


Hospital Readmissions After Implementation of a Discharge Care Program for Patients with COVID-19 Illness



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BACKGROUND: The surge of coronavirus 2019 (COVID-19) hospitalizations in New York City required rapid discharges to maintain hospital capacity.

OBJECTIVE: To determine whether lenient provisional discharge guidelines with remote monitoring after discharge resulted in safe discharges home for patients hospitalized with COVID-19 illness.

DESIGN: Retrospective case series

SETTING: Tertiary care medical center

PATIENTS: Consecutive adult patients hospitalized with COVID-19 illness between March 26, 2020, and April 8, 2020, with a subset discharged home

INTERVENTIONS: COVID-19 Discharge Care Program consisting of lenient provisional inpatient discharge criteria and option for daily telephone monitoring for up to 14 days after discharge

MEASUREMENTS: Fourteen-day emergency department (ED) visits and hospital readmissions

RESULTS: Among 812 patients with COVID-19 illness hospitalized during the study time period, 15.5% died prior to discharge, 24.1% remained hospitalized, 10.0%

were discharged to another facility, and 50.4% were discharged home. Characteristics of the 409 patients discharged home were mean (SD) age 57.3 (16.6) years; 245 (59.9%) male; 27 (6.6%) with temperature ≥ 100.4 °F; and 154 (37.7%) with oxygen saturation $< 95\%$ on day of discharge. Over 14 days of follow-up, 45 patients (11.0%) returned to the ED, of whom 31 patients (7.6%) were readmitted. Compared to patients not referred, patients referred for remote monitoring had fewer ED visits (8.3% vs 14.1%; OR 0.60, 95% CI 0.31–1.15, $p = 0.12$) and readmissions (6.9% vs 8.3%; OR 1.15, 95% CI 0.52–2.52, $p = 0.73$).

LIMITATIONS: Single-center study; assignment to remote monitoring was not randomized.

CONCLUSIONS: During the COVID-19 surge in New York City, lenient discharge criteria in conjunction with remote monitoring after discharge were associated with a rate of early readmissions after COVID-related hospitalizations that was comparable to the rate of readmissions after other reasons for hospitalization before the COVID pandemic.

Key Points

Question: What are the short-term outcomes of patients hospitalized with coronavirus 19 (COVID-19) that are discharged home following the institution of lenient discharge criteria in conjunction with a remote monitoring program after discharge?

Findings: In this case series that included 812 consecutive patients hospitalized at a hospital in New York City, 7.6% of the 409 patients discharged home were readmitted within 14 days. The remote monitoring component of the program consisting of daily telephone surveillance of patients discharged home was associated with high patient satisfaction, a lower rate of return to the emergency department, and fewer 14-day readmissions, though these differences were not statistically significant.

Meaning: Lenient discharge criteria that allow patients with fever and mild hypoxia to be discharged home with remote monitoring after discharge can be safely used as an approach to maximizing hospital capacity during surges in COVID-19 infections.

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INTRODUCTION

In March of 2020, the COVID-19 pandemic resulted in a massive surge in hospitalizations across New York City, from one case on March 2 to nearly 30,000 by mid-April 2020.^{1–4} Limited knowledge about the clinical course of COVID-19 illness contributed to unclear discharge criteria for hospitalized patients.⁵ At the same time, social distancing policies limited options for usual outpatient follow-up at post-discharge clinic visits or by home-based programs such as visiting nurses. Concerns about these gaps in post-discharge care for patients with COVID-19 illness and an uncertain clinical course had the potential to delay hospital discharges.

In response to this pressing need to maximize hospital capacity through rapid discharges, a multidisciplinary team of clinicians and hospital leaders created a COVID-19 Discharge Care Program consisting of provisional discharge criteria and remote monitoring. At the time, there were few published guidelines for safe discharge parameters for patients hospitalized with COVID-19 illness⁶ and few known risk factors for readmission.⁷ The major goals of the COVID-19 Discharge Care Program were to (1) promote a lenient strategy toward discharges; (2) provide monitoring to prevent unnecessary emergency department (ED) visits while fostering early detection of deteriorating patients; (3) support patients’ social and psychological needs; and (4) standardize the care of COVID-19 patients after discharge home. This report describes the characteristics and outcomes of patients discharged home following institution of the COVID-19 Discharge Care Program, which we hypothesized would be associated with a low rate of return to hospital among discharged patients.

METHODS

Patients

The total sample was comprised of consecutive adult patients, excluding those admitted to the obstetric or labor and delivery services, with COVID-19-related illness that were hospitalized at Columbia-New York Presbyterian Hospital (New York, New York) from March 26 to April 8, 2020. COVID-19 status was determined based on a confirmed severe acute respiratory syndrome coronavirus 2 infection by positive result on polymerase chain reaction testing of a nasopharyngeal sample. Clinical outcomes were assessed until April 22, 2020, to allow for 14 days of follow-up on all patients discharged home. The institutional review board of Columbia University Irving Medical Center (CUIMC) approved this case series as minimal-risk research using data collected as part of routine clinical practice and waived the requirement for informed consent.

Interventions

The COVID-19 Discharge Care Program, launched on March 26, consisted of provisional discharge criteria for patients hospitalized with COVID-19 illness and daily telephone monitoring of patients discharged home using a structured protocol. To establish provisional discharge criteria, a multidisciplinary team of hospitalists, primary care providers, pulmonologists, infectious disease experts, and health system leaders came to consensus on provisional discharge criteria (Table 1). Notable components of these criteria included allowance for fever at time of discharge so long as the fever curve was improving and allowance for mild hypoxia so long as the resting oxygen saturation was $\geq 92\%$ on room air at time of discharge. Criteria involving exertional oxygen saturation were not included due to the practical difficulties of exercising patients with COVID-19 illness in the hospital and the lack of evidence demonstrating prognostic significance of exertional desaturation in patients with acute illnesses.^{8,9} Oxygen saturation was required to be at room air as home oxygen was not readily available during the time period described.

Concurrently, a multidisciplinary team of hospitalists, primary care providers, health system leaders, and experts in human-centered design used an agile process to create the COVID Remote Care Program (Appendix). Inpatient teams were made aware of the eligibility criteria and referral process to this remote monitoring program through communications from hospitalist leadership. Eligibility criteria included age 18 years or older, admitted with COVID-19 illness, discharged home, and capable of being contacted by telephone. Patients admitted to the obstetrics or labor and delivery services and those discharged to home hospice were ineligible. Referrals were made by emailing patient contact information to a Remote Care Coordinator that distributed cases to a team of Telehealth Guides (Fig. 1). Telehealth Guides were expected to have some clinical experience; third- and fourth-year medical students served in this role during the described time period. Telehealth Guides conducted daily telephone calls to discharged patients following a structured assessment tool that

Table 1 Provisional Criteria for Hospital Discharge to Home for Patients with COVID-19 Illness

Characteristic	Criteria for discharge to home
Vital signs	<ul style="list-style-type: none"> • Stable measured respiratory rate (< 20 breaths per minute) • Stable blood pressure • Temperature afebrile or improving fever curve • Resting oxygen saturation $\geq 92\%$ on room air
Social considerations	<ul style="list-style-type: none"> • Access to resources such as food, pharmacy, and other necessities for daily living • Access to appropriate caregivers if limited ability to engage in self-care • Transmission risk within the home (e.g., the availability of a separate bedroom to minimize sharing of immediate living spaces with others, ability to adhere to home isolation, respiratory and hand hygiene, and the presence of household members at increased risk for COVID-19 complications)
Risk enhancers	<ul style="list-style-type: none"> • Age ≥ 60 years • Comorbid illnesses (chronic lung disease, heart disease, poorly controlled diabetes mellitus, body mass index (BMI) ≥ 40 kg/m², chronic kidney disease (stage 3 or higher), immunosuppression—e.g., transplant, other immunosuppression (transplant, other immunosuppressive medications, poorly controlled HIV, malignancy if patient underwent chemotherapy or surgery in the past month)

All vital sign and social consideration criteria had to be met for patients to qualify for discharge home. Risk enhancers indicated patient characteristics that should be considered when deciding whether to follow the lenient provisional criteria

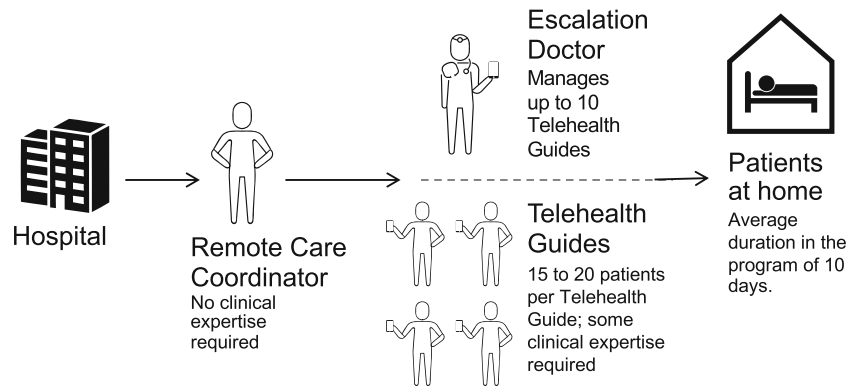


Figure 1 The COVID Remote Care Program for Patients Discharged Home after Hospitalization for COVID-19 Illness. The Remote Care Coordinator receives patient referrals to the program from the inpatient teams and distributes patients to a team of Telehealth Guides. Telehealth Guides then make daily telephone calls to patients in their home following a structured protocol that includes flags that identify patients potentially at risk for readmission. The Escalation Doctor reviews patients that flag with the Telehealth Guides, and directly contact patients when indicated.

investigated COVID-19-related symptoms (cough, shortness of breath, fever) expected to be associated with readmission risk (Appendix). Body temperature, oxygen saturation, and pulse were also monitored if corresponding devices were available in the home. Assessments had the potential to trigger flags that indicated a need for Telehealth Guides to escalate review of patients' need to return to the hospital with a more experienced clinician, called the Escalation Doctor (Table 2). Escalation Doctors, comprised of general internists, directly contacted flagged patients on a case by case basis, after discussion with the Telehealth Guide. Telehealth Guides were also responsible for screening patients for emotional distress, counseling on self-quarantining, identifying other social or medical needs, and scheduling patients for remote visits with primary care providers or specialists if needed. Examples of actions taken by Telehealth Guides or Escalation Doctors that could have averted returns to the ED included prescribing medications for refractory COVID symptoms, linking patients to community resources for delivery of food or medical supplies, and providing reassurance to those with distressing symptoms. Telehealth Guides followed patients for up to 14 days after discharge with the option of completing follow-up after 7 days if patients had become asymptomatic.

Measurements

Patient sociodemographic, medical characteristics, and clinical outcomes including discharge disposition, and 14-day ED

visits, readmissions, and mortality were extracted from the CUIMC data warehouse. Race and ethnicity were self-reported by patients. Vital signs were extracted from the last recorded vital signs prior to discharge. Symptoms of new or worsening cough, new or worsening shortness of breath with light activities, subjective or objectively measured fever, oxygen saturation, and pulse (if devices available) were assessed daily by the Telehealth Guides. Emotional distress was assessed 1 week after discharge using the validated Generalized Anxiety Disorder-2 item (GAD-2)¹⁰ and the Patient Health Questionnaire-2 item (PHQ-2).¹¹ Loneliness was assessed using a single item that asked patients how often they felt lonely since returning from the hospital ("not at all" to "nearly every day").¹² Patient satisfaction with remote monitoring was assessed at the completion of the program by asking patients how likely they would be to recommend the program to other patients who had been hospitalized with COVID-19 illness (0, not at all likely; 10, extremely likely).

Statistical analysis

Descriptive statistics were used to describe patient characteristics and clinical outcomes. Gradual diffusion of information about the remote monitoring program led to incomplete uptake in its first 2 weeks and created an opportunity to compare patients who were and were not referred. Chi-squared and Mann-Whitney *U* tests were used to compare characteristics of discharged patients who were and were not referred for

Table 2 Criteria for Flagging Patients for Escalation During Remote Monitoring of Recently Hospitalized Patients with COVID-19 Illness

Characteristic	Criteria for flagging patients for escalation during remote monitoring
Symptoms	<ul style="list-style-type: none"> • New or worsening shortness of breath with light activities • New or worsening cough • New or worsening subjective fever (if no thermometer available)
Vital signs	<ul style="list-style-type: none"> • Temperature ≥ 100.4 °F (if thermometer available) • O₂ saturation < 95% (if pulse oximeter available) • Pulse ≥ 110 beats per minute (if pulse oximeter available)
Other reasons	<ul style="list-style-type: none"> • At discretion of the Telehealth Guide. Examples of other reasons included other concerning signs (e.g., low blood pressure) or symptoms (e.g., syncope, chest pain, severe anxiety), prescribing needs, and assistance with organizing home care and specialty referrals

remote monitoring. Logistic regression models were applied to estimate the associations between remote monitoring and two binary outcomes: return to the ED and readmission. In addition to the multivariable analysis that adjusted for potentially confounding factors (demographics, comorbidities, vital signs at discharge), inverse probability weighting (IPW) based on propensity score was used. Conventional covariate adjustment using a multivariable regression model may yield biased estimation when the functional form of the outcome model is unspecified; applying IPW can be more robust in this case. The individual propensities for being referred for remote monitoring were estimated based on a logistic regression model. The predicted probabilities from the propensity score model were used to calculate the stabilized IPW weight. To control for potential confounding that was not fully addressed after weighting, we fitted multivariable logistic regression models concurrently adjusting for IPW and covariates. Analyses were performed using SAS 9.4 (Cary, NC) and R (version 3.6.1). The significance threshold was 0.05 and two-side p values are reported.

Role of the Funding Source

Individual authors received support from the National Institutes of Health, Agency for Healthcare Research and Quality, and the Health Resources and Services Administration. None of the funders had a role in the conduct or interpretation of the study.

RESULTS

Between March 26 and April 8, 812 patients were hospitalized with COVID-19 illness (mean age 63 years, 60.6% male). Of these patients, 15.5% died in hospital, 24.1% remained hospitalized, 5.0% were discharged to a skilled nursing facility or nursing home, 4.9% were discharged to hospice, and 50.4% were discharged home.

Patients who were discharged home had a mean age of 57 years, 59.9% were men, 51.1% were Hispanic, and 22.8% were Black (Table 3). The most common comorbidities were hypertension (39.1%) and diabetes (26.2%). Consistent with the lenient discharge criteria, a substantial proportion of patients that were discharged home had abnormal vital signs on the day of discharge. Specifically, 6.6% had a last recorded temperature ≥ 100.4 °F, 23.5% had a respiratory rate ≥ 20 breaths per minute, 11.0% had a pulse ≥ 100 beats per minute, and 37.7% had an oxygen saturation $< 95\%$. Furthermore, a substantial number of patients were discharged home even though the last recorded vital sign did not meet the lenient discharge criteria (i.e., respiratory rate ≥ 20 breaths per minute, 23.5%; pulse ≥ 110 beats per minute, 2.4%; oxygen saturation $< 92\%$, 4.2%).

Among the 409 patients that were discharged home after initiating the COVID Discharge Care Program, 45 patients (11.0%) returned to the ED within 14 days, and of these, 31 patients (7.6%) were readmitted. Seven patients (1.7%) died in

hospital after being readmitted. The median [IQR] days to readmission was 4 [3, 7], range 0–14 days. Compared to patients that were discharged home but not readmitted, patients who were readmitted were significantly older (66.3 years vs 56.6 years, $p = 0.002$), more likely to have hypertension (67.7% vs 36.8%, $p < 0.001$), chronic kidney disease (38.7% vs 12.2%, $p < 0.001$), coronary artery disease (32.3% vs 13.5%, $p = 0.01$), and heart failure (19.4% vs 8.7%, $p = 0.10$), but not diabetes (32.3% vs 25.7%, $p = 0.42$) or chronic lung disease (19.4% vs 15.3%, $p = 0.61$). There were no differences in day of discharge body temperature (99.0 °F vs 98.7 °F, $p = 0.32$), respiratory rate (18.4 vs 18.4, $p = 0.56$), pulse (85.5 vs 83.0, $p = 0.30$), or oxygen saturation (95.5% vs 95.2%, $p = 0.58$) between those who were and were not readmitted, respectively.

Of the 409 patients discharged home, 217 patients (53.1%) were referred for remote monitoring (41.3% of all discharges in week 1 and 64.4% of all discharges in week 2). Patients discharged home with a referral for remote monitoring were similar to those who were discharged without such a referral, but had lower rates of hypertension, diabetes, and chronic kidney disease; longer length of stay during the index hospitalization; and lower oxygen saturation at discharge (Table 4).

The majority of patients referred for remote monitoring (86.2%) completed at least one call with the Telehealth Guide. Reasons for not completing any calls included inability to contact (11.0%), completed early due to improved health (0.9%), readmitted before first call (0.5%), and declined to participate (1.4%). Among patients who completed at least one call, the median [IQR] number of calls completed per patient was 4 [3, 5] and the median [IQR] duration of follow-up was 5 [4, 7] days. Reasons for completing fewer phone calls than expected included challenges reaching patients by telephone, patients declining daily phone calls, or patients returning to the ED early. Overall, 1406 calls were completed, of which 7.9% were associated with at least 1 flag, relevant to 28.1% of all patients. The most common reasons for flags pertained to new or worsening cough (2.8%), new or worsening shortness of breath (2.2%), oxygen saturation $< 95\%$ (1.9%), and new or increased fever (1.6%). While the number of times Escalation Doctors directly contacted patients was not tracked, this occurred for a minority of flagged Telehealth Guide encounters.

Emotional distress questionnaires were completed by 90 patients. A substantial percentage of patients did not complete these assessments as they were scheduled on days calls were not completed. Among patients that completed the questionnaires, 12.4% screened positive for anxiety (GAD-2 ≥ 3), 7.9% screened positive for depression (PHQ2 ≥ 3) and 11.1% were lonely on more than half the days since discharge. Of 105 patients that completed a program satisfaction question, 86.7% reported they would be very likely to recommend the monitoring program to others (score of 9 or 10), 10.5% scored the program a 7 or 8, and 2.8% scored the program < 7 .

Table 3 Characteristics of Patients Hospitalized with COVID-19 Illness

Characteristic	All hospitalized patients (N = 812)	Patients discharged home (N = 409)	Patients readmitted after discharge home (N = 31)
Age, years	62.8 ± 16.9	57.3 ± 16.6	66.3 ± 19.3
Male sex	492 (60.6%)	245 (59.9%)	19 (61.3%)
Race			
White	161 (19.8%)	80 (19.6%)	7 (22.6%)
Black	185 (22.8%)	95 (23.2%)	4 (12.9%)
Other	264 (32.5%)	139 (34.0%)	13 (41.9%)
Unknown	202 (24.9%)	95 (23.2%)	7 (22.6%)
Ethnicity			
Hispanic	409 (50.4%)	209 (51.1%)	21 (67.7%)
Non-Hispanic	195 (24.0%)	93 (22.7%)	6 (19.4%)
Unknown	208 (25.6%)	107 (26.2%)	4 (12.9%)
Comorbidities			
Hypertension	363 (44.7%)	160 (39.1%)	21 (67.7%)
Diabetes	277 (34.1%)	107 (26.2%)	10 (32.3%)
Coronary artery disease	159 (19.6%)	61 (14.9%)	10 (32.3%)
Chronic lung disease	134 (16.5%)	64 (15.7%)	6 (19.4%)
Heart failure	114 (14.0%)	39 (9.5%)	6 (19.4%)
Chronic kidney disease	149 (18.4%)	58 (14.2%)	12 (38.7%)
Body mass index*, kg/m ²			
<30	368 (58.7%)	186 (59.1%)	20 (64.5%)
30–40	203 (32.4%)	102 (32.4%)	10 (32.3%)
>40	56 (8.9%)	27 (8.6%)	1 (3.2%)
Invasive mechanical ventilation	98 (12.1%)	0	0
Vitals on discharge			
Temperature, °F	–	98.7 ± 1.0	99.0 ± 1.2
< 100.4	–	382 (93.4%)	27 (87.1%)
≥ 100.4	–	27 (6.6%)	4 (12.9%)
Systolic blood pressure, mmHg	–	123.2 ± 17.3	123.4 ± 19.1
Diastolic blood pressure, mmHg	–	74.7 ± 9.2	72.6 ± 8.5
Respiratory rate, breaths per minute	–	18.4 ± 2.0	18.4 ± 1.7
< 20	–	313 (76.5%)	23 (74.2%)
≥ 20	–	96 (23.5%)	8 (25.8%)
Pulse, beats per minute	–	83.2 ± 16.0	85.5 ± 13.7
< 100	–	364 (89.0%)	25 (80.7%)
100–110	–	35 (8.6%)	4 (12.9%)
≥ 110	–	10 (2.4%)	2 (6.5%)
Oxygen saturation (room air), %	–	95.2 ± 2.3	95.5 ± 2.4
< 92	–	17 (4.2%)	1 (3.2%)
92–94	–	137 (33.5%)	8 (25.8%)
95–96	–	136 (33.3%)	12 (38.7%)
≥ 97	–	119 (29.1%)	10 (32.3%)

Data are presented as mean ± standard deviation or as N (%). Chronic lung disease was defined as any of the following: asthma, chronic obstructive pulmonary disease, emphysema, chronic bronchitis, or interstitial lung disease. Invasive mechanical ventilation was defined as being placed on a ventilator at any time during hospital admission.

*Data were missing on body mass index for 185 patients

There was a trend toward a lower percentage of patients with an ED visit within 14 days of discharge in patients that were referred to remote monitoring versus those not referred (8.3% vs 14.1%, $p = 0.06$; Table 4). Among patients referred for remote monitoring, 61.1% (11 of 18) of those with an ED visit were flagged by one or more escalation criteria. There were no significant differences in the percentage of patients referred versus not referred that were readmitted (6.9% vs 8.3%, $p = 0.59$) or that died (1.4% vs 2.1%, $p = 0.59$) within 14 days. In the unweighted, multivariable analysis, remote monitoring was associated with a decreased risk of an ED visit (OR 0.63, 95% CI 0.32–1.24, $p = 0.18$) and an increased risk of readmission (OR 1.29, 95% CI 0.55–3.01, $p = 0.56$), but these differences were not statistically significant. In the main IPW analysis, remote monitoring was similarly associated with risk of returning to hospital (OR 0.60, 95% CI 0.31–1.15, $p = 0.12$) and risk of readmission (OR 1.15, 95% CI 0.52–2.52, $p = 0.73$). No covariates were significantly

associated with return to the ED or readmission in these models (data not shown).

DISCUSSION

The implementation of a COVID-19 Discharge Care Program consisting of lenient discharge criteria and remote telephone monitoring after discharge was associated with a low rate of 14-day readmission and mortality. To our knowledge, this study represents one of the first case series of patients with COVID-19 illness that reports on follow-up after discharge. While the rate of readmission in this sample was higher than that found in another recent case series of patients from New York, our sample was followed for 14 days after discharge, whereas the prior study had a mean follow-up of only 3 days.¹³ The 14-day readmission rate was similar to the readmission rate for other common reasons for hospitalization.¹⁴

Table 4 Characteristics of Patients Discharged Home, With and Without Referral to Remote Monitoring Program

Characteristic	Patients discharged home with remote monitoring (N = 217)	Patients discharged home without remote monitoring (N = 192)	p value
Age, years	56.7 ± 15.2	58.0 ± 18.0	0.40
Male sex	137 (63.1%)	108 (56.3%)	0.16
Race			0.48
White	39 (18.0%)	41 (21.4%)	
Black	46 (21.2%)	49 (25.5%)	
Other	79 (36.4%)	60 (31.3%)	
Unknown	53 (24.4%)	42 (21.9%)	
Ethnicity			0.81
Hispanic	111 (51.2%)	98 (51.0%)	
Non-Hispanic	47 (21.7%)	46 (24.0%)	
Unknown	59 (27.2%)	48 (25.0%)	
Comorbidities			
Hypertension	73 (33.6%)	87 (45.3%)	0.02
Diabetes	47 (21.7%)	60 (31.3%)	0.03
Chronic lung disease	34 (15.7%)	30 (15.6%)	0.99
Coronary artery disease	31 (14.3%)	30 (15.6%)	0.70
Chronic kidney disease	19 (8.8%)	39 (20.3%)	< .001
Heart failure	19 (8.8%)	20 (10.4%)	0.57
Body mass index, kg/m ²	30.1 ± 7.3	29.6 ± 6.4	0.64
Vitals on discharge			
Temperature	98.6 ± 1.0	98.8 ± 1.0	0.01
< 100.4 °F	204 (94.0%)	178 (92.7%)	
≥ 100.4 °F	13 (6.0%)	14 (7.3%)	
Systolic blood pressure, mmHg	122.6 ± 16.9	123.9 ± 17.8	0.45
Diastolic blood pressure, mmHg	74.9 ± 8.8	74.4 ± 9.6	0.80
Respiratory rate, breaths per minute	18.5 ± 2.1	18.4 ± 1.8	0.65
< 20	163 (75.1%)	150 (78.1%)	
≥ 20	54 (24.9%)	42 (21.9%)	
Pulse, beats per min	82.1 ± 13.8	84.4 ± 18.0	0.21
< 100	196 (90.3%)	168 (87.5%)	
100–110	17 (7.8%)	18 (9.4%)	
≥ 110	4 (1.8%)	6 (3.1%)	
Oxygen saturation at room air, mean ± SD, %	95.0 ± 2.3	95.5 ± 2.3	0.05
< 92%	9 (4.2%)	8 (4.2%)	
92–94%	79 (36.4%)	58 (30.2%)	
95–96%	71 (32.7%)	65 (33.9%)	
≥ 97%	58 (26.7%)	61 (31.8%)	
Length of stay for index hospitalization, days	5.0 ± 3.9	4.2 ± 3.2	0.05
14-day readmission	15 (6.9%)	16 (8.3%)	0.59
14-day emergency department visit	18 (8.3%)	27 (14.1%)	0.06
14-day mortality (all in hospital)	3 (1.4%)	4 (2.1%)	0.59

Data are presented as mean ± standard deviation or as N (%). Chronic lung disease was defined as any of the following: asthma, chronic obstructive pulmonary disease, emphysema, chronic bronchitis, or interstitial lung disease

Accordingly, the discharge criteria used in this program, which were substantially more lenient than those used by the National Health Commission of China,⁶ appeared to be safe with respect to readmissions and mortality.

The remote monitoring component of the COVID-19 Discharge Care Program was associated with rapid uptake by inpatient teams, with two thirds of discharged patients referred to the program by its second week. There was also a high rate of participation by patients, with less than 2% declining remote follow-up. A bigger challenge was having accurate contact information for patients, of particular relevance in our socioeconomically diverse patient population. Though the program was designed to provide patients with phone calls on at least 7 days after discharge, a lower number of phone calls were typically completed. Patients that participated rated the remote monitoring program highly, suggesting it may be an important part of a patient-centered approach to post-discharge care in patients hospitalized with COVID-19 illness. While referral to remote monitoring was not associated with a statistically significant reduction in 14-day readmissions, referral was

associated with a trend toward an approximately 40% reduction in patients returning for an ED visit. This reduction in return visits to the hospital may be particularly important in the context of new surges in COVID-19 infections that arise when social distancing measures are relaxed.^{15,16}

Though results were only available for a subset of patients that participated in remote monitoring, only about 1 in 10 surveyed patients screened positive for anxiety, depression, and loneliness in the week after discharge. This is one of the first studies to assess mental health outcomes in patients discharged home after COVID-19 hospitalization. For context, prior studies suggest that at least 20% of patients have elevated anxiety and depressive symptoms after hospitalizations for pneumonia and acute coronary syndromes.^{17,18}

Limitations

There were several limitations to our study. First, the study evaluated patients hospitalized at a single hospital in New York City, and home oxygen was not available during the

study period, limiting generalizability. Second, data on readmissions and mortality were missing for patients that had events occur outside the health system. Third, the follow-up period was limited to 14 days after discharge. Fourth, less than half of patients were referred for remote monitoring, likely due to incomplete dissemination of the referral process to busy inpatient providers during the roll-out of the program. Fifth, even among patients referred to the program, there were incomplete responses to emotional assessments such that data on mental health screening should be interpreted cautiously. Further, mental health assessments were made by Telehealth Guides, which may have led to underreporting on mood questionnaires. Sixth, comparisons between patients who were and were not referred for remote monitoring should be interpreted cautiously given differences in patient characteristics between members of these groups and the lack of randomization; nevertheless, we sought to control for these differences by incorporating covariates and IPW into multivariable analyses. Seventh, some patients may have been discharged without meeting the lenient discharge criteria; nevertheless, these criteria were not intended to replace clinical judgment of inpatient teams and chart extraction from flowsheets may have missed vital sign data recorded elsewhere in the medical record. Finally, while older age and comorbidities were associated with readmission risk on bivariate analyses, too few patients had early readmissions to reliably identify predictors of these adverse outcomes; future studies should re-examine these predictors as outcomes accrue.

Conclusions

A COVID-19 Discharge Care Program comprised of lenient discharge criteria and post-discharge remote monitoring via telephone was associated with a low rate of readmissions and high patient satisfaction. Other health systems may wish to create similar programs, particularly when surges in the volume of patients hospitalized with COVID-19 illness outpace hospital capacity.

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Author Contributions Dr. Kronish had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Concept and design: Kronish, Moise

Acquisition, analysis, or interpretation of data: All authors

Drafting of the manuscript: Kronish

Critical revision of the manuscript for important intellectual content: All authors

Statistical analysis: Kronish, Hiura, Sun

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Compliance with Ethical Standards:

The institutional review board of Columbia University Irving Medical Center (CUIMC) approved this case series as minimal-risk research using data collected as part of routine clinical practice and waived the requirement for informed consent.

Conflict of Interest: Dr. Geleris reports non-financial support from Allergan Inc, Alexion Pharmaceuticals, Inc, Boehringer Ingelheim Pharmaceuticals, Inc, Jansen Pharmaceuticals, Inc, Pfizer, Inc, outside the submitted work.

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