Title: Impact of COVID-19 on psychiatric assessment in emergency and outpatient settings measured using electronic health records

Running Title: COVID-19 and psychiatry notes

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Key Points

Question: How did documentation of psychiatric symptoms in outpatient and emergency room settings change with onset of COVID-19 infection in Eastern Massachusetts?

Findings: In this cohort study spanning 2 academic medical centers and 3 community hospitals, prevalence of narrative notes referencing depression or anxiety decreased 75-81% in outpatient settings following onset of coronavirus in March 2019, and by 44-45% in emergency departments.

Meaning: The observation that documentation of psychiatric symptoms declined sharply with increasing coronavirus infection in Massachusetts, even as prevalence of such symptoms is anticipated to increase, suggests additional efforts may be required to address these symptoms in the context of COVID-19.

Abstract

Importance: As with other traumatic events, pandemics such as coronavirus-19 (COVID-19) may precipitate or exacerbate psychiatric symptoms such as anxiety and depression, while potentially interfering with health systems' capacity to treat such symptoms.

Objective: To quantify the impact of increasing COVID-19 infection on extent of psychiatric assessment across 5 Eastern Massachusetts hospitals.

Design: In silico cohort using narrative clinical notes generated between 1/2/2020 and 3/25/2020.

Setting: Emergency department and outpatient settings from 2 academic medical centers and 3 community hospitals.

Participants: All individuals age 13 and older presenting to emergency department or outpatient clinics.

Main Outcome or Measure: Documentation of psychiatric symptoms reflecting depression, anxiety, psychosis, or suicide, and documentation of violence, was drawn from previously-validated term lists.

Results: A total of 2,483,159 outpatient and 205,957 emergency department visit notes were analyzed. Instances of notes referencing depression or anxiety decreased 75-81% in outpatient settings with onset of coronavirus in March 2019, and by 44-45% in emergency departments. In adjusted logistic regression, presence of individual psychiatric symptoms in outpatient notes was associated with significant decreases in likelihood of coronavirus testing (for depression, OR=0.636, 95% CI 0.606-0.667). Conversely, presence of violence in an emergency department note was associated with greater likelihood of testing (OR=1.487, 95% CI 1.249-1.761).

Conclusions and Relevance: Documentation of psychiatric symptoms in both outpatient and emergency department settings diminished sharply in the context of increasing

coronavirus infection in Massachusetts, suggesting that efforts to provide additional

resources to manage psychiatric symptoms will be needed.

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Introduction

Evidence from prior pandemics suggests that, along with the direct consequences of the infection itself, the public health impact can also be profound from a psychiatric perspective. As with any traumatic event, the acute stressor can be associated with increases in anxiety and depression, among other psychiatric symptoms[12].

While the emergence of the worldwide coronavirus-19 (COVID-19) pandemic has been characterized in near-real-time, less is known about its impact on psychiatric care, particularly in the United States. Reviews suggest that beyond fear of the pandemic itself, containment strategies such as quarantine can also have profound effects[3]. Multiple surveys suggest significant prevalence of depression and anxiety among health care workers responding to COVID-19 in Wuhan, and China more broadly[45]. Web-based surveys[6] likewise find broad prevalence of such symptoms in less selected populations in China. In the United Kingdom, more than 60% of adults endorsed anxiety or worry[7] in a recent survey, and in the United States, ~1/3 of surveyed individuals reported COVID-19 had impacted their mental health[8].

Particularly given constraints on ability to provide direct patient care imposed by quarantines and resource limitations, understanding the impact of the COVID-19 pandemic on provision of psychiatric care is critical. To date, many more individuals have been impacted by the fear of the pandemic and consequences of quarantine than by infection itself. Moreover, insofar as acute symptoms likely predict risk for longer-term sequelae such as posttraumatic stress syndrome, the ability to address such symptoms may have implications for efforts to anticipate and potentially reduce such sequelae[910].

In the present study, we utilized electronic health records from 2 large academic medical centers and 3 affiliated community hospitals to investigate documentation of psychiatric symptoms, including depression and anxiety, among narrative clinical notes. We examined both outpatient and emergency room settings, describing prevalence of these symptoms since January 2, 2020, as the pandemic emerged in the northeast United States. Specifically, we sought to understand how documentation of psychiatric symptoms changed as disease activity increased in Eastern Massachusetts, and whether presence of documented psychiatric symptoms was associated with greater or lesser probability of COVID-19 testing.

Methods

Subjects

The cohort included all individuals seen in outpatient visits or emergency rooms across 2 academic medical centers and 3 community affiliate hospitals between January 2, 2019 and March 25, 2020. Narrative clinical notes for all visits were extracted from the electronic health record serving all of these sites. Sociodemographic data including age, sex, race, and ethnicity were also drawn from the electronic health record. Presence of a coronavirus test was determined from the enterprise laboratory feed (LOINC:94309-2). All data were extracted from the Partners Research Patient Data Registry[11] and managed as an i2b2 datamart.[12]

The Partners HealthCare Human Research Committee approved the study protocol. As no participant contact was required in this study based on secondary use of data arising from

routine clinical care, the committee waived the requirement for informed consent as detailed by 45 CFR 46.116.

Detection of Symptoms in Narrative Clinical Notes

Presence of individual symptoms was determined by identifying presence of tokens curated by application of a previously-described method for estimating transdiagnostic neuropsychiatric phenotypes via natural language processing (NLP).[13] This method utilizes an expert-curated set of tokens associated with NIMH Research Domain Criteria (RDoC) domains, included terms drawn from the RDoC Workgroup statements, and expanded to include synonyms commonly found in health care notes. These estimated RDoC domain scores have been validated against clinician review, and shown to predict longitudinal outcomes among psychiatric and non-psychiatric populations[14,15]. For the present study, token lists were drawn from the appropriate domain(s) to reflect depression, anxiety, suicide, and psychosis. While not necessarily reflecting psychiatric symptoms, tokens capturing violence were also drawn from this set.

Study Design and Analysis

Each of the 2 cohorts, reflecting a single treatment setting, was analyzed individually. Primary descriptive analysis sought to capture volume of documentation by individual symptoms by day, based upon all notes, in comparison with volume of COVID-19 testing. Logistic regression was used to examine the relationship between presence of coronavirus testing in the month of March (i.e., after testing was initiated) and individual psychiatric tokens, adjusted for age, sex, and race/ethnicity. Notes were treated as clustered within-

individual, and included only those which occurred at or before time of testing. (Sensitivity analysis considering one randomly-selected note per individual, or index note, did not yield meaningfully different results and are not presented here, consistent with previous work using narrative notes in this health system; see, e.g., McCoy[14].) All analyses utilized R 3.6.0[16].

Results

A total of 2,483,159 outpatient and 205,957 emergency department notes were analyzed; distribution by sociodemographic features is summarized in Table 1. For reference, characteristics of individuals in the outpatient and emergency department cohorts are presented in Supplemental Table 1.

Figure 1 illustrates frequency of notes, by week, reflecting depression and anxiety. The top panel (A) illustrates frequency of coronavirus testing, for comparison. The initial 2 decrements in frequency correspond to 4-day weeks (President's weekend, e.g.) and provide insight regarding magnitude of subsequent decrease in visit frequency. Notes with mentions of anxiety dropped 75% for outpatient and 45% for ED from a weekly average in January and February, excluding holidays, to the week spanning 3/19/2020-3/25/2020 (decrease from 96,280 to 24,113 outpatient notes and 3,533 to 1,940, respectively). A similar decrease was observed for mentions of depression with a drop of 81% for outpatient and 44% for ED (decrease from 49,132 to 9,315 outpatient notes and 1,446 to 816, respectively). Similarly, Figure 1 (C) shows references to suicide, overdose, and violence, illustrating a similar pattern. For comparison, Figure 2 shows relative stability of age by week.

In logistic regression models, we examined the association between presence of a coronavirus test and individual psychiatric symptoms, adjusting for sociodemographic features (Table 2). In the outpatient setting, notes with presence of psychiatric terms were associated with reduction in likelihood of coronavirus testing for an individual patient, with adjusted odds ratios ranging from 0.795 (95% CI 0.770-0.821) for anxiety to 0.631 (95% CI 0.563-0.705) for psychosis. Conversely, in the emergency department setting, presence of psychiatric terms was not associated with greater likelihood of testing. However, where violence was referenced, odds of testing were increased by nearly 50% (OR 1.487, 95% CI 1.249-1.761).

Discussion

In this electronic health records-based study of psychiatric symptoms during the first 3 months of 2020 across 5 Boston-area hospitals, we detect marked reduction in notes documenting psychiatric symptoms that corresponds to the emergence of COVID-19 diagnoses in the Boston area, and closely parallels the increase in COVID-19 testing. Such reductions are consistent across a range of symptoms, including psychosis, suggesting that they reflect a consistent diminution of psychiatric assessment.

While the magnitude of this change is notable, the presence of a shift is unsurprising, as outpatient visits are cancelled and individuals may be more reluctant to come to the emergency room out of concern for infection risk. Moreover, in settings where such symptoms might ordinarily be assessed, it is likely that clinicians dealing with limited resources and seeking to reduce exposure are more focused on addressing the primary diagnosis than would typically be the case. Outpatient notes do include telemedicine visits,

such that had visits simply shifted to video or audio, no such decrement would have been observed.

We also examined the relationship between COVID-19 testing and presence or absence of psychiatric symptom documentation. In the outpatient setting, likelihood of such testing was significantly diminished when psychiatric symptoms were documented. This result may indicate a dichotomy between visits focused on suspected COVID-19, and psychiatric visits, with clinicians focusing treating such complaints as mutually exclusive. However, among emergency department notes, while symptoms were not associated with testing, reference to violence was associated with greater likelihood of testing. This latter finding may reflect a shift in psychopathology evaluation in the emergency department in the initial stages of the COVID-19 pandemic in the Boston area, although further investigation and longer follow-up will be required to understand this shift. Importantly, these results cannot establish causation, and do not imply that individuals with psychiatric symptoms are more or less likely to be tested as a result of their symptoms per se.

We note several additional limitations in interpreting our results. First, our detection of psychiatric symptoms uses simple string-matching in the interest of expediency and transferability to other health systems. While symptom tokens have previously been validated[13], it is likely that more sophisticated natural language processing incorporating negation and bigrams would be more sensitive and specific. The advantage of the present approach is that is readily implemented in, for example, SQL query language. Second, while our results capture 5 Boston-area hospitals, other health systems will likely vary substantially in their response to onset and exacerbation of COVID-19. As such, rather than focusing on the magnitude of reduction, these results are likely better understood to

indicate the probability of reduction and the need to anticipate such changes in provision of psychiatric care.

More generally, our results demonstrate the potential for application of electronic health records to enable near-real-time understanding of how psychiatric assessments, and potentially individual symptoms, change across health systems. Given abundant evidence from China that the COVID-19 pandemic has had substantial impact on psychiatric symptoms among health care workers[45] and more broadly[6], and emerging survey data from the UK and US[78], one might expect to see an increase rather than decrease in such symptom presentations in Boston-area hospitals. Indeed, if visits were not markedly diminished, it seems likely such a change would be observed. However, the present results suggest that, if such an increase in symptoms exists, it is not driving more psychiatric visits. As such, efforts to provide more accessible psychiatric care during the acute phase of the COVID-19 pandemic become particularly important: symptoms are likely to be increasing, while access is objectively decreasing. The accelerating shift to telemedicine may help to address this need[17]. However, given the apparent magnitude of the decrease, other strategies are also urgently needed to ensure that another consequence of the broadening pandemic is not neglect of new or worsening psychiatric symptoms.

Acknowledgements

Role of the Funding Source

No funding source contributed to any aspect of study design, data collection, data analysis,

or data interpretation. The corresponding author (RHP) had full access to all the data in the

study. All authors shared the final responsibility for the decision to submit for publication.

Figures and Tables

Table 1.

	ED (Notes=205,957)	Outpatient (Notes=2,483,159)	Total (Notes=2,689,116)
Gender			
Female	111,679 (54.2%)	1,525,338 (61.4%)	1,637,017 (60.9%)
Age (years)			
Mean (SD)	47.1 (23.5)	52.0 (21.4)	51.7 (21.663)
Race			
Asian	8,119 (3.9%)	108,327 (4.4%)	116,446 (4.3%)
Black	3,0914 (15.0%)	164,712 (6.6%)	195,626 (7.3%)
Other	22,224 (10.8%)	133,952 (5.4%)	156,176 (5.8%)
Unknown	16,128 (7.8%)	170,988 (6.9%)	187,116 (7.0%)
White	128,572 (62.4%)	1,905,180 (76.7%)	2,033,752 (75.6%)
Ethnicity			
Hispanic	103,44 (5.0%)	88,524 (3.6%)	98,868 (3.7%)
Hospital Type			
Academic Medical Centers	124,518 (60.5%)	1,920,205 (77.3%)	2044,723 (76.0%)
Community Hospitals	81,439 (39.5%)	562,954 (22.7%)	644,393 (24.0%)
COVID-19 Lab Order			
	5,635 (2.7%)	34,165 (1.4%)	39,800 (1.5%)
Anxiety term in note			
	39,978 (19.4%)	978,308 (39.4%)	1,018,286 (37.9%)
Depression term in note			
	16,810 (8.2%)	491,612 (19.8%)	508,422 (18.9%)
Psychosis term in note			
	10,272 (5.0%)	121,612 (4.9%)	131,884 (4.9%)
Suicide term in note			
	11,007 (5.3%)	133,022 (5.4%)	144,029 (5.4%)
Violence term in note			
	4,722 (2.3%)	234,381 (9.4%)	239,103 (8.9%)

Table 1. Sociodemographic summary of patients seen from 1/2/2020-3/25/2020. Counts and percentages are total number of notes by visit setting.

Table 2.

Emergency Department

feature	OR	SE	statistic	p-value	[95%	CI]
Gender (male)	0.863	0.032	-4.651	<0.001	0.811	0.918
Age (decade)*	1.054	0.007	7.434	<0.001	1.039	1.069
Race (White)	1.091	0.034	2.609	0.009	1.022	1.166
anxiety	1.076	0.043	1.709	0.088	0.989	1.169
depression	0.935	0.061	-1.100	0.271	0.828	1.053
psychosis	1.108	0.074	1.374	0.169	0.956	1.279
suicide	1.054	0.075	0.707	0.480	0.909	1.218
violence	1.487	0.088	4.528	<0.001	1.249	1.761

Outpatient

| feature	OR	SE	statistic	p-value	[95%	CI]
Gender (male)	0.713	0.014	-23.77	<0.001	0.693	0.733
Age (decade)*	0.842	0.003	-55.08	<0.001	0.837	0.847
Race (White)	0.933	0.015	-4.63	<0.001	0.906	0.961
anxiety	0.795	0.016	-14.00	<0.001	0.770	0.821
depression	0.636	0.024	-18.52	<0.001	0.606	0.667
psychosis	0.631	0.057	-8.08	<0.001	0.563	0.705
suicide	0.732	0.051	-6.16	<0.001	0.662	0.807
violence	0.400	0.042	-21.80	<0.001	0.368	0.434

Table 2: Clustered logistic regression models examining the relationship between coronavirus lab orders and individual symptoms and individual symptoms. OR, odds ratio; SE, standard error; CI, confidence interval. *For interpretability, age is normalized by subtracting 50 and dividing by 10.

Figure 1
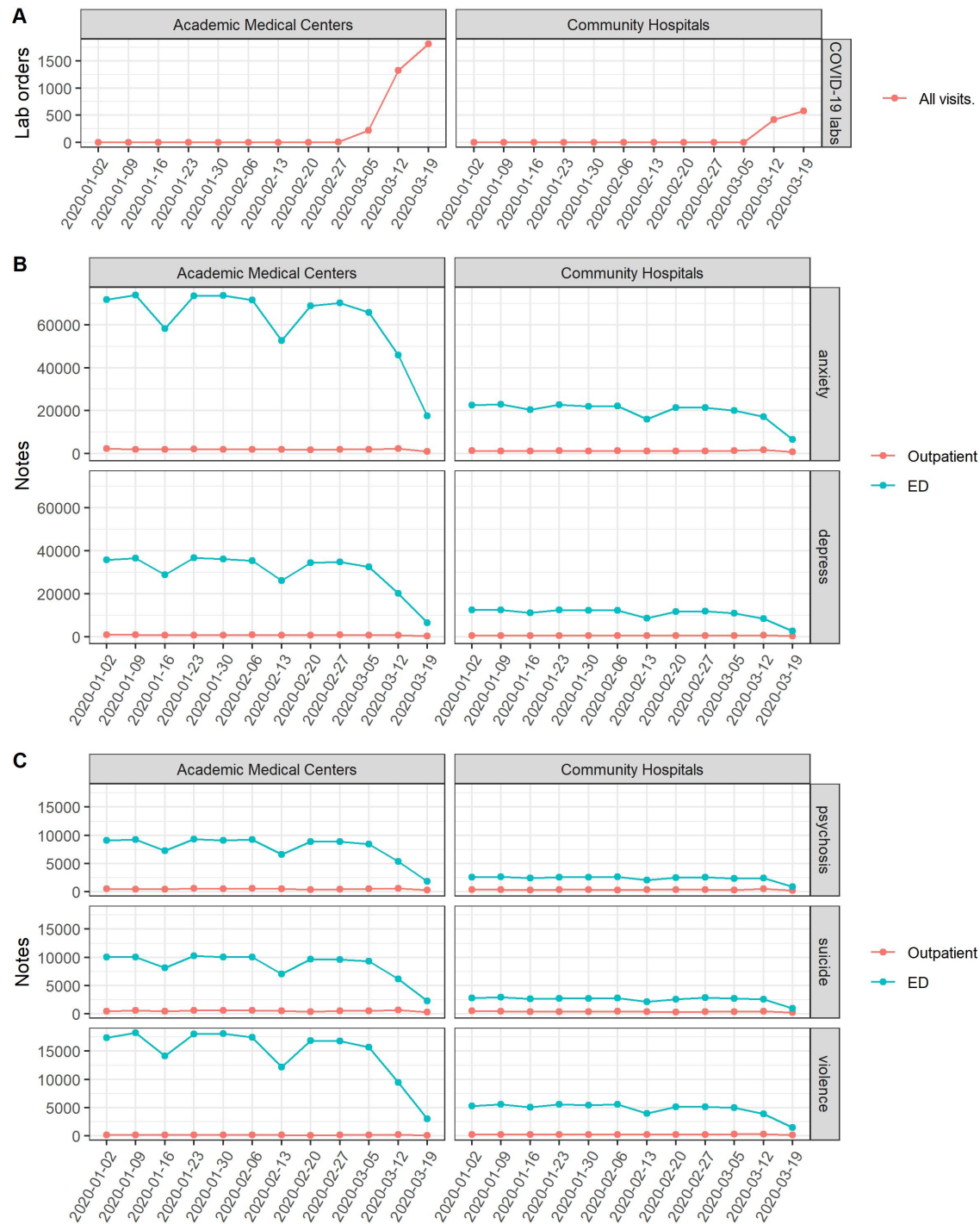
Figure 1. Trends in COVID-19 lab orders and psychiatric tokens by week for date period 1/2/2020 – 3/25/2020. Counts are computed using weeks starting Thursdays and ending on Wednesdays. (A) COVID-19 lab orders from either outpatient or ED patients. (B) Count of notes with anxiety and depression mentions over time. (C) Count of notes with psychosis, suicide, and violence mentions over time.

Figure 2
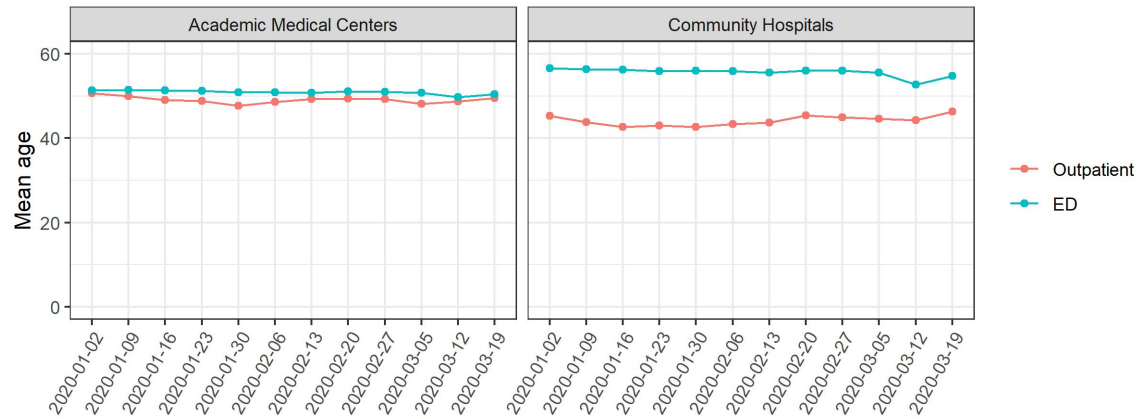
Figure 2. Trends in mean patient age at time of visit by week for date period 1/2/2020 – 3/25/2020. Counts are computed using weeks starting Thursdays and ending on Wednesdays.

Supplemental Table 1.

	Emergency (N Patients = 60,428)	Outpatient (N Patients = 541,307)
Gender		
Female	32550 (53.9%)	324823 (60.0%)
Age (years)		
Mean (SD)	44.305 (24.549)	50.874 (21.662)
Race		
Asian	2590 (4.3%)	23965 (4.4%)
Black	7991 (13.2%)	31994 (5.9%)
Other	6629 (11.0%)	25332 (4.7%)
Unknown	4747 (7.9%)	38427 (7.1%)
White	38471 (63.7%)	421589 (77.9%)
Hispanic ethnicity	2818 (4.7%)	18513 (3.4%)
Hospital type		
Academic Medical Centers	30500 (50.5%)	395546 (73.1%)
Community Hospitals	29928 (49.5%)	145761 (26.9%)
COVID-19 lab test	896 (1.5%)	4255 (0.8%)

Supplemental Table 1. Characteristics of individual patients reflected in Figure 1.

Supplemental Materials

Token lists used for symptom identification in narrative notes.

"depression": ["depressed", "depressive", "dysphoric", "dysthymic", "sad", "tearful"],

"anxiety" :["anxiety", "anxious", "fearful", "frighten", "hypervigilant", "nervous", "panic", "phobia", "phobic", "scared", "stress", "tense", "worried"],

"suicide":["suicide","suicidal", "suicidality"],

"psychosis":["psychotic","psychosis","hallucinations","delusions","hallucination","delusion", "paranoid","paranoia","hallucinate","hallucinated","delusional"],

"violence":["violence","violent"]

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