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MAJOR ARTICLE

# Risk Factors for Admission Within a Hospital-Based COVID-19 Home Monitoring Program

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***Background.*** Despite increasing vaccination rates, coronavirus disease 2019 (COVID-19) continues to overwhelm heath systems worldwide. Few studies follow outpatients diagnosed with COVID-19 to understand risks for subsequent admissions. We sought to identify hospital admission risk factors in individuals with COVID-19 to guide outpatient follow-up and prioritization for novel therapeutics.

***Methods.*** We prospectively designed data collection templates and remotely monitored patients after a COVID-19 diagnosis, then retrospectively analyzed data to identify risk factors for 30-day admission for those initially managed outpatient and for 30-day re-admissions for those monitored after an initial COVID-19 admission. We included all patients followed by our COVID-19 follow-up monitoring program from April 2020 to February 2021.

***Results.*** Among 4070 individuals followed by the program, older age (adjusted odds ratio [aOR], 1.05; 95% CI, 1.03–1.06), multiple comorbidities (1–2: aOR, 5.88; 95% CI, 2.07–16.72; ≥3: aOR, 20.40; 95% CI, 7.23–57.54), presence of fever (aOR, 2.70; 95% CI, 1.65–4.42), respiratory symptoms (aOR, 2.46; 95% CI, 1.53–3.94), and gastrointestinal symptoms (aOR, 2.19; 95% CI, 1.53–3.94) at initial contact were associated with increased risk of COVID-19-related 30-day admission among those initially managed outpatient. Loss of taste/smell was associated with decreased admission risk (aOR, 0.46; 95% CI, 0.25–0.85). For postdischarge patients, older age was also associated with increased re-admission risk (aOR, 1.04; 95% CI, 1.01–1.06).

***Conclusions.*** This study reveals that in addition to older age and specific comorbidities, the number of high-risk conditions, fever, respiratory symptoms, and gastrointestinal symptoms at diagnosis all increased odds of COVID-19-related admission. These data could enhance patient prioritization for early treatment interventions and ongoing surveillance.

**Keywords.** COVID-19; SARS-CoV-2; hospitalization.

With >530 million cases of coronavirus disease 2019 (COVID-19) worldwide and >84 million cases and >1 million deaths in the United States [1], COVID-19 remains a critical public health issue and ongoing pandemic. Despite rapid vaccine development, most of the world remains unvaccinated, and variant strains continue to emerge [1–3].

Although the majority of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)–positive patients experience mild to moderate disease manageable at home, hospitalization rates among unvaccinated individuals are still up to 23 times the rates of those who have been fully vaccinated and received a booster dose [4]. Outpatient risk assessment for novel therapeutics and monitoring postdiagnosis could be essential to proactively prevent rapid decompensation and hospitalizations. Targeted telehealth programs have emerged to monitor patients remotely, optimize at-home care, and guide outreach frequency to facilitate transitions to higher levels of care [5–8].

For programs to prioritize limited outpatient treatments and proactively identify severe disease progression, recognizing demographic and clinical factors that predict re-admission is essential. Although many studies have described risk factors for severe COVID-19 in hospitalized patients, few studies have addressed hospitalization risk factors among patients diagnosed and followed in ambulatory settings or included symptom data in their analyses [8–10].

COVID-19 has exacerbated preexisting racial/ethnic and socioeconomic health and health care disparities in the United States and disproportionally impacted people of color, notably individuals who identify as Black or Hispanic [11]. Inequities in

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social determinants of health such as higher housing density, lower education levels, lower income and savings, and decreased health care access, as well as higher likelihoods of working essential jobs and experiencing ongoing discrimination, likely contribute to the increased disease and mortality risk observed among these groups [12].

We created a robust, institutional COVID-19 home monitoring program to improve health care access and closely monitor all patients diagnosed with COVID-19 in our diverse patient population. This study aimed to identify clinical and sociodemographic predictors of COVID-19-related hospital admissions among confirmed SARS-CoV-2-positive patients followed by this program.

## METHODS

### Setting

Boston Medical Center (BMC) is an urban academic medical center and the largest safety-net hospital in New England [13]. BMC primarily serves neighborhoods with high social vulnerability indexes (SVIs), with many of BMC's patients identifying as Hispanic (>20%), Black (>50%), and nonprimary English-speaking (>32%), or experiencing housing instability [14]. In response to the first COVID-19 surge in March 2020, our institution established dedicated teams to notify patients of COVID-19 test results and conduct prospective clinical monitoring of patients diagnosed with COVID-19 (hereafter referred to as the COVID-19 Follow-up Program). Led by infectious diseases and general internal medicine physicians and an operations manager, the program includes physicians, advanced practice providers (APPs), nurses, and medical assistants. The program has adapted to the rapidly changing national and local guidance, staffing, and clinical changes as the pandemic has evolved. Nurses or medical assistants call patients to report initial results, and nurses, APPs, and/or physicians conduct follow-up telehealth visits.

The program notifies all nonadmitted patients tested at BMC of positive COVID-19 results; negative test results are viewed via patient electronic health record (EHR) access. Using an EHR report, the program also contacts patients with COVID-19 upon hospital discharge. The team then utilizes EHR templates to record symptoms, clinical trajectory, and determine risk stratification (low, moderate, or high risk for severe disease progression) (Appendix 1). The highest-risk individuals are advised to present to the emergency department (ED). Telehealth follow-up frequency for those at moderate to high risk is every 1–2 days, and for low-risk patients, every 3 days, until near resolution of symptoms. All EHR templates also include current Centers for Disease Control and Prevention (CDC) and local department of health recommendations to advise patients on household infection control practices and isolation and close contact quarantine guidance and to provide contact information for questions or worsening symptoms. The COVID-19 Follow-up Program continues monitoring all BMC primary care patients and those without established primary care; patients with outside primary care are referred to their providers after initial contact for further follow-up per local health center preferences.

### Study Population

We included all patients who had ≥1 COVID-19 Follow-up Program contact from April 2020 to February 2021 within 4 weeks of a polymerase chain reaction (PCR)–confirmed SARS-CoV-2 infection (Appendix 2). We classified patients as "outpatient" if their initial positive SARS-CoV-2 PCR test occurred in an outpatient or ED setting without hospital admission before COVID-19 Follow-up Program contact and as "postdischarge" if their initial contact with the Follow-up Program succeeded discharge from a hospital admission.

### Data Collection

We retrospectively extracted the following data from the BMC Clinical Data Warehouse, which houses the health system's EHR: demographics, underlying medical conditions (using International Classification of Diseases, 10th edition [ICD-10], codes from active problem lists), hospital admissions, symptoms, risk assessment, clinical trajectory, comorbidities, imaging findings, and number of calls from the COVID-19 Follow-up Program's EHR templates. We recorded medical conditions associated with increased risk of severe COVID-19 as potential confounders for initial or repeat hospital admission: diabetes, chronic lung disease, cirrhosis, hypertension, chronic kidney disease, sickle cell anemia, coronary artery disease, heart failure, obesity, smoking (current or former), rheumatologic disease, and immunocompromising conditions [15]. We defined severe immunosuppression as documented active chemotherapy, high-dose steroids, or individuals with HIV with a CD4 cell count <200 cells/$mm^3$ within 6 months prior. We grouped the following clinically similar COVID-19 symptoms: fatigue/generally feeling sick, headaches/body aches, nasal congestion/sore throat, and loss of taste/smell. We calculated SVI using patient home zip codes and categorized scores as >0.5 (socially vulnerable) or ≤0.5 [16,17]. The primary outcome was COVID-19-associated hospital admission (primary diagnosis of COVID-19 or a potential complication) (Appendix 3) within 30 days of first Follow-up Program contact.

The Boston University Medical Campus Institutional Review Board approved this study as exempt human subject research for EHR data review only.

### Analysis

We used descriptive statistics to characterize patients in each of the outpatient and postdischarge subsets given baseline differences in disease severity and course between groups. We used

logistic regression to determine associations between covariates (demographics, medical history, COVID-19 symptoms, and trajectory) and subsequent hospital admissions. Variables with unadjusted *P* values <.2 were considered for the multivariable model. Age and race/ethnicity were forced in the multivariable model regardless of unadjusted *P* value given literature reports of the significance of these factors [8–10]. We used pairwise chi-square comparisons to test correlations between categorical independent variables due to significant associations suspected or reported in the literature. When 2 variables were highly correlated (Pearson's correlation coefficient >0.4), we included only the variable with greater clinical impact in the multivariable model or used 2 separate models if each variable was clinically important. In the postdischarge group, we had only 33 outcome observations; therefore, we limited this multivariable model to 3 covariates: age, sex, and race/ethnicity. We analyzed risk stratification in a separate analysis combining both groups given missing data in 33%.

We performed a sensitivity analysis including individuals with >1 COVID-19 Follow-up Program contact to isolate individuals with continued home monitoring using the same analysis plan. With closer follow-up, this longitudinal group may have been less likely to present to an outside hospital ED, resulting in more reliable acute health care utilization data and ability to track symptom evolution. Due to small numbers in this subgroup, we examined a composite outcome that included any acute care utilization (ED visit, observation stay, or hospital admission) within 30 days of first Follow-up Program contact. Finally, to ensure results were not confounded by analyzing children and adults together, we repeated the analysis excluding children.

All analyses were conducted using SAS, version 9.4 (SAS Institute Inc, Cary, NC, USA).

## RESULTS

Altogether, 4070 patients met inclusion criteria (age range 0–99+ years old, including 356 children aged 0–17 years): 3185 in the outpatient group and 885 patients in the postdischarge group, for a total of 11 627 COVID-19 Follow-up Program contacts. In the outpatient group, 53.7% were female with a mean age of 41.6 years; 43.6% identified as non-Hispanic Black or African American, 33.3% as Hispanic, and 9.9% as non-Hispanic White (Table 1). Over one-third (37.7%) listed a language other than English as their primary language. More than half (55.3%) had Medicaid insurance, 11.1% Medicare, and 26.1% had private insurance. The mean SVI was 0.682; 80.0% lived in zip codes considered socially vulnerable (SVI >0.5). Sixty-six percent had at least 1 comorbidity, and 67.9% reported ≥1 symptom at initial contact (most commonly respiratory symptoms, 40.1%). In total, 245 patients (7.7%) had a COVID-19-related acute care utilization, and 83 (2.6%) had a COVID-19-related hospital admission within 30 days of first COVID-19 Follow-up Program contact.

Compared with the outpatient group, the postdischarge group had a higher mean age (53.2 years), mean SVI (0.697), proportion that was Medicare-insured (26.9%), and proportion with any comorbidities (85.9%). Most postdischarge patients (64.9%) reported no symptoms at initial contact. Sixty-six postdischarge patients (7.5%) had any COVID-19-related acute care utilization, and 33 (3.7%) a COVID-19-related re-admission within 30 days.

In unadjusted analyses within the outpatient group, older age, Medicare insurance, reporting fatigue/generally feeling sick, headaches/body aches, fever, gastrointestinal symptoms, respiratory symptoms, or presence of ≥4 symptoms, and having ≥1 comorbidity or severe immunosuppression were associated with increased odds of admission (Table 2). Adjusting for sex, race/ethnicity, SVI, loss of taste/smell, and severe immunosuppression, older age (aOR, 1.05; 95% CI, 1.03–1.06), presence of gastrointestinal symptoms (aOR, 2.19; 95% CI, 1.53–3.94), and presence of respiratory symptoms (aOR, 2.46; 95% CI, 1.53–3.94) were significantly associated with hospital admission. Language, insurance, number of symptoms, and total comorbidities were excluded from the main multivariable model due to strong correlations with race/ethnicity, age, individual symptoms, and age, respectively.

Fever was significantly associated with COVID-19-related admissions (aOR, 2.70; 95% CI, 1.65–4.42) when included instead of respiratory symptoms. Using total comorbidities instead of age also yielded similar results, and those with 1–2 (aOR, 5.88; 95% CI, 2.07–16.72) and ≥3 (aOR, 20.40; 95% CI, 7.23–57.54) comorbidities had significantly higher odds of being admitted. Loss of taste/smell was significantly associated with decreased odds of admission (aOR, 0.46; 95% CI, 0.25–0.85). Severe immunosuppression, race/ethnicity, sex, SVI, and clinical trajectory were not significantly associated with admission in any model.

Age, Medicare insurance, and severe immunosuppression were all significantly associated with re-admission in the postdischarge group unadjusted analyses (Table 3); however, we retained age and excluded insurance for the adjusted analyses due to the high correlation we found between age and Medicare status. Older age predicted higher likelihood of re-admission in the adjusted model (aOR, 1.04 for each additional year of age; 95% CI, 1.01–1.06). A second adjusted model including severe immunosuppression also demonstrated significantly decreased re-admission odds with non-Hispanic Black race/ethnicity (aOR, 0.33; 95% CI, 0.11–0.95). Severe immunosuppression and having ≥3 comorbidities each had a large effect size in the adjusted model but did not meet statistical significance.

Those stratified as moderate or high risk had twice the odds of 30-day admission or re-admission compared with those who reported resolution of symptoms (OR, 1.93; 95% CI, 0.97–3.83; aOR, 2.02; 95% CI, 1.19–3.44, respectively) (Table 4).

**Table 1. Demographic Characteristics, Comorbidities, Clinical Disease Data, and Follow-up Outreach Among All Patients, Stratified by Initial Testing Site**

| Variable | Outpatient[a] (n = 3185), No. (%) | Postdischarge[a] (n = 885), No. (%) | *P* Value |
|---|---|---|---|
| Age, mean ± SD, y | 41.6 ± 19.9 | 53.2 ± 19.0 | <.001 |
| Female | 1710 (53.7) | 446 (50.4) | .08 |
| Race/ethnicity | | | |
| Non-Hispanic Black or African American | 1387 (43.6) | 365 (41.2) | .22 |
| Non-Hispanic White | 316 (9.9) | 119 (13.5) | .003 |
| Hispanic | 1061 (33.3) | 306 (34.6) | .48 |
| Another[b] | 133 (4.2) | 49 (5.5) | .08 |
| Unknown | 288 (9.0) | 46 (5.2) | .002 |
| Primary language | | | |
| English | 1986 (62.4) | 479 (54.1) | <.001 |
| Spanish | 672 (21.1) | 232 (26.2) | .001 |
| Other[c] | 527 (16.6) | 174 (19.7) | .03 |
| Insurance | | | |
| Medicaid | 1762 (55.3) | 461 (52.1) | .09 |
| Medicare | 353 (11.1) | 238 (26.9) | <.001 |
| Private | 832 (26.1) | 144 (16.3) | <.001 |
| Other[d] | 238 (7.5) | 42 (4.8) | .005 |
| SVI, mean ± SD | 0.682 ± 0.254 | 0.697 ± 0.226 | .11 |
| SVI >0.5 | 2548 (80.0) | 757 (85.5) | <.001 |
| Comorbidities | | | |
| Diabetes | 487 (15.3) | 263 (29.7) | <.001 |
| Coronary artery disease | 94 (3.0) | 68 (7.7) | <.001 |
| Chronic lung disease | 506 (15.9) | 131 (14.8) | .43 |
| Cirrhosis | 32 (1.0) | 15 (1.7) | .09 |
| Hypertension | 918 (28.8) | 405 (45.8) | <.001 |
| Chronic kidney disease | 78 (2.5) | 86 (9.7) | <.001 |
| Obesity | 1317 (41.4) | 482 (54.5) | <.001 |
| Heart failure | 70 (2.2) | 68 (7.7) | <.001 |
| Current or former smoker | 629 (19.8) | 307 (34.7) | <.001 |
| HIV | 44 (1.4) | 21 (2.4) | .04 |
| Sickle cell | 4 (0.1) | 6 (0.7) | .003 |
| Rheumatologic disease | 44 (1.4) | 17 (1.9) | .24 |
| Total comorbidities | | | |
| 0 | 1095 (34.4) | 125 (14.1) | <.001 |
| 1–2 | 1497 (47.0) | 418 (47.2) | .90 |
| 3–4 | 497 (15.6) | 22 (29.6) | <.001 |
| 5+ | 96 (3.0) | 80 (9.0) | <.001 |
| Abnormal CXR/chest CT | 43 (1.4) | 93 (10.5) | <.001 |
| Severely immunosuppressed[e] | 34 (1.1) | 40 (4.5) | <.001 |
| Symptoms | | | |
| Fatigue/generally feeling sick | 908 (28.5) | 166 (18.8) | <.001 |
| Headache/body aches | 1206 (37.9) | 102 (11.5) | <.001 |
| Runny nose/sore throat | 979 (30.7) | 56 (6.3) | <.001 |
| Loss of taste or smell | 813 (25.5) | 52 (5.9) | <.001 |
| Any fever[f] | 642 (20.2) | 71 (8.0) | <.001 |
| Any GI symptom[g] | 385 (12.1) | 52 (5.9) | <.001 |
| Any respiratory symptom[g] | 1277 (40.1) | 214 (24.2) | <.001 |
| Scaled number of symptoms | | | |
| 0 | 1021 (32.1) | 574 (64.9) | <.001 |
| 1 | 586 (18.4) | 110 (12.4) | <.001 |
| 2 | 502 (15.8) | 92 (10.4) | <.001 |
| 3 | 438 (13.8) | 48 (5.4) | <.001 |
| 4+ | 638 (20.0) | 61 (6.9) | <.001 |
| Clinical trajectory | | | |
| Symptoms resolved | 1106 (34.7) | 227 (25.6) | <.001 |
| Improving | 742 (23.3) | 193 (21.8) | .35 |
| Staying the same | 718 (22.5) | 52 (5.9) | <.001 |
| Worsening | 55 (1.7) | 3 (0.3) | .002 |
| Unknown | 564 (17.7) | 410 (46.3) | <.001 |
| Total follow-up calls within 30 d | | | |
| <3 | 1898 (59.6) | 544 (61.5) | .31 |
| 3–5 | 967 (30.4) | 213 (24.1) | <.001 |
| 6+ | 320 (10.1) | 128 (14.5) | <.001 |
| Initial call risk stratification | | | |
| Already re-admitted | 7 (0.2) | 8 (0.9) | .003 |
| Sent to ED | 14 (0.4) | 0 (0.0) | – |
| High (next call tomorrow) | 185 (5.8) | 64 (7.2) | .12 |
| Moderate (next call in 2 d) | 447 (14.0) | 107 (12.1) | .14 |
| Low (next call in 3 d) | 699 (22.0) | 89 (10.6) | <.001 |
| Symptoms resolved, no follow-up needed | 983 (30.8) | 212 (24.0) | <.001 |
| Community health center patient, no follow-up needed | 571 (17.9) | 304 (34.4) | <.001 |
| Unable to reach after 3 attempts | 279 (8.8) | 101 (11.4) | .02 |

Abbreviations: COVID-19, coronavirus disease 2019; CT, computed tomography scan; CXR, chest x-ray; ED, emergency department; EHR, electronic health record; GI, gastrointestinal; PCR, polymerase chain reaction; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; SVI, social vulnerability index.

[a]Patients stratified by initial COVID-19 testing site—outpatient (including patients tested in and discharged from the ED and those with SARS-CoV-2 PCR completed elsewhere but captured in the EHR) or postdischarge (those tested during an inpatient stay or admitted before first COVID-19 follow-up program contact).

[b]Includes Asian, American Indian/Native American, Native Hawaiian/Pacific Islander, and "other."

[c]Includes Haitian Creole, Cape Verdean/Port Creole, Portuguese, Vietnamese, Amharic/Ethiopian, and other languages with <3 patients each.

[d]Includes no insurance on file, worker's compensation, Veterans Affairs insurance, and grant-funded medical coverage.

[e]Includes those receiving active chemotherapy, high-dose steroids, or with HIV with CD4 cell count <200 cells/mm$^3$.

[f]Subjectively reported or recorded temperature >100.4°F.

[g]See Appendix 1 for details of the questions asked to elicit whether any gastrointestinal or respiratory symptoms were present; those with mild, moderate, or severe symptoms were grouped together as having any symptoms in the category "present."

The longitudinal group sensitivity analysis included 1683 individuals (see Appendix 4 for characteristics of those excluded). Compared with the full cohort, the longitudinally followed group had higher prevalence of each individual symptom and comorbidity and greater risk of any acute care utilization within 30 days (9.6% vs 7.6%). Older age, Medicare insurance, report of fatigue/generally feeling sick, headaches/body aches, fever, gastrointestinal or respiratory symptoms, >3 symptoms, any comorbidities, and severe immunosuppression were all associated in unadjusted analyses with increased odds of any acute care utilization in the outpatient group (Appendix 5). We retained age

**Table 2. Hospital Admissions Within 30 Days of Initial Contact by COVID-19 Follow-up Program in All Patients Initially Tested in Outpatient Setting**

| Variable | No Admission Within 30 Days[a] (n = 3102), No. (%) | Admission Within 30 Days[a] (n = 83), No. (%) | Unadjusted OR (95% CI) | With Respiratory Symptoms, Adjusted OR (95% CI)[b] | With Fever, Adjusted OR (95% CI)[c] | With Total Comorbidities, Adjusted OR (95% CI)[d] |
|---|---|---|---|---|---|---|
| Age, mean ± SD, y | 41.1 ± 19.7 | 58.1 ± 19.2 | 1.05 (1.03–1.06) | 1.05 (1.03–1.06) | 1.05 (1.04–1.06) | – |
| Female | 1672 (53.9) | 38 (45.8) | 0.72 (0.47–1.12) | 0.67 (0.43–1.05) | 0.69 (0.44–1.10) | 0.71 (0.45–1.12) |
| Race/ethnicity | | | | | | |
| Non-Hispanic Black or African American | 1355 (43.7) | 32 (38.6) | 0.91 (0.42–1.99) | 1.07 (0.46–2.49) | 0.97 (0.30–2.23) | 1.02 (0.44–2.37) |
| Non-Hispanic White | 308 (9.9) | 8 (9.6) | Ref | Ref | Ref | Ref |
| Hispanic | 1027 (33.1) | 34 (41.0) | 1.28 (0.58–2.78) | 1.62 (0.71–3.72) | 1.42 (0.91–2.26) | 1.67 (0.73–3.83) |
| Another[e] | 130 (4.2) | 3 (3.6) | 0.89 (0.23–3.40) | 0.83 (0.21–3.27) | 0.72 (0.18–2.84) | 1.18 (0.30–4.71) |
| Unknown | 282 (9.1) | 6 (7.2) | 0.82 (0.28–2.39) | 1.05 (0.34–3.19) | 0.91 (0.30–2.76) | 1.31 (0.43–4.01) |
| Language | | | | | | |
| English | 1941 (62.6) | 45 (54.2) | Ref | – | – | – |
| Spanish | 507 (16.3) | 18 (21.7) | 1.19 (0.68–2.07) | – | – | – |
| Other[f] | 507 (16.3) | 20 (24.1) | 1.70 (1.00–2.91) | – | – | – |
| Insurance | | | | | | |
| Medicaid | 1730 (55.8) | 32 (38.6) | 0.75 (0.43–1.32) | – | – | – |
| Medicare | 325 (10.5) | 28 (33.7) | 3.50 (1.94–6.30) | – | – | – |
| Private | 812 (26.2) | 20 (24.1) | Ref | – | – | – |
| Other[g] | 235 (7.6) | 3 (3.6) | 0.52 (0.15–1.76) | – | – | – |
| SVI, mean ± SD | 0.681 ± 0.253 | 0.693 ± 0.261 | 1.21 (0.50–2.90) | 1.23 (0.50–3.31) | 1.31 (0.51–3.35) | 1.01 (0.39–2.58) |
| SVI category | | | | | | |
| ≤0.5 | 620 (20.0) | 17 (20.5) | Ref | – | – | – |
| SVI >0.5 | 2482 (80.0) | 66 (79.5) | 0.97 (0.57–1.66) | – | – | – |
| Total comorbidities | | | | | | |
| 0 | 1091 (35.2) | 4 (4.8) | Ref | – | – | Ref |
| 1–2 | 1464 (47.2) | 33 (39.8) | 6.15 (2.17–17.41) | – | – | 5.88 (2.07–16.72) |
| 3+ | 547 (17.7) | 29 (34.9) | 22.94 (8.21–64.05) | – | – | 20.40 (7.23–57.54) |
| Severely immunosuppressed[h] | 31 (1.0) | 3 (3.6) | 3.72 (1.11–12.40) | 2.07 (0.58–7.37) | 2.13 (0.61–7.49) | 1.58 (0.44–5.64) |
| Symptoms | | | | | | |
| Fatigue/generally feeling sick | 866 (27.9) | 42 (50.6) | 2.65 (1.71–4.10) | – | – | – |
| Headache/body aches | 1164 (37.5) | 42 (50.6) | 1.71 (1.10–2.64) | – | – | – |
| Nose/throat symptoms | 961 (31.0) | 18 (21.7) | 0.62 (0.36–1.05) | – | – | – |
| Loss of taste or smell | 799 (25.8) | 14 (16.9) | 0.59 (0.33–1.05) | 0.56 (0.30–1.04) | 0.55 (0.30–1.03) | 0.46 (0.25–0.85) |
| Any fever[i] | 610 (19.7) | 32 (38.6) | 2.56 (1.63–4.02) | – | 2.70 (1.65–4.42) | – |
| Any GI symptom[j] | 366 (11.8) | 19 (22.9) | 2.22 (1.32–3.75) | 2.19 (1.53–3.94) | 2.05 (1.16–3.63) | 1.79 (1.02–3.15) |
| Any respiratory symptom[j] | 1225 (39.5) | 52 (62.7) | 2.57 (1.64–4.03) | 2.46 (1.53–3.94) | – | 2.18 (1.35–3.51) |
| Scaled number of symptoms | | | | | | |
| 0 | 1002 (32.3) | 19 (22.9) | Ref | – | – | – |
| 1 | 576 (18.6) | 10 (12.1) | 0.92 (0.42–1.98) | – | – | – |
| 2 | 493 (15.9) | 9 (10.8) | 0.96 (0.43–2.14) | – | – | – |
| 3 | 424 (13.7) | 14 (16.9) | 1.74 (0.87–3.51) | – | – | – |
| 4+ | 607 (19.6) | 31 (37.4) | 2.69 (1.51–4.81) | – | – | – |
| Clinical trajectory | | | | | | |
| Symptoms resolved | 1079 (34.8) | 27 (32.5) | Ref | – | – | – |
| Improving | 718 (23.2) | 24 (28.9) | 1.34 (0.77–2.33) | – | – | – |
| Staying the same | 697 (22.5) | 21 (25.3) | 1.20 (0.68–2.15) | – | – | – |
| Worsening | 54 (1.7) | 1 (1.2) | 0.74 (0.10–5.55) | – | – | – |
| Unknown | 554 (17.9) | 10 (12.1) | 0.72 (0.35–1.50) | – | – | – |

Abbreviations: COVID-19, coronavirus disease 2019; GI, gastroinstestinal; OR, odds ratio; SVI, social vulnerability index.

[a]Within 30 days of first COVID-19 follow-up team contact.

[b]Multivariate model includes age, female, race/ethnicity, SVI, loss of taste or smell, any respiratory symptom, any gastro symptom, and severely immunosuppressed variables.

[c]Multivariate model includes age, female, race/ethnicity, SVI, loss of taste or smell, any fever, any GI symptom, and severely immunosuppressed variables.

[d]Multivariate model includes female, race/ethnicity, SVI, loss of taste or smell, any respiratory symptom, any GI symptom, total comorbidities, and severely immunosuppressed variables.

[e]Includes Asian, American Indian/Native American, Native Hawaiian/Pacific Islander, and "other."

[f]Includes Haitian Creole, Cape Verdean/Port Creole, Portuguese, Vietnamese, Amharic/Ethiopian, and other languages with <3 patients each.

[g]Includes no insurance on file, worker's compensation, Veterans Affairs insurance, and grant-funded medical coverage.

[h]Includes those receiving active chemotherapy, high-dose steroids, or with HIV with CD4 cell count <200 cells/$mm^3$.

[i]Subjectively reported or recorded temperature >100.4°F.

[j]See Appendix 1 for details of the questions asked to elicit whether any gastrointestinal or respiratory symptoms were present; those with mild, moderate, or severe symptoms were grouped together as having any symptoms in the category present.

**Table 3. Hospital Admissions Within 30 Days of Initial Contact by COVID-19 Follow-up Program in All Postdischarge Patients**

| Variable | Not Admitted Within 30 Days[a] (n = 852), No. (%) | Admitted Within 30 Days[a] (n = 33), No. (%) | Unadjusted OR (95% CI) | With Sex, Adjusted OR (95% CI)[b] | With Severely Immunosuppressed, Adjusted OR (95% CI)[c] | With Total Comorbidities, Adjusted OR (95% CI)[d] |
|---|---|---|---|---|---|---|
| Age, mean ± SD, y | 52.8 ± 19.0 | 62.9 ± 18.0 | 1.03 (1.01–1.05) | 1.04 (1.01–1.06) | 1.04 (1.01–1.06) | – |
| Female | 434 (50.9) | 12 (36.4) | 0.55 (0.27–1.14) | 0.54 (0.26–1.14) | – | – |
| Race/ethnicity | | | | | | |
| Non-Hispanic Black or African American | 3507 (41.9) | 8 (24.2) | 0.36 (0.13–1.01) | 0.37 (0.13–1.05) | 0.33 (0.11–0.95) | 0.34 (0.12–0.96) |
| Non-Hispanic White | 112 (13.2) | 7 (21.2) | Ref | Ref | Ref | Ref |
| Hispanic | 292 (34.3) | 14 (42.4) | 0.77 (0.30–1.95) | 0.95 (0.36–3.85) | 0.87 (0.34–2.26) | 0.84 (0.33–2.17) |
| Another[e] | 45 (5.3) | 4 (12.1) | 1.42 (0.40–5.10) | 1.47 (0.40–5.44) | 1.20 (0.33–4.40) | 1.81 (0.48–6.90) |
| Unknown | 46 (5.4) | 0 (0.0) | N/A | N/A | N/A | N/A |
| language | | | | | | |
| English | 461 (54.1) | 18 (54.6) | Ref | – | – | – |
| Spanish | 222 (26.1) | 10 (30.3) | 1.15 (0.52–2.54) | – | – | – |
| Other[f] | 169 (19.8) | 5 (15.2) | 0.76 (0.28–2.07) | – | – | – |
| Insurance | | | | | | |
| Medicaid | 446 (52.4) | 15 (45.5) | 4.81 (0.63–36.69) | – | – | – |
| Medicare | 222 (26.1) | 16 (48.5) | 10.3 (1.35–78.47) | – | – | – |
| Private | 143 (16.8) | 1 (3.0) | Ref | – | – | – |
| Other[g] | 41 (4.8) | 1 (3.0) | 3.49 (0.21–56.92) | – | – | – |
| SVI, mean ± SD | 0.696 ± 0.226 | 0.718 ± 0.218 | 1.55 (0.31–7.81) | – | – | – |
| SVI >0.5 | 728 (85.5) | 39 (87.9) | 1.24 (0.43–3.57) | – | – | – |
| Total comorbidities | | | | | | |
| 0 | 123 (14.4) | 2 (6.1) | Ref | – | – | Ref |
| 1–2 | 405 (47.5) | 13 (39.4) | 1.97 (0.44–8.86) | – | – | 2.07 (0.45–9.59) |
| 3+ | 324 (38.1) | 18 (54.5) | 3.42 (0.78–14.93) | – | – | 4.25 (0.93–19.50) |
| Abnormal CXR/chest CT | 91 (10.7) | 2 (6.1) | 0.54 (0.13–2.29) | – | – | – |
| Severely immunosuppressed[h] | 36 (4.2) | 4 (12.1) | 3.13 (1.04–9.37) | – | 3.06 (0.99–9.43) | 2.89 (0.93–19.50) |
| Symptoms | | | | | | |
| Fatigue/generally feeling sick | 159 (18.7) | 7 (21.2) | 1.17 (0.50–2.75) | – | – | – |
| Headache/body aches | 98 (11.5) | 4 (12.1) | 1.06 (0.37–3.08) | – | – | – |
| Nose/throat symptoms | 56 (6.6) | 0 (0.0) | N/A | – | – | – |
| Loss of taste or smell | 50 (5.9) | 2 (6.1) | 1.04 (0.24–4.45) | – | – | – |
| Any fever[i] | 68 (8.0) | 3 (9.1) | 1.15 (0.34–3.88) | – | – | – |
| Any gastro symptom[j] | 50 (5.9) | 2 (6.1) | 1.04 (0.24–4.45) | – | – | – |
| Any respiratory symptom[j] | 208 (24.4) | 6 (18.2) | 0.69 (0.28–1.69) | – | – | – |
| Scaled number of symptoms | | | | | | |
| 0 | 551 (64.7) | 23 (69.7) | Ref | – | – | – |
| 1 | 106 (12.4) | 4 (12.1) | 0.90 (0.31–2.67) | – | – | – |
| 2 | 90 (10.6) | 2 (6.1) | 0.53 (0.12–2.30) | – | – | – |
| 3 | 47 (5.5) | 1 (3.0) | 0.51 (0.07–3.86) | – | – | – |
| 4+ | 58 (6.8) | 3 (9.1) | 1.24 (0.36–4.25) | – | – | – |
| Clinical trajectory | | | | | | |
| Symptoms resolved | 217 (25.5) | 10 (30.3) | Ref | – | – | – |
| Improving | 187 (22.0) | 6 (18.2) | 0.70 (0.25–1.95) | – | – | – |
| Staying the same | 48 (5.6) | 4 (12.1) | 1.81 (0.54–6.01) | – | – | – |
| Worsening | 3 (0.4) | 0 (0.0) | N/A | – | – | – |
| Unknown | 397 (46.6) | 13 (39.4) | 0.71 (0.31–1.65) | – | – | – |

Abbreviations: COVID-19, coronavirus disease 2019; CT, computed tomography scan; CXR, chest x-ray; OR, odds ratio; SVI, social vulnerability index.

[a]Within 30 days of first COVID-19 follow-up team contact.

[c]Only controlled for 3 variables (age, female, and severely immunosuppressed) due to low number of outcome variables.

[d]Only controlled for 3 variables (race/ethnicity, total comorbidities, and severely immunosuppressed) due to low number of outcome variables.

[e]Includes Asian, American Indian/Native American, Native Hawaiian/Pacific Islander, and "other."

[f]Includes Haitian Creole, Cape Verdean/Port Creole, Portuguese, Vietnamese, Amharic/Ethiopian, and other languages with <3 patients each.

[g]Includes no insurance on file, worker's compensation, Veterans Affairs insurance, and grant-funded medical coverage.

[h]Includes those receiving active chemotherapy, high-dose steroids, or with HIV with CD4 cell count <200 cells/$mm^3$.

[i]Subjectively reported or recorded temperature >100.4°F.

[j]See Appendix 1 for details of the questions asked to elicit whether any gastrointestinal or respiratory symptoms were present; those with mild, moderate, or severe symptoms were grouped together as having any symptoms in the category "present."

**Table 4. Hospital Admissions Within 30 Days of Initial Contact by Initial Call Risk Stratification**

| Variable | Not Admitted Within 30 Days[a] (n = 3954), No. (%) | Admitted Within 30 Days[a] (n = 116), No. (%) | Unadjusted OR (95% CI)[b] |
|---|---|---|---|
| Initial call risk stratification | | | |
| Sent to emergency department | 14 | 0 (0.0) | N/A |
| High (next call tomorrow) | 237 (6.0) | 12 (10.3) | 1.93 (0.97–3.83) |
| Moderate (next call in 2 d) | 526 (13.3) | 28 (24.1) | 2.02 (1.19–3.44) |
| Low (next call in 3 d) | 769 (19.4) | 19 (16.4) | 0.94 (0.52–1.69) |
| Symptoms resolved, no follow-up needed | 1103 (27.9) | 29 (25.0) | Ref |
| Unknown | 1305 (33.0) | 28 (24.1) | – |

Abbreviations: COVID-19, coronavirus disease 2019; OR, odds ratio.

[a]Within 30 days of first COVID-19 Follow-up Program contact.

[b]Only patients with known initial risk stratification were included in regression model.

and excluded insurance again for the adjusted analyses due to the high correlation we found between age and Medicare status. The adjusted model demonstrated increased age (aOR, 1.03; 95% CI, 1.01–1.05), presence of fever (aOR, 1.87; 95% CI, 1.22–2.86) or gastrointestinal symptoms (aOR, 2.00; 95% CI, 1.29–3.09), ≥5 comorbidities (aOR, 5.84; 95% CI, 2.45–13.91), and severe immunosuppression (aOR, 6.24; 95% CI, 2.44–15.98) to each be significantly associated with increased odds of COVID-19-related acute care utilization. Among the postdischarge longitudinal group, older age and the presence of gastrointestinal symptoms were associated with increased adjusted odds of acute care utilization (aOR, 1.03; 95% CI, 1.00–1.05; and aOR, 2.88; 95% CI, 1.13–7.36, respectively) (Appendix 6). Non-Hispanic Black race was associated with decreased risk of acute care utilization (aOR, 0.20; 95% CI, 0.07–0.63).

Pediatric characteristics are shown in Appendix 7. Analyses excluding children revealed no additional significant risk factors for hospital admission (data not shown).

## DISCUSSION

In this large study of outpatients monitored for ongoing COVID-19 symptoms after an initial positive SARS-CoV-2 PCR test, we found that older age, the presence of fever, respiratory symptoms, or gastrointestinal symptoms at initial contact, and high-risk comorbidities (particularly having ≥3) were associated with increased risk of initial COVID-19-related 30-day hospital admission. Loss of taste/smell, conversely, was associated with decreased admission risk. Among patients followed postdischarge from a COVID-19-related admission, older age was also associated with re-admission risk, and non-Hispanic Black race/ethnicity was associated with decreased re-admission risk. Clinical trajectory was not associated with admission or re-admission risk in any analyses but may have been limited by few individuals reporting worsening disease at initial contact (<4%).

Severely immunosuppressed individuals had more admissions, re-admissions, or any acute care utilizations in the 30 days following initial follow-up team contact in all groups, but only had significantly increased odds for any acute care utilization in the longitudinally followed group, perhaps due to the small number of severely immunosuppressed individuals overall.

These findings are consistent with European studies and 1 other US study, which also found that age >45 years, male sex, obesity, cancer, diabetes, chronic renal, liver, respiratory and/or heart disease, immunosuppression, fever, and shortness of breath were associated with increased risk of hospital admission and that loss of taste/smell was associated with decreased hospitalization risk [8–10]. Studies differed on the role of race as a risk factor. Our study adds to this evidence base and further contributes our findings that primary language, SVI, and Medicaid insurance were not significantly associated with risk of COVID-19-related acute care utilization. Although many social determinants of health can affect risk of infection from COVID-19 and other conditions [12,18], our results do not reflect increased admissions or re-admissions due to these factors in our study population. We also found, consistent with another US study [10], that those who identify as non-Hispanic Black were less likely to be re-admitted in the postdischarge group. Interestingly, other studies in the United States have found much higher rates of hospitalization among Black and Latino patients compared with our program data [19,20]. Although causality cannot be determined with the present data, our program's lack of higher hospitalization rates among these patients could indicate that this type of equity-centric home monitoring program improves health care access among these groups and helps combat disproportionately high hospitalization rates. This lack of higher hospitalization rate among Black and Latino patients also may be impacted BMC's many outreach programs, wide interpreter use, and health care equity improvement efforts overall [21]. Alternatively, this may be because our study only examines individuals already diagnosed with COVID-19, and therefore does not capture differences in initial health care utilization or COVID-19 infection risk.

This study has several limitations. The retrospective design relied on accuracy and completeness of EHR template data. We did not prospectively follow patients to capture non-BMC

admissions or out-of-hospital deaths. Despite a large sample size (n = 4070), the study was limited by few acute care utilizations, particularly in the postdischarge and longitudinal groups. We therefore could not control for many variables, including individual comorbidities rather than total comorbidities combined, in any 1 model and had limited power. However, we still were able to observe significant associations with several variables across groups. Another possible limitation is selection bias; we excluded those unable to be reached by the COVID-19 Follow-up Program as their data were incomplete. Obtaining greater data on those not contacted by the COVID-19 Follow-Up Program would be beneficial to the evaluation of our program's impact, but we are limited by the data available to abstract. Additionally, as successfully contacted patients may have differed from those who did not seek care or respond to calls, this study likely missed milder cases and did not capture sociodemographic differences of those not reached. Other unmeasured variables, such as homelessness, which can affect admission rates, could have confounded our results. This was mitigated in our population by standard use of nonhospital recuperation and isolation units set up for unstably housed individuals with COVID-19 [22].

Finally, this study occurred during circulation of primarily the SARS-CoV-2 Alpha strain and before widespread SARS-CoV-2 vaccination. In Massachusetts, vaccine rollout for those aged 65+ and those with 2 or more certain comorbidities began in February 2021, when our study period ended [23]. Risk predictors may differ for other variants and in vaccinated hosts. However, the majority of severe COVID-19 infections and hospitalizations continue to occur in unvaccinated individuals [24].

Our data highlight acute care utilization risk factors for COVID-19 outpatient treatment and home monitoring programs to prioritize patients who will benefit from therapeutics and/or close follow-up. These findings add to prior literature to confirm the importance of age but also to underline the impact the number of high-risk comorbidities and particular symptoms may have in predicting hospital admission risk. These data are critical to incorporate into priority tiering of patients for limited-availability antivirals and monoclonal antibodies at this time [5–7]. Monitoring programs may also benefit patients, reduce disparities in health care utilization, and reduce unneeded health care utilization through ongoing proactive assessments. Although vaccination rates are increasing worldwide, the end of the COVID-19 pandemic is still not in sight. Particularly given disparities in vaccine access and hesitancy [25,26] and limited hospital capacity nationally and worldwide, we must continue to support programs and research to understand how to best equitably prevent COVID-19 health care utilizations.


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***Author contributions.*** All authors had access to the data and had a role in writing the manuscript.

***Patient consent.*** The Boston University Medical Campus Institutional Review Board approved this study as exempt human subject research. As such, patient consent was not required for this retrospective review of electronic health record data.


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## APPENDIX 1

**Appendix 1A. Clinical Assessment Guide for Symptom Stratification Used by BMC COVID-19 Follow-up Program**

Symptom Stratification Clinical Assessment

| Symptom Assessment | Mild | Moderate | Severe |
|---|---|---|---|
| How is your breathing? | • New cough and no SOB<br>• In patient with chronic cough, cough worse and no SOB | • Cough with mild SOB<br>• Aware of breathing but comfortable<br>• Able to complete sentence without taking a breath midsentence<br>• Able to climb a flight of stairs without losing breath. If at baseline has dyspnea with climbing stairs, worse from baseline | • SOB with 1 flight of stairs<br>• Any chest pain<br>• Unable to speak in full sentences |
| What is your oxygen saturation | • O2 Sat ≥94% and has not fallen by >4% in last 4–8 h | • O2 Sat 91%–94% and has not fallen by >4% in last 4–8 h | • O2 Sat ≤90% OR<br>O2 sat has fallen by >4% in last 4–8 h |
| What is your temperature? | • Temperature <100.4°F OR subjective no fever | • Temperature 100.4°F–102.5°F but responding to fever medicine<br>OR subjective fever | • Temperature >102.5°F or >100.4°F and not responsive to fever medicine<br>OR subjective fever unresponsive to fever medicine and/or confusion |
| How is your intake of liquids?<br>Are you having vomiting or diarrhea? | • Mild vomiting/diarrhea<br>• Able to drink liquids<br>• Urinating every 4–6 h | • Moderate vomiting or diarrhea<br>• Decreased fluid intake (<50% usual)<br>• Urinating at least 3x daily, has tears | • Severe vomiting or diarrhea<br>• Unable to keep fluids down<br>• Decreased urine output to <3x daily<br>• Syncope or near syncope |
| Are you (or your family member) more confused than usual? | • Mentation normal/at baseline | • Mentation is normal/at baseline | • Mentation not at baseline: confused, waxing and waning consciousness, not able to concentrate, hallucinating |
| Have you had a change in your mobility or a fall? | • Function is normal<br>• Able to perform ADLs without change in level of assistance | • Function is mildly reduced but patient is able to manage daily function safely<br>• Needs some increased assistance in performing ADLs from baseline | • Sustained a fall<br>• Function severely reduced<br>• Needs significantly increased assistance in performing ADLs from baseline |

Abbreviations: ADLs, activities of daily living; SOB, shortness of breath.

**Appendix 1B. Clinical Assessment Guide for Symptom Stratification Used by BMC COVID-19 Follow-up Program**

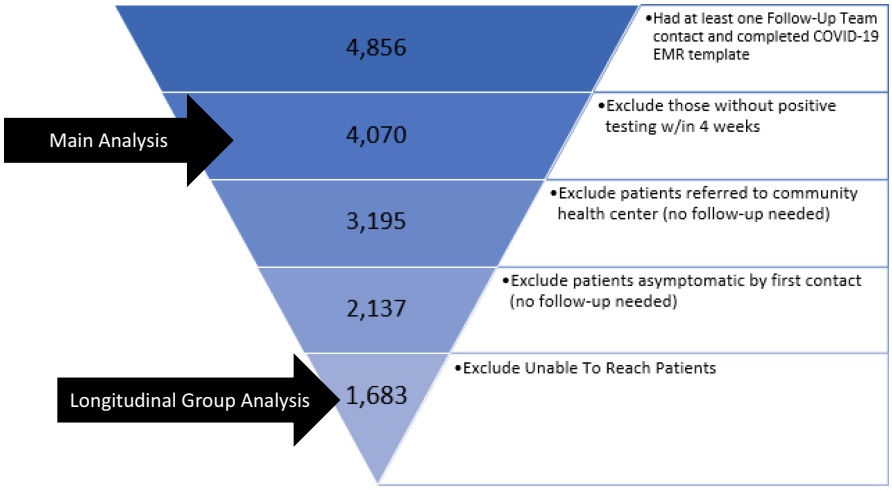
| Symptoms & Clinical Trajectory[a] | With Risk Factors | No Risk Factors |
|---|---|---|
| Any severe symptom(s) | Send to ED | Send to ED |
| Moderate respiratory + worsening | Send to ED | Send to ED vs high risk (next day) |
| Moderate respiratory + stable | Send to ED vs high risk (next day) | Send to ED vs high risk (next day) vs moderate risk (2nd day) |
| Moderate respiratory + improving | Moderate risk (2nd day) | Moderate risk (2nd day) |
| Mild respiratory + worsening | Send to ED vs high risk (next day) | High risk (next day) vs moderate risk (2nd day) vs send to ED |
| Mild respiratory + stable/improving | Moderate risk (2nd day) vs graduate[b] | Low risk (3rd day) vs graduate[b] |
| Moderate fever/GI symptoms/mobility only | Moderate risk (2nd day) | Moderate risk (2nd day) |
| Mild fever/GI symptoms/mobility only | Low risk (3rd day) vs graduate[b] | Low risk (3rd day) vs graduate[b] |
| No symptoms | Low risk (3rd day) vs graduate[b] | Low risk (3rd day) vs graduate[b] |

Abbreviations: BMC, Boston Medical Center; COVID-19, coronavirus disease 2019; ED, emergency department; GI, gastrointestinal; ICU, intensive care unit.

[a]These are guides as to appropriate follow-up; clinical judgment takes precedence when determining action.

[b]Criteria for graduation (we stop following patients in the team; patient is cleared from isolation): currently inpatient (admitted); cannot reach the patient by any means for 3 days; meet symptom-based clearance for isolation (More than 10 days have passed since symptom onset, 1 day without fever (without use of antipyretics), AND 1 day with improvement in other symptoms; OR for patients admitted to the ICU or receiving a biologic, they must isolate for 20 days from symptom onset).

## APPENDIX 2




**Appendix 2. Decision Flowchart for Study Participant Inclusion and Exclusion.**

## APPENDIX 3

**Appendix 3. Primary Diagnoses and Associated ICD-10 Codes Used for Determining COVID-19-associated Hospital Admissions**

| Primary Diagnosis | ICD-10 Code |
|---|---|
| Other specified sepsis | A41.89 |
| Sepsis, unspecified organism | A41.9 |
| Hb-SS disease with acute chest syndrome | D57.01 |
| Neutropenia, unspecified | D70.9 |
| Insomnia, unspecified | G47.00 |
| Other specified cardiac arrhythmias | I49.8 |
| Pneumonia due to COVID-19 | J12.82 |
| Moderate persistent asthma with (acute) exacerbation | J45.41 |
| Decreased fetal movements, third trimester, not applicable or unspecified | O36.8130 |

**Appendix 3. Continued**

| Primary Diagnosis | ICD-10 Code |
|---|---|
| Other viral diseases complicating childbirth | O98.52 |
| Cough | R05 |
| Dyspnea, unspecified | R06.00 |
| Shortness of breath | R06.02 |
| Precordial pain | R07.2 |
| Other chest pain | R07.89 |
| Epigastric pain | R10.13 |
| Right lower quadrant pain | R10.31 |
| Unspecified abdominal pain | R10.9 |
| Nausea with vomiting, unspecified | R11.2 |
| Delirium | R41.0 |
| Altered mental status, unspecified | R41.82 |
| Dizziness and giddiness | R42 |
| Fever, unspecified | R50.9 |
| Localized enlarged lymph nodes | R59.0 |
| COVID-19 | U07.1 |
| Contact with and (suspected) exposure to COVID-19 | Z20.822 |
| Contact with and (suspected) exposure to other viral communicable diseases | Z20.828 |

Abbreviations: COVID-19, coronavirus disease 2019; Hb-SS, sickle cell anemia ; ICD-10, International Classification of Diseases, 10th Edition.

## APPENDIX 4

**Appendix 4. Baseline Characteristics of Those Included in Longitudinal Group Sensitivity Analysis Compared With Those who Were Excluded (Community Health Center Patients, Those Asymptomatic by First Contact and Not Needing Follow-up, and Those Unable to Be Reached)**

| Variable | Longitudinal Group (n = 1683), No. (%) | Community Health Center Patients (n = 875), No. (%) | Asymptomatic by First Contact (n = 1058), No. (%) | Unable to Be Reached (n = 454), No. (%) |
|---|---|---|---|---|
| Age, mean ± SD, y | 45.9 ± 21.2 | 44.7 ± 20.1 | 40.5 ± 18.9 | 44.3 ± 19.3 |
| Female | 923 (54.0) | 465 (52.8) | 550 (52.0) | 218 (48.2) |
| Race/ethnicity | | | | |
| Non-Hispanic Black or African American | 835 (47.0) | 278 (28.3) | 430 (37.9) | 209 (42.4) |
| Non-Hispanic White | 136 (8.3) | 117 (13.9) | 118 (11.0) | 64 (14.1) |
| Hispanic | 519 (32.5) | 357 (42.6) | 363 (36.0) | 128 (30.0) |
| Another[a] | 59 (3.9) | 65 (7.8) | 47 (4.7) | 11 (2.8) |
| Unknown | 134 (8.3) | 58 (7.3) | 100 (10.5) | 42 (10.6) |
| Language | | | | |
| English | 1045 (59.1) | 487 (54.2) | 646 (58.3) | 287 (59.9) |
| Spanish | 333 (21.7) | 248 (29.5) | 241 (25.0) | 82 (19.4) |
| Other[b] | 305 (19.3) | 140 (16.3) | 171 (16.7) | 85 (20.6) |
| Insurance | | | | |
| Medicaid | 889 (56.3) | 498 (59.1) | 586 (57.0) | 250 (57.7) |
| Medicare | 309 (15.4) | 120 (11.4) | 90 (6.4) | 72 (12.8) |
| Private | 398 (22.7) | 184 (21.2) | 291 (27.0) | 103 (22.4) |
| Other[c] | 87 (5.6) | 73 (8.3) | 91 (9.6) | 29 (7.2) |
| SVI, mean ± SD | 0.697 ± 0.247 | 0.686 ± 0.240 | 0.674 ± 0.251 | 0.667 ± 0.260 |
| SVI >0.5 | 1381 (81.3) | 725 (81.6) | 845 (79.6) | 354 (76.7) |

Abbreviations: SVI, social vulnerability index; VA, Veterans Affairs.

[a]Includes Asian, American Indian/Native American, Native Hawaiian/Pacific Islander, and "other."

[b]Includes Haitian Creole, Cape Verdean/Port Creole, Portuguese, Vietnamese, Amharic/Ethiopian, and other languages with <3 patients each.

[c]Includes no insurance on file, worker's compensation, VA insurance, and grant-funded medical coverage.

## APPENDIX 5

**Appendix 5. Acute Care Utilization (ED Visit, Observation Stay, or Hospital Admission) Within 30 Days of Initial Contact by COVID-19 Follow-up Program in All Patients Initially Tested in Outpatient Setting**

| Outpatient Group Only | | | | |
|---|---|---|---|---|
| Variable | No Acute Care Utilization Within 30 Days[a] (n = 1322), No. (%) | Any Acute Care Utilization Within 30 Days[a] (n = 130), No. (%) | Unadjusted OR (95% CI) | Adjusted OR (95% CI) |
| Age, mean ± SD, y | 43.2 ± 20.9 | 50.45 ± 20.43 | 1.02 (1.01–1.03) | 1.03 (1.01–1.05) |
| Female | 754 (57.0) | 68 (52.3) | 0.83 (0.57–1.19) | 0.72 (0.49–1.08) |
| Race/ethnicity | | | | |
| Non-Hispanic Black or African American | 647 (48.9) | 56 (43.1) | 0.92 (0.46–1.87) | 1.18 (0.54–2.57) |
| Non-Hispanic White | 104 (7.9) | 10 (7.7) | Ref | Ref |
| Hispanic | 413 (31.2) | 49 (37.7) | 1.28 (0.63–2.62) | 1.53 (0.70–3.35) |
| Another[b] | 47 (3.6) | 5 (3.9) | 1.11 (0.36–3.44) | 1.68 (0.51–5.54) |
| Unknown | 111 (8.4) | 10 (7.7) | 0.94 (0.38–2.36) | 1.48 (0.55–3.94) |
| language | | | | |
| English | 842 (63.7) | 73 (56.2) | Ref | – |
| Spanish | 256 (19.4) | 32 (24.6) | 1.47 (0.95–2.29) | – |
| Other[c] | 224 (16.9) | 25 (19.2) | 1.27 (0.79–2.04) | – |
| Insurance | | | | |
| Medicaid | 727 (55.0) | 65 (50.0) | 0.97 (0.62–1.52) | – |
| Medicare | 187 (14.2) | 30 (23.1) | 1.75 (1.02–2.98) | – |
| Private | 336 (25.4) | 31 (23.9) | Ref | – |
| Other[d] | 72 (5.5) | 4 (3.1) | 0.58 (0.20–1.70) | – |
| SVI, mean ± SD | 0.691 ± 0.252 | 0.693 ± 0.243 | 1.05 (0.51–2.15) | 1.02 (0.46–2.25) |
| SVI >0.5 | 1071 (81.0) | 107 (82.3) | 1.11 (0.69–1.78) | – |
| Total comorbidities | | | | |
| 0 | 351 (26.6) | 17 (3.1) | Ref | Ref |
| 1–2 | 652 (49.3) | 59 (45.4) | 1.91 (1.10–3.33) | 1.76 (0.96–3.21) |
| 3–4 | 265 (20.0) | 34 (26.2) | 2.75 (1.50–5.04) | 2.00 (0.99–4.05) |
| 5+ | 54 (4.1) | 20 (15.4) | 8.26 (4.05–16.87) | 5.84 (2.45–13.91) |
| Severely immunosuppressed[e] | 20 (1.5) | 10 (7.7) | 7.88 (3.38–18.35) | 6.24 (2.44–15.98) |
| Symptoms | | | | |
| Fatigue/generally feeling sick | 520 (39.3) | 78 (66.2) | 2.44 (1.69–3.53) | 1.45 (0.94–2.24) |
| Headache/body aches | 636 (48.1) | 86 (66.2) | 2.24 (1.53–3.27) | 1.39 (0.88–2.19) |
| Nose/throat symptoms | 508 (38.4) | 49 (37.7) | 1.00 (0.69–1.45) | – |
| Loss of taste or smell | 436 (33.0) | 48 (36.9) | 1.23 (0.85–1.79) | – |
| Any fever[f] | 361 (27.3) | 64 (49.2) | 2.78 (1.93–4.01) | 1.87 (1.22–2.86) |
| Any gastro symptom[g] | 217 (16.4) | 45 (34.6) | 2.95 (1.99–4.37) | 2.00 (1.29–3.09) |
| Any respiratory symptom[g] | 695 (52.6) | 90 (69.3) | 2.12 (1.44–3.13) | 1.27 (0.82–1.97) |
| Scaled number of symptoms | | | | |
| 0 | 249 (18.8) | 11 (8.5) | Ref | – |
| 1 | 238 (18.0) | 12 (9.2) | 1.14 (0.49–2.64) | – |
| 2 | 221 (16.7) | 19 (14.6) | 2.03 (0.94–4.35) | – |
| 3 | 223 (16.9) | 21 (16.2) | 2.23 (1.05–4.73) | – |
| 4+ | 391 (29.6) | 67 (51.5) | 4.27 (2.21–8.25) | – |
| Clinical trajectory | | | | |
| Symptoms resolved | 397 (30.0) | 43 (33.1) | Ref | – |
| Improving | 334 (25.3) | 39 (30.0) | 1.06 (0.67–1.68) | – |
| Staying the same | 370 (28.0) | 36 (27.7) | 0.90 (0.56–1.43) | – |
| Worsening | 40 (3.0) | 5 (3.9) | 1.22 (0.46–3.29) | – |
| Unknown | 181 (13.7) | 7 (5.4) | 0.33 (0.15–0.75) | – |

Abbreviations: COVID-19, coronavirus disease 2019; ED, emergency department; OR, odds ratio; SVI, social vulnerability index; VA, Veterans Affairs.

[a]Within 30 days of first COVID-19 follow-up team contact.

[b]Includes Asian, American Indian/Native American, Native Hawaiian/Pacific Islander, and "other."

[c]Includes Haitian Creole, Cape Verdean/Port Creole, Portuguese, Vietnamese, Amharic/Ethiopian, and other languages with <3 patients each.

[d]Includes no insurance on file, worker's compensation, VA insurance, and grant-funded medical coverage.

[e]Includes those receiving active chemotherapy, high-dose steroids, and/or having HIV with CD4 <200.

[f]Subjectively reported or recorded temperature >100.4°F.

[g]See Appendix 1A for details of the questions asked to elicit whether any gastrointestinal or respiratory symptoms were present; those with mild, moderate, or severe symptoms were grouped together as having any symptoms in the category "present."

## APPENDIX 6

**Appendix 6. Acute Care Utilization (ED Visit, Observation Stay, or Hospital Admission) Within 30 Days of Initial Contact by COVID-19 Follow-up Program in All Postdischarge Patients**

Postdischarge Group Only

| Variable | No Acute Care Utilization Within 30 Days[a] (n = 298), No. (%) | Any Acute Care Utilization Within 30 Days[a] (n = 31), No. (%) | Unadjusted OR (95% CI) | Adjusted OR (95% CI)[b] |
|---|---|---|---|---|
| Age, mean ± SD, y | 55.1 ± 19.0 | 61.61 ± 14.99 | 1.02 (1.00–1.04) | 1.03 (1.00–1.05) |
| Female | 141 (47.3) | 13 (41.9) | 0.79 (0.37–1.67) | – |
| Race/ethnicity | | | | |
| Non-Hispanic Black or African American | 169 (56.7) | 11 (35.5) | 0.23 (0.08–0.69) | 0.20 (0.07–0.63) |
| Non-Hispanic White | 25 (8.4) | 6 (19.4) | Ref | Ref |
| Hispanic | 78 (26.2) | 13 (41.9) | 0.59 (0.20–1.73) | 0.56 (0.18–1.72) |
| Another[c] | 8 (2.7) | 1 (3.2) | 0.42 (0.04–4.03) | 0.50 (0.05–5.07) |
| Unknown | 18 (6.0) | 0 (0.0) | N/A | N/A |
| Language | | | | |
| English | 173 (58.1) | 18 (58.1) | Ref | – |
| Spanish | 66 (22.2) | 9 (29.0) | 1.45 (0.62–3.40) | – |
| Other[d] | 59 (19.8) | 4 (12.9) | 0.58 (0.19–1.78) | – |
| Insurance | | | | |
| Medicaid | 139 (46.6) | 11 (35.5) | 0.63 (0.22–1.79) | – |
| Medicare | 96 (32.2) | 13 (41.9) | 1.07 (0.38–3.01) | – |
| Private | 51 (17.1) | 6 (19.4) | Ref | – |
| Other[e] | 12 (4.0) | 1 (3.2) | 0.63 (0.07–5.70) | – |
| SVI, mean ± SD | 0.722 ± 0.223 | 0.725 ± 0.185 | 1.04 (0.20–5.58) | – |
| SVI >0.5 | 260 (87.2) | 28 (90.3) | 1.42 (0.41–4.91) | – |
| Total comorbidities | | | | |
| 0 | 24 (8.1) | 3 (9.7) | Ref | – |
| 1–2 | 119 (39.9) | 10 (32.3) | 0.64 (0.16–2.53) | – |
| 3–4 | 117 (39.3) | 15 (48.4) | 1.02 (0.27–3.82) | – |
| 5+ | 38 (12.8) | 3 (9.7) | 0.61 (0.11–3.30) | – |
| Severely immunosuppressed[f] | 20 (6.7) | 4 (12.9) | 2.04 (0.65–6.42) | – |
| Symptoms | | | | |
| Fatigue/generally feeling sick | 127 (42.6) | 15 (48.4) | 1.31 (0.62–2.75) | – |
| Headache/body aches | 69 (23.2) | 7 (22.6) | 0.97 (0.40–2.34) | – |
| Nose/throat symptoms | 45 (15.1) | 5 (16.1) | 1.15 (0.42–3.18) | – |
| Loss of taste or smell | 44 (14.8) | 6 (19.4) | 1.44 (0.56–3.73) | – |
| Any fever[g] | 53 (17.8) | 6 (19.4) | 1.13 (0.44–2.91) | – |
| Any gastro symptom[h] | 40 (13.4) | 8 (25.8) | 2.60 (1.08–6.29) | 2.88 (1.13–7.36) |
| Any respiratory symptom[h] | 159 (53.4) | 16 (51.6) | 0.95 (0.45–2.00) | – |
| Scaled number of symptoms | | | | |
| 0 | 79 (26.5) | 7 (22.6) | Ref | – |
| 1 | 63 (21.1) | 9 (29.0) | 1.71 (0.60–4.85) | – |
| 2 | 72 (24.2) | 3 (9.7) | 0.47 (0.12–1.89) | – |
| 3 | 33 (11.1) | 4 (12.9) | 1.47 (0.40–5.38) | – |
| 4+ | 51 (17.1) | 8 (25.8) | 1.96 (0.67–5.75) | – |
| Clinical trajectory | | | | |
| Symptoms resolved | 79 (26.5) | 8 (25.8) | Ref | – |
| Improving | 140 (47.0) | 13 (41.9) | 1.05 (0.40–2.75) | – |
| Staying the same | 42 (14.1) | 7 (22.6) | 1.90 (0.62–5.80) | – |
| Worsening | 3 (1.0) | 0 (0.0) | N/A | – |
| Unknown | 34 (11.4) | 3 (9.7) | 0.93 (0.23–3.83) | – |

Abbreviations: COVID-19, coronavirus disease 2019; ED, emergency department; OR, odds ratio; SVI, social vulnerability index; VA, Veterans Affairs.

[a]Within 30 days of first COVID-19 follow-up team contact.

[b]Only controlled for 3 variables due to low number of outcome variables.

[c]Includes Asian, American Indian/Native American, Native Hawaiian/Pacific Islander, and "other."

[d]Includes Haitian Creole, Cape Verdean/Port Creole, Portuguese, Vietnamese, Amharic/Ethiopian, and other languages with <3 patients each.

[e]Includes no insurance on file, worker's compensation, VA insurance, and grant-funded medical coverage.

[f]Includes those receiving active chemotherapy, high-dose steroids, and/or having HIV with CD4 <200.

[g]Subjectively reported or recorded temperature >100.4°F.

[h]See Appendix 1A for details of the questions asked to elicit whether any gastrointestinal or respiratory symptoms were present; those with mild, moderate, or severe symptoms were grouped together as having any symptoms in the category "present."

## APPENDIX 7

**Appendix 7. Demographic Characteristics, Comorbidities, Clinical Disease Data, and Follow-up Outreach Among All Patients Aged 0–17 Years**

| Variable | Patients Aged 0–17 (n = 356), No. (%) |
|---|---|
| Age, mean ± SD, y | 8.3 ± 5.8 |
| Female | 182 (51.1) |
| Race/ethnicity | |
| Non-Hispanic Black or African American | 145 (40.7) |
| Non-Hispanic White | 23 (6.5) |
| Hispanic | 117 (32.9) |
| Another[a] | 17 (4.8) |
| Unknown | 54 (15.2) |
| Primary language | |
| English | 235 (66.0) |
| Spanish | 53 (14.9) |
| Other[b] | 68 (19.1) |
| Insurance | |
| Medicaid | 292 (82.0) |
| Private | 52 (14.6) |
| Other[c] | 12 (3.4) |
| SVI, mean ± SD | 0.695 ± 0.256 |
| SVI >0.5 | 285 (80.1) |
| Comorbidities[d] | |
| Chronic lung disease | 66 (18.5) |
| Obesity | 65 (18.3) |
| Total comorbidities | |
| 0 | 244 (68.5) |
| 1–2 | 110 (30.9) |
| 3–4 | 2 (0.6) |
| Symptoms | |
| Fatigue/generally feeling sick | 63 (17.7) |
| Headache/body aches | 70 (19.7) |
| Nose/throat symptoms | 105 (29.5) |
| Loss of taste or smell | 44 (12.4) |
| Any fever[e] | 39 (11.0) |
| Any gastro symptom[f] | 24 (6.7) |
| Any respiratory symptom[g] | 92 (25.8) |
| Scaled number of symptoms | |
| 0 | 165 (46.4) |
| 1 | 71 (19.9) |
| 2 | 58 (16.3) |
| 3 | 31 (8.7) |
| 4+ | 31 (8.7) |
| Clinical trajectory | |
| Symptoms resolved | 1106 (34.7) |
| Improving | 742 (23.3) |
| Staying the same | 718 (22.5) |
| Worsening | 55 (1.7) |
| Unknown | 564 (17.7) |
| Total follow-up calls within 30 d | |
| <3 | 225 (63.2) |
| 3–5 | 115 (32.3) |
| 6+ | 16 (4.5) |
| Initial call risk stratification | |
| High (next call tomorrow) | 9 (2.5) |
| Moderate (next call in 2 d) | 47 (13.2) |
| Low (next call in 3 d) | 108 (30.3) |
| Symptoms resolved, no follow-up needed | 104 (29.2) |
| CHC patient, no follow-up needed | 65 (18.3) |
| Unable to reach after 3 attempts | 23 (6.5) |

[a]Includes Asian, American Indian/Native American, Native Hawaiian/Pacific Islander, and "other."

[b]Includes Haitian Creole, Cape Verdean/Port Creole, Portuguese, Vietnamese, Amharic/Ethiopia, and other languages with <3 patients each.

[c]Includes no insurance on file, worker's compensation, Veteran's Administration insurance, and grant-funded medical coverage.

[d]We only listed those comorbidities with 5 or more individuals; <5 individuals had severe immunosuppression.

[e]Subjectively reported or recorded temperature >100.4°F.

[f]See Appendix 1A for details of the questions asked to elicit whether any gastrointestinal or respiratory symptoms were present; those with mild, moderate, or severe symptoms were grouped together as having any symptoms in the category "present."