depression; S.E., standard error.; QIDS-SR, Quick Inventory of Depressive Symptomatology Self-Report Scale.

*Significant at the 0.05 level, 2-sided test, adjusted for false discovery rate.

†Weighted to represent treatment distribution in population; Estimates in the target column are in true metrics of the scales, whereas estimates in the other columns are based on standardized values of the row variables, with mean of 0 and variables of 1.0.

‡Either saw a mental health specialist or referred to mental health treatment.

Table 4. Associations of Comorbidity with Setting and Type of Treatment (n = 2610)†

| | Primary Care | | | | | | | | | | Specialty Mental Health | | | | | | | | | | |
| | Target | | Psychotherapy[a] (n = 290) | | ADM (n = 439) | | Combined (n = 219) | | Total (n = 948) | | Psychotherapy[a] (n = 697) | | ADM (n = 373) | | Combined (n = 592) | | Total (n = 1662) | | F_5 | F_1 |
	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)		
Presenting problems (weighted count‡)																				
PTSD	1.86	(0.02)	−0.10	(0.06)	−0.25*	(0.05)	−0.11	(0.07)	−0.15*	(0.03)	0.01	(0.04)	0.15	(0.05)	0.15*	(0.04)	0.08*	(0.02)	8.6*	30.7*
Other anxiety disorders§	4.21	(0.04)	−0.13*	(0.06)	−0.07	(0.05)	−0.05	(0.07)	−0.09	(0.03)	−0.05	(0.04)	0.17*	(0.05)	0.15*	(0.04)	0.05	(0.02)	6.4*	11.7*
Substance Use Disorder	0.36	(0.02)	−0.04	(0.06)	−0.12	(0.04)	−0.16	(0.05)	−0.09*	(0.03)	0.00	(0.04)	0.05	(0.05)	0.14*	(0.05)	0.05	(0.03)	4.1*	11.7*
Anger	1.12	(0.02)	0.02	(0.06)	−0.18*	(0.05)	−0.08	(0.07)	−0.06	(0.03)	0.06	(0.04)	0.03	(0.05)	0.00	(0.04)	0.03	(0.02)	2.7	5.6
Other emotional problems	0.52	(0.02)	0.01	(0.06)	−0.06	(0.05)	−0.18	(0.06)	−0.05	(0.03)	0.02	(0.04)	0.01	(0.05)	0.04	(0.04)	0.03	(0.02)	1.6	3.6
SSD	0.00	(0.02)	0.03	(0.06)	−0.03	(0.05)	0.08	(0.07)	0.02	(0.03)	−0.07	(0.04)	−0.01	(0.05)	0.08*	(0.04)	−0.01	(0.02)	1.9	0.6
Number of comorbid disorders¶																				
0	22.76	(0.82)	0.03	(0.06)	0.24*	(0.05)	0.23	(0.08)	0.14*	(0.04)	−0.02	(0.04)	−0.13	(0.05)	−0.14*	(0.04)	−0.07*	(0.02)	8.7*	28.0*
1	32.17	(0.91)	0.06	(0.06)	−0.07	(0.05)	−0.06	(0.07)	−0.01	(0.03)	0.05	(0.04)	−0.03	(0.05)	−0.05	(0.04)	0.00*	(0.02)	1.5	0.1
2	24.38	(0.84)	−0.01	(0.06)	−0.11	(0.04)	−0.09	(0.06)	−0.06	(0.03)	0.00	(0.04)	0.08	(0.05)	0.06	(0.04)	0.03	(0.02)	1.8	5.1
3+	20.69	(0.79)	−0.09	(0.05)	−0.05	(0.05)	−0.07	(0.06)	−0.07	(0.03)	−0.03	(0.04)	0.09	(0.05)	0.13	(0.04)	0.04	(0.03)	3.5*	7.5*
EMR mental disorders during recruitment																				
Anxiety disorder	26.79	(0.87)	0.02	(0.06)	−0.05	(0.05)	0.07	(0.07)	0.01	(0.03)	−0.13*	(0.03)	0.11	(0.05)	0.14*	(0.04)	0.00	(0.02)	6.3*	0.1
PTSD	20.12	(0.78)	−0.16*	(0.05)	−0.12	(0.04)	−0.06	(0.06)	−0.13*	(0.03)	−0.03	(0.04)	0.15	(0.06)	0.18*	(0.05)	0.07	(0.03)	8.0*	22.1*
Adjustment disorder	4.47	(0.40)	−0.06	(0.05)	−0.10	(0.04)	0.18	(0.09)	−0.02	(0.03)	−0.04	(0.03)	−0.02	(0.05)	0.11*	(0.05)	0.01	(0.03)	3.6*	0.5
Other reactions to stress	4.12	(0.39)	0.08	(0.07)	−0.14*	(0.03)	−0.02	(0.07)	−0.01	(0.03)	0.01	(0.04)	−0.04	(0.05)	0.04	(0.04)	0.01	(0.02)	1.9	0.2
Substance Use Disorder	9.89	(0.58)	−0.12	(0.05)	−0.18*	(0.03)	−0.19*	(0.05)	−0.15*	(0.02)	0.00	(0.04)	0.09	(0.06)	0.21	(0.05)	0.08	(0.03)	9.4*	32.0*

Continued

Table 4. Continued

| | Target | | Primary Care | | | | | | | | | | Specialty Mental Health | | | | | | | | | | |
| | | | Psychotherapy[a] (n = 290) | | ADM (n = 439) | | Combined (n = 219) | | Total (n = 948) | | Psychotherapy[a] (n = 697) | | ADM (n = 373) | | Combined (n = 592) | | Total (n = 1662) | | | |
	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	F_5	F_1
Other mental disorders	6.28	(0.48)	−0.07	(0.05)	−0.05	(0.04)	0.07	(0.08)	−0.04	(0.03)	−0.06	(0.03)	0.19	(0.07)	0.06	(0.05)	0.02	(0.03)	4.1*	1.7
Number of comorbid EMR disorders																				
0	45.66	(0.98)	0.14	(0.06)	0.27*	(0.05)	−0.04	(0.07)	0.14*	(0.03)	0.11	(0.04)	−0.22*	(0.05)	−0.31*	(0.04)	−0.07	(0.02)	21.5*	28.0*
1	39.28	(0.96)	−0.07	(0.06)	−0.19*	(0.04)	0.05	(0.07)	−0.09	(0.03)	−0.05	(0.04)	0.13	(0.05)	0.15*	(0.04)	0.04	(0.02)	6.5*	10.0*
2+	15.06	(0.70)	−0.09	(0.05)	−0.11	(0.04)	−0.01	(0.07)	−0.08	(0.03)	−0.09	(0.03)	0.13	(0.06)	0.22*	(0.05)	0.04	(0.03)	9.1*	9.2*

ADM, antidepressant medication; EMR, electronic medical record; Est, standardized mean estimates; PTSD, post-traumatic stress disorder; S.E., standard error; SSD, somatic symptom disorder.

*Significant at a 0.05 level, 2-sided test, adjusted for false discovery rate.

[†]Weighted to represent treatment distribution in population; estimates in the target column are in true metrics of the scales, whereas estimates in the other columns are based on standardized values of the row variables, with mean of 0 and variables of 1.0.

[‡]Presenting problems are scored 3 for any primary problem, 2 for secondary and not primary problem, 1 for screening positive and not a primary or secondary problem, and 0 for none.

[§]Anxiety disorder scores range from 0 to 9 and include GAD, panic/phobias, and OCD.

[‖]Number of comorbid disorders was scored in the range 0-1 as the sum of: (1) PTSD as either a primary or secondary presenting problem or a score in the clinical range of a PTSD Checklist for DSM-5 (PCL-5) screening scale calibrated to the full PCL-5; (2) the quartile of the sample with the highest score of presenting problems for a range of other anxiety disorders as either primary (2 points) or secondary (1) point; (3) substance use disorder as either a primary or secondary presenting problem or a score in the clinical range on the PROMIS Alcohol/Substance Use Short Form–7a scale; (4) anger as either a primary or secondary presenting problem; (5) other emotional disorder as either a primary or secondary presenting problem; and (6) a score in the clinical range for a study-specific screening scale for DSM-5 somatic symptom disorder.

[¶]Either saw a mental health specialist or referred to mental health treatment.

patients with the lowest severity-complexity receiving PC ADM treatment and those with the highest severity-complexity receiving SMH combined treatment. These differences are broadly consistent with the goals of PC-MHI. However, third, patients with these setting-type treatment combinations were more similar than different with respect to the predictors examined, as indicated by the fact that sophisticated ensemble machine learning models using all predictors considered along with their interactions to optimize discrimination of patients across settings and treatment types yielded cross-validated AUCs of 0.50-.68. Clinically significant AUCs are typically considered to be at least .70.[35]

The premise that depression severity is the primary driver explaining treatment decisions is challenged by the weak association of severity with treatment assignment in our data. Other factors, unmeasured or unexplored in this analysis, likely played an important role in treatment decisions. These might include patient factors (eg, care preferences and barriers), provider factors (eg, preferences, time constraints), and system factors (eg, availability of referral resources, incentives). We do not consider the weak association with severity evidence for suboptimal performance of the PC-MHI system but a consequence of treatment providers attempting to adapt VHA recommendations[12] to differing patient needs, preferences, and resource constraints. In comparing PC to SMH patients, we expected to see more severe and complex major depressive episode cases receiving SMH combined treatment. However, with no external benchmark against which to compare these results, we consider the weak statistically significant associations found between severity-complexity and treatment type useful information for generating hypotheses in subsequent analyses to explore other determinants.

One reason for weaker than expected associations may be incomplete PC-MHI implementation.[36–38] Structural barriers to implementation have been identified and initiatives have been launched to address these barriers,[39,40] but this remains a work in progress throughout health care systems, including VHA. It is likely that variation in PC-MHI implementation across sites dilutes the ability of high-functioning collaborative care to optimally tailor the aforementioned factors in ways that are efficient and acceptable to patients. However, in this study we found it challenging to extract reliable indicators of evidence-based PC-

MHI implementation from VHA records to examine measures of collaborative care and their relationships with treatment selection. Future studies should evaluate the extent to which patient, provider, and system factors mediate or moderate the relationship between severity-complexity and treatment setting-type.

It is also important to recognize that some mismatch between severity-complexity and treatment setting-type is inevitable even given VHA initiatives to guide treatment assignment given that both PC and PC-MHI function as a safety net for patients who refuse specialty treatment due to stigma or other concerns or are unable to access specialty care due to barriers. This means that the practical alternative to a severe-complex depressed patient getting PC monotherapy, with or without the collaborative assistance of PC-MHI, may be getting no treatment at all rather than getting SMH combined treatment. Both patients and providers can have strong preferences on treatment settings. In addition, patients can have strong feelings about medication or psychotherapy that lead them to demand or refuse treatment types.[19,41,42]

Controlled studies show that depression treatment engagement is higher and treatment response better when treatments match patient preferences.[15,43,44] It is unclear how to weigh this fact in attempting to optimize treatment selection, although it is noteworthy that evidence suggests positive effects of patient preference on outcomes might be limited to situations in which patients had previous successful depression treatment.[45] Questions about preferences and past treatment experience were included in our survey, allowing us in future analyses to investigate effects on what seem to be mismatches between severity-complexity and treatment setting-type and subsequently investigate effects of these different factors on treatment response.

These results need to be interpreted within the context of several limitations. First, the low survey response rate could have introduced sample bias despite small discrepancies on administrative variables between the sample and population. Second, the weight introduced because we undersampled patients with ADM only introduced differential sampling that affected statistical power even though it removed bias introduced by the sampling strategy. Third, the generalizability of our results is reduced by our exclusion of patients whose depression was not a presenting problem (Appendix 8) and those who received

watchful waiting or active surveillance but did not either receive an ADM prescription or a psychotherapy referral. Fourth, the actual effect of PC-MHI is doubtlessly stronger than the attenuated estimate found here because of variation in PC-MHI implementation and the fact that use of the PC-MHI encounter code is not a guarantee that collaborative care existed in the treatment provided. Similar to coding inaccuracies of diagnostic data within VHA,[46] coding of PC-MHI has been identified as a potential source of error in other studies.[9,10] Fifth, baseline assessments were made between 4 and 7 days after the initial visit. To the extent that symptoms diminished within 4-7 days of a first visit and there is mood-congruent recall bias, the proportion of patients reporting severe depression might be lower than if assessment had occurred on the day of first visit. Sixth, we did not investigate influences of treatment history or patient preferences in determining setting or type of treatment. Given that interventions that incorporate patient preferences are associated with positive outcomes,[13,15,20] further examination of these factors is warranted.

Conclusions

Within the context of these limitations, we found statistically significant associations of depression severity-complexity with treatment setting-type similar to those found for other collaborative care applications in civilian samples. With increasing adoption of collaborative care principles (ie, shifting mental health services for less severe cases to PC, with shared treatment responsibilities) in the VHA[7,47] and other health systems,[48] continuous monitoring of the distribution of patients in primary and specialty settings as well as delivery of treatments consistent with the collaborative care model will aid in continuous improvement of programs that attend to specific mental health needs of the patient population.

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Appendix 1. ICD-9-CM1 and ICD-10-CM2 Mental and Behavioral Health Codes

Disorder	Codes
Major depression	ICD-9-CM codes: 296.2X, 296.3X, 300.4, 311
	ICD-10-CM codes: F32.XX (excluding F32.81 and F32.89), F33.XX
Suicide attempt	ICD-9-CM codes: E950.X, E951.X, E952.X, E953.X, E954, E955.X, E956, E957.X
	ICD-10-CM codes: T14.91, T36.XX2, T37.XX2, T38.XX2, T39.XX2, T40.XX2, T41.XX2, T42.XX2, T43.XX2, T44.XX2, T45.XX, T46.XX2, T47.XX2, T48.XX2, T49.XX2, T50.XX2, T51.XX2, T52.XX2, T53.XX2, T54.XX2, T55.XX2, T56.XX2, T57.XX2, T58.XX2, T59.XX2, T60.XX2, T61.XX2, T62.XX2, T63.XX2, T64.XX2, T65.XX2, T71.1 × 2, T71.2 × 2
Bipolar disorder	ICD-9-CM codes: 296.0X, 296.1X, 296.4X, 296.5X, 296.6X, 296.7, 296.80, 296.81, 296.89, 301.13
	ICD-10-CM codes: F30.X, F31.X, F34.0
Nonaffective psychosis	ICD-9-CM codes: 293.81, 293.82, 293.89, 295.XX, 297.X, 298.X, 301.22
	ICD-10-CM codes: F06.0, F06.1, F20.XX, F21, F22, F23, F24, F25.X, F28, F29, F53
Dementia	ICD-9-CM codes: 290.XX, 294.1X, 294.8
	ICD-10-CM codes: F01.XX, F01.XX, F03.XX
Intellectual disabilities	ICD-9-CM codes: 317, 318, 319
	ICD-10-CM codes: F70, F71, F72, F73, F78, F79
Autism	ICD-9-CM code: 299.XX
	ICD-10-CM code: F84.0
Tourette's disorder	ICD-9-CM code: 307.23
	ICD-10-CM code: F95.2
Stereotyped movement disorders	ICD-9-CM code: 307.3
	ICD-10-CM code: F98.4
Borderline intellectual functioning	ICD-10-CM code: R41.83

ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification[1]; ICD-10-CM, International Classification of Diseases, Tenth Revision, Clinical Modification.[2]

Appendix 2. Self-Report Measures of Depression and Psychiatric Comorbidity

Depression Symptom Severity

It was noted in the text that depression symptom severity in the 2 weeks before seeking treatment was assessed in the self-report survey with the 16-item self-report Quick Inventory of Depressive Symptomatology Self-Report Scale (QIDS-SR)[3] and that scores on this scale were converted into estimated severity levels on the Hamilton Rating Scale of Depression (HRSD).[4] In addition, we asked 8 questions about melancholic features from the full Inventory of Depressive Symptomatology Self-Report Scale (IDS-SR)[5]; 5 questions about anhedonia based on the Dimensional Anhedonia Rating Scale (DARS)[6] and the Motivation and Pleasure Scale–Self-Report (MAP-SR)[7]; the 4-question reduced version of the Beck Hopelessness Scale[8]; 4 questions about difficulties with concentration and decision-making from the PROMIS Applied Cognition-Abilities Short Form 4a[9]; 6 questions to operationalize Criterion A of the DSM-5 Mixed Features Specifier for Depressive Disorders[10] based on the cyclothymic temperament subscale of the Temperament Evaluation of Memphis, Pisa, Paris and San Diego-autoquestionnaire (TEMPS-A)[11]; and 7 questions from the 10-question Ruminative Responses Scale-Short Form (RSS-SF).[12]

We also assessed the 6 dimensions other than depressive symptom severity in the self-report Remission from Depression Questionnaire (RDQ).[13] These dimensions were found in developmental research for the RDQ to be the most important ones for patients in defining recovery from a depressive episode. The 6 dimensions include other symptoms that often co-occur with depression (anxiety, irritability), role functioning, coping ability, and 3 positive dimensions (life satisfaction, general sense of well-being, and positive sense of mental health). Symptoms were assessed using the same 2-week recall period as in the QIDS-SR. The first dimension was operationalized with questions from the RDQ,[13] the full IDS-SR,[5] and the Composite International Diagnostic Interview (CIDI)[14] on irritability and the DSM-5 Anxious Distress Specifier for Depressive Disorders.[10] The second dimension was operationalized with the Sheehan Disability Scale.[15] The last 4 dimensions were operationalized with 3 items per dimension from the RDQ.[13]

Depression Persistence

Questions from the CIDI[14] were used to obtain retrospective assessments of depression age of onset, number of years with at least 1 month of depression sufficiently severe to cause substantial distress or interference with functioning, and length of the current depressive episode.
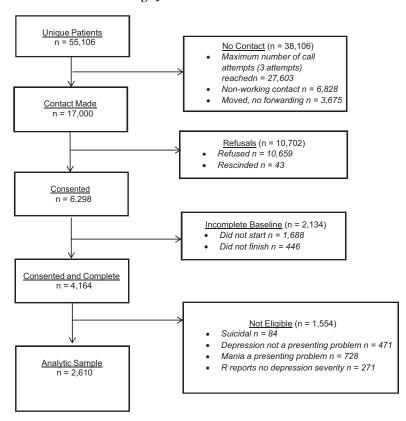
Comorbidity

Patients were asked which of their presenting problems were primary and secondary. As noted in the text, the few patients who reported bipolar disorder were excluded from further study. Other presenting complaints and diagnoses recorded as the focus of clinical attention in VHA records were collapsed into 6 categories: post-traumatic stress disorder (PTSD), other anxiety disorders, substance use disorder, anger problems, other emotional problems, and somatic symptom disorder. In addition, we administered brief dimensional self-report screening scales for comorbid disorder dimensions of special interest: a 6-question version of the PTSD Checklist for DSM-5 (PCL-5)[16] calibrated to the full PCL-5 based on analysis of the Army STARRS data[17]; 4 questions from the CIDI[14] to operationalize the DSM-5 PTSD Dissociative Symptom Specifier[10]; the 7-question PROMIS Alcohol/ Substance Use Short Form-7a[18] to assess symptoms of substance use disorder and scored using the recommended PROMIS scoring procedures[19]; and the 12-question Somatic Symptoms Disorder-B Criteria Scale (SSD-12)[20,21] to operationalize the 3 psychological criteria (cognitive, affective, behavioral) of DSM-5 Somatic Symptom Disorder.[10]

Appendix 3. Brief Description of Machine Learning Algorithms Included in the SuperLearner Library

Algorithm	R Package	Description
Regularization[22]	glmnet	• Penalized regression reduces overfit due to collinear independent variables
Elastic net		• Ridge regression shrinks coefficients for collinear independent variables toward zero but does not fully eliminate any independent variable
		• Elastic net regression allows various penalties where coefficients for collinear independent variables are shrunk toward zero (but not to eliminating contributions to the predicted probability) and/or to zero (eliminating their contributions to the predicted probability)
		• Mixing parameter penalty (alpha) is set somewhere between 0.01 and .99
		• Lasso regression shrinks coefficients for collinear covariate coefficients to zero, eliminating their contributions to the predicted probability
Spline		
Adaptive splines[23]	earth	• Adaptive spline regression flexibly captures interactions and linear and nonlinear associations
Adaptive polynomial splines[24]		• Linear segments (splines) of varying slopes are connected and smoothed to create piecewise curves (basis functions)
	polspline	• Final fit is built using a stepwise procedure that selects the optimal combination of basis functions
		• Earth and polymars are generally similar but differ in the order that basis functions (eg, linear vs nonlinear) are added to build the final model
Decision trees		
Random forest[25]	ranger	• Decision tree methods capture interactions and nonlinear associations
		• Independent variables are partitioned (based on values) and stacked to build decision trees and assemble an aggregate "forest"
		• Random forest builds numerous trees in bootstrapped samples and generates an aggregate tree by averaging across trees (reducing overfit)
		• Suitable for large data sets but may be unstable and overfitting
Gradient boosting[26,27]	xgboost	• Extreme gradient boosting decision tree algorithm.
		• Final predictions are formulated by models sequentially built (using gradient descent algorithm to minimize loss) to resolve residual error made by existing models
Neural networks[28]	nnet	• Connections between predictors and the outcome are modeled as a network
		• Predictors affect the outcome through intermediate layers
		• Weights are assigned to connections
		• Capture interactions and nonlinear associations
		• Low interpretability

Appendix 4. Patients Seen for Incident Depression as Reported in the Veterans Health Administration Electronic Medical Records from December 2018 through June 2020

Appendix 5. Factor Analysis (n = 2,169)[†]

	Seven-Factor Solution						
	I	II	III	IV	V	VI	VII
I. Depression severity							
Sad	**0.59**	-0.23	-0.01	-0.13	0.02	0.06	-0.18
So sad nothing could cheer up	**0.62**	-0.17	-0.07	-0.10	0.01	0.13	-0.16
Not feeling much better when good things happen	**0.54**	-0.14	-0.15	-0.10	-0.02	0.18	-0.10
Emotionally numb, empty, unable to feel	**0.50**	-0.08	-0.19	-0.07	-0.05	0.24	-0.05
Excessively guilty or self-blaming	**0.40**	-0.27	0.09	-0.10	0.18	0.09	-0.01
Helpless	**0.45**	-0.40	0.13	-0.10	0.02	0.13	-0.08
Irritable	**0.75**	0.03	-0.11	0.03	-0.10	-0.15	0.13
Extremely irritable	**0.74**	0.04	-0.12	0.05	-0.10	-0.09	0.19
Worried and anxious	**0.75**	-0.06	0.09	0.08	0.05	-0.09	-0.07
Difficulty concentrating because of worry	**0.68**	-0.02	0.05	0.26	0.06	-0.07	0.00
Keyed up or tense	**0.80**	0.08	0.00	0.12	0.01	-0.09	0.03
Unusually restless	**0.78**	0.12	-0.01	0.09	-0.02	-0.07	0.13
Might lose control	**0.54**	-0.11	0.06	0.06	-0.03	0.12	0.18
Fearing something awful	**0.50**	-0.17	0.09	0.02	0.07	0.09	0.08
II. Positive mental health							
Less worthwhile than other people	0.39	**-0.45**	0.07	-0.14	0.10	0.08	-0.04
Coped well with normal stresses	-0.07	**0.51**	-0.02	-0.28	0.02	0.11	0.00
Able to bounce back from stressful situations	-0.05	**0.54**	-0.02	-0.26	0.03	0.11	0.03
Can keep from feeling depressed	-0.13	**0.59**	0.05	-0.07	0.06	0.09	0.06
Satisfied with life	0.05	**0.83**	0.05	0.09	0.05	-0.06	0.03
Felt life was fulfilling	0.09	**0.84**	0.07	0.12	0.05	-0.05	0.01
Engaged with life rather than hiding from it	0.07	**0.72**	0.10	-0.07	0.07	-0.06	-0.02
Felt mentally healthy	-0.17	**0.54**	0.01	-0.23	0.01	0.08	0.11
Felt in control of emotions	-0.17	**0.57**	-0.05	-0.21	0.06	0.08	-0.06
Had a general sense of well-being	-0.08	**0.74**	0.00	-0.09	0.08	0.01	0.07
Had a positive outlook on life	0.03	**0.85**	0.07	0.04	0.07	0.00	0.06
Had the desire to do things	0.00	**0.55**	0.22	-0.13	0.07	0.01	0.06
Felt confident	-0.04	**0.69**	0.02	-0.16	0.02	0.04	0.14
Great faith in the future	0.10	**0.84**	0.08	0.09	0.08	-0.03	0.07
Expect to succeed	0.09	**0.81**	0.03	-0.01	0.09	0.01	0.09
Future seemed dark	0.09	**-0.58**	0.03	-0.13	0.04	0.13	0.01
Felt you don't get the breaks	0.04	**-0.58**	0.03	-0.10	0.03	0.12	0.22
Equally worthwhile/deserving as other people	-0.01	**0.49**	-0.03	-0.00	-0.15	-0.04	-0.02
Ask "What could I have done to deserve this?"	0.01	**-0.41**	0.06	-0.03	0.36	-0.01	0.28
III. Anhedonia: unable to experience pleasure when...							
having favorite food or drinks	-0.03	0.03	**0.74**	-0.01	-0.06	0.03	-0.04
spending leisure time with friends	-0.07	0.07	**0.78**	0.02	-0.03	0.02	-0.06
doing favorite hobbies or pastimes	-0.04	0.05	**0.78**	-0.03	-0.06	0.05	-0.01
spending quality time with close loved ones	0.01	0.10	**0.77**	0.03	-0.07	-0.02	-0.01
having big success at work, school, or in finances	0.06	0.06	**0.72**	-0.08	-0.04	-0.03	-0.02
IV. Cognitive difficulties							
Problems with concentration/decision-making	0.15	-0.03	0.03	**0.61**	0.03	0.03	-0.07
Feeling slowed down	0.01	0.09	0.01	**0.62**	0.00	0.24	-0.04
Low energy level	0.10	-0.02	-0.05	**0.49**	0.05	0.07	-0.09
Mind as sharp as usual	-0.01	0.10	0.13	**-0.67**	0.07	-0.04	0.02
Memory much worse than usual	0.06	0.00	0.05	**0.59**	0.02	0.11	-0.05
Thinking as fast as usual	0.14	0.10	0.16	**-0.66**	0.01	-0.03	0.03
Not able to keep track of activities	0.08	0.07	0.06	**0.56**	0.00	0.08	0.04

Continued

	Seven-Factor Solution						
	I	II	III	IV	V	VI	VII
V. Rumination							
Analyze recent events to understand why depressed	0.02	0.15	-0.05	-0.02	**0.80**	-0.02	-0.13
Think about why depressed	0.06	0.06	-0.12	-0.04	**0.69**	0.07	-0.06
Write down your thoughts and analyze them	-0.01	0.27	-0.03	0.05	**0.55**	0.11	-0.20
Analyze personality to understand why depressed	-0.04	0.19	-0.10	-0.03	**0.83**	0.01	-0.14
Ask "Why do I always react this way?"	0.00	-0.24	0.01	0.10	**0.56**	-0.09	0.26
VI. Dissociation							
Feeling not real or cut off from the world	0.09	-0.17	-0.05	0.00	0.06	**0.64**	0.08
Feeling outside of body, watching yourself	-0.01	-0.02	0.05	0.14	0.01	**0.80**	0.07
Feeling like surroundings detached or unreal	0.00	0.00	0.00	0.18	0.00	**0.82**	0.06
Feeling surroundings dreamlike, distant, or distorted	-0.02	0.01	0.02	0.19	0.00	**0.82**	0.08
VII. Mixed episodes							
Much better mood, happier, excitable than usual	-0.11	0.15	0.03	-0.06	-0.02	0.04	**0.66**
Extremely self-confident or optimistic, could do anything	-0.01	0.32	-0.07	-0.11	-0.02	0.05	**0.62**
Mood changed rapidly: very happy, very sad, very angry	0.29	-0.02	-0.07	0.00	-0.13	0.05	**0.60**
More talkative than usual	0.01	0.05	0.02	0.00	-0.11	0.10	**0.70**
Thoughts raced through mind so fast hardly kept track	0.30	0.04	-0.02	0.13	0.00	0.11	**0.45**
Much more engaged, busy, productive than usual	0.10	0.21	-0.06	-0.13	-0.02	-0.01	**0.66**

[†]Principal axis factor analysis. The parallel analysis simulation method was used to determine the number of factors to extract.[29] Promax rotation was used to improve interpretability.

Appendix 6. Correlations Among Factors in Promax Rotated Factor Solution

	Factors						
	I	II	III	IV	V	VI	VII
Depression severity	1.00						
Positive mental health	-0.53	1.00					
Anhedonia	-0.24	0.40	1.00				
Cognitive difficulties	0.44	-0.40	-0.28	1.00			
Rumination	0.33	-0.17	0.10	0.15	1.00		
Dissociation	0.42	-0.23	-0.16	0.16	0.24	1.00	
Mixed episodes	0.17	0.16	0.21	0.09	0.27	0.16	1.00

Appendix 7. AUC of 10-fold Externally Cross-Validated SuperLearner Models[†]

	AUC (95% CI)
I. Primary care	
Primary care versus specialty mental health	0.645 (0.623, 0.668)
Psychotherapy versus total sample	0.550 (0.520, 0.580)
Medication versus total sample	0.684 (0.649, 0.718)
Combined versus total sample	0.530 (0.487, 0.572)
Any primary care versus total sample	0.574 (0.552, 0.595)
III. Specialty mental health	
Psychotherapy versus total sample	0.534 (0.511, 0.556)
Medication versus total sample	0.572 (0.539, 0.604)
Combined versus total sample	0.602 (0.576, 0.627)
Any specialty mental health versus total sample	0.500 (0.483, 0.518)

AUC, area under the ROC curve; 95% CI, 95% confidence interval.
[†]See Appendix 3 for the list of classifiers.

Appendix 8. Comparison of Primary Problems and Diagnoses between Analytic Sample and Those Who Did Not Report Depression as a Problem

	Analytic Sample (n = 2610)		No Self-Reported Depression (n = 471)	
	%	(S.E.)	%	(S.E.)
Primary presenting problems				
Depression	71.79	(0.88)	0.00	—
Anxiety disorder	49.69	(0.98)	22.17	(1.89)
PTSD	42.45	(0.97)	20.52	(1.84)
Substance use disorder	4.81	(0.42)	2.42	(0.70)
Anger	15.48	(0.71)	7.13	(1.17)
Other emotional problems	11.38	(0.62)	10.45	(1.39)
Primary EMR diagnosis				
Depression	60.11	(0.96)	58.40	(2.24)
Anxiety disorder	8.79	(0.55)	9.70	(1.35)
PTSD	11.94	(0.63)	13.83	(1.57)
Adjustment disorder	2.71	(0.32)	1.97	(0.63)
Other reactions to stress	1.96	(0.27)	0.64	(0.36)
Substance use disorder	1.97	(0.27)	4.70	(0.96)
Other mental disorders	2.12	(0.28)	3.51	(0.84)

EMR, electronic medical record; PTSD, post-traumatic stress disorder; S.E., standard error.

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