Healthcare 9 (2021) 100512

Contents lists available at ScienceDirect

Healthcare

journal homepage: www.elsevier.com/locate/healthcare

Discharge characteristics and care transitions of hospitalized patients with COVID-19

Leah B. Loerinc [a], Amy M. Scheel [a], Sean T. Evans [a], Julie M. Shabto [a], Ghazala A. O'Keefe [a,b], James B. O'Keefe [a,c,*]

[a] Emory University School of Medicine, 100 Woodruff Circle, Atlanta, GA, 30322, USA
[b] Department of Ophthalmology, Emory University School of Medicine, 100 Woodruff Circle, Atlanta, GA, 30322, USA
[c] Department of Medicine, Division of General Medicine and Geriatrics, Emory University School of Medicine, 100 Woodruff Circle, Atlanta, GA, 30322, USA

ARTICLE INFO

Keywords:
Coronavirus disease 2019
Transitions of care
Post-acute
Discharge
Readmission
Primary care

ABSTRACT

Little is known about the follow-up healthcare needs of patients hospitalized with coronavirus disease 2019 (COVID-19) after hospital discharge. Due to the unique circumstances of providing transitional care in a pandemic, post-discharge providers must adapt to specific needs and limitations identified for the care of COVID-19 patients. In this study, we conducted a retrospective chart review of all hospitalized COVID-19 patients discharged from an Emory Healthcare Hospital in Atlanta, GA from March 26 to April 21, 2020 to characterize their post-discharge care plans. A total of 310 patients were included in the study (median age 58, range: 23–99; 51.0% female; 69.0% African American). The most common presenting comorbidities were hypertension (200, 64.5%), obesity (BMI≥30) (138, 44.5%), and diabetes mellitus (112, 36.1%). The median length of hospitalization was 5 days (range: 0–33). Sixty-seven patients (21.6%) were admitted to the intensive care unit and 42 patients (13.5%) received invasive mechanical ventilation. The most common complications recorded at discharge were electrolyte abnormalities (124, 40.0%), acute kidney injury (86, 27.7%) and sepsis (55, 17.7%). The majority of patients were discharged directly home (281, 90.6%). Seventy-five patients (24.2%) required any home service including home health and home oxygen therapy. The most common follow-up need was an appointment with a primary care provider (258, 83.2%). Twenty-four patients (7.7%) had one or more visit to an ED after discharge and 16 patients (5.2%) were readmitted. To our knowledge, this is the first large study to report on post-discharge medical care for COVID-19 patients.

1. Introduction

Coronavirus disease 2019 (COVID-19) was officially declared a worldwide pandemic by the World Health Organization on March 11, 2020. As of October 25, there have been over 8.5 million cases and 220,000 deaths in the United States (US) alone,[1] with a cumulative hospitalization rate of 193.7 per 100,000 persons.[2] While the clinical characteristics and short-term outcomes of hospitalized patients with COVID-19 are well described in the literature,[3–10] there have been little data published on the healthcare needs of these individuals after discharge. Patients who are discharged from the hospital often require follow-up for new conditions diagnosed during admission and for monitoring of the care plan formulated by the discharging hospital team. In light of ongoing isolation requirements, lack of in-person healthcare services, and scaled-down clinic schedules, COVID-19 patients may represent a population with unique post-discharge needs.

Post-discharge care for patients after acute-care hospitalization comprises a wide range of medical providers and caregivers and involves in-person and remote monitoring. Recommendations for care are determined by the discharging care team, with goals including rehabilitation and recovery, prevention of readmission, and monitoring of newly diagnosed or chronic conditions that may become unstable due to the hospitalization.[11] In order to anticipate the specific needs of COVID-19 patients after hospital discharge and coordinate their post-discharge care with primary care providers (PCPs), it is necessary to describe the profiles of these individuals.

In this study, we describe the demographics, baseline comorbidities, hospital course, and post-discharge care plans of patients with COVID-19 discharged from hospitals within an academic healthcare system in Atlanta, Georgia.

* Corresponding author. Emory University Hospital, Emory Clinic A, 1365 Clifton Road NE, Atlanta, GA, 30322, USA.
E-mail address: jbokeef@emory.edu (J.B. O'Keefe).

https://doi.org/10.1016/j.hjdsi.2020.100512
Received 7 July 2020; Received in revised form 30 October 2020; Accepted 18 December 2020
Available online 24 December 2020

2. Material and methods

Retrospective chart review was conducted for all patients at one of four Emory Healthcare affiliated hospitals using the electronic medical record (PowerChart; Cerner). The following inclusion criteria were applied: confirmed infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) by polymerase chain reaction (PCR) testing or ICD-10 code for COVID-19 and discharged from the hospital between March 26 to April 21, 2020. Patients were predominantly admitted to general medicine services; however, all patients with confirmed COVID-19, regardless of admitting service, were reviewed. The following patients were excluded: (1) patients who died during their index hospital stay, (2) patients admitted for unrelated reasons and incidentally tested (at provider discretion) for COVID-19, (3) patients discharged to home for end-of-life care with no additional post-discharge needs, and (4) patients who were transferred from Emory to an outside facility for continued hospitalization.

Data were collected on patient demographics, baseline health status, hospital course, and outcomes (emergency department (ED) visits, readmissions, death, and hospice). Data from the hospital course included length of stay, treatments received, provider-documented complications, ongoing symptoms at discharge, new medications at discharge, and post-discharge needs (isolation requirements, oxygen therapy, home health, and follow-up referrals). These data were manually collected from physician discharge notes, discharge medication reconciliation, case management and registered nurse (RN) notes at time of discharge, and post-hospital transition care management (TCM) RN notes (standardized for all patients with COVID-19 discharged after April 13, 2020 within Emory Healthcare). Patients were stratified into groups for analysis based on 30 day outcomes following discharge: those with no ED visits or hospital readmission(s), those who returned to the ED with final disposition to home or facility (not admitted), and those who were readmitted to the hospital. Outcomes were determined to be COVID-19 related (either with ongoing symptoms or secondary complications) or non-COVID-19 related based on the ED and inpatient teams' assessments. Deaths and hospice placement were identified using documentation during readmission or follow-up TCM notes, respectively. Outcomes were limited to events that occurred at an Emory facility or with specific documentation in the Emory medical record of a visit at an outside hospital. Transfers from one in-system hospital to another were merged and considered a single visit. Data were analyzed using descriptive statistics in Excel.

This study was conducted as a primary care-based transitional care management quality improvement initiative and met criteria for determination of non-human subject research by the Emory University Institutional Review Board.

3. Results

3.1. Patient characteristics

A total of 385 patients diagnosed with COVID-19 and hospitalized at an Emory facility over the study period were reviewed. Of these, 10 were hospitalized for unrelated reasons and incidentally tested positive for COVID-19. Four patients were discharged formally on end-of-life care, five patients were transferred to an outside facility for continued hospitalization, and 56 patients died during their index hospital stay for a mortality rate of 14.5%. The remaining 310 patients met inclusion criteria and were included in data analysis. Complete data were available on all patients except one who left against medical advice on hospital day one. Analysis was stratified into four groups: (1) all patients who survived to discharge, (2) patients with no ED visit or readmission after discharge, (3) patients with ED treat and release after discharge, and (4) patients who were readmitted.

All patient characteristics are summarized in Table 1. Of the 310 patients included, 284 (91.6%) had no ED visit or readmission, 10 (3.2%) had an ED treat and release visit, and 16 (5.2%) were readmitted. The median age was 58 (range: 23–99), 158 patients (51.0%) were female, and the majority (214, 69.0%) were African American.A The most common comorbid conditions were hypertension (200, 64.5%), obesity (BMI≥30) (138, 44.5%), and diabetes mellitus (112, 36.1%). Of the 16 readmitted patients, seven (43.8%) were female and 14 (87.5%) were African American. The most common comorbidities in this cohort were hypertension (9, 56.3%), chronic kidney disease (8, 50.0%), obesity (BMI≥30) (7, 43.8%), diabetes mellitus (7, 43.8%), and immunosuppression (3, 18.8%). Of all patients, 126 (40.6%) had private insurance, 113 (36.5%) had Medicare, 13 (4.2%) had Medicaid, 21 (6.8%) were uninsured, and 37 (11.9%) had miscellaneous or unknown coverage.

Table 1
Baseline characteristics of patients with COVID-19 who survived to discharge.

	No. (%)			
	All patients survived to discharge	Patients with no ED visits or readmissions	Patients with ED treat and release	Patients readmitted
Demographics				
Total no.	310	284	10	16
Median age (range), years	58 (23–99)	58 (23–99)	70 (35–84)	51 (24–88)
Sex				
Female	158 (51)	146 (51.4)	5 (50)	7 (43.8)
Male	152 (49)	138 (48.6)	5 (50)	9 (56.3)
Race/ethnicity				
African American	214 (69)	191 (67.3)	9 (90)	14 (87.5)
White	57 (18.4)	55 (19.4)	1 (10)	1 (6.3)
Hispanic	12 (3.9)	12 (4.2)	0 (0)	0 (0)
Other	27 (8.7)	26 (9.1)	0 (0)	1 (6.3)
Comorbid conditions				
Hypertension	200 (64.5)	184 (64.8)	7 (70)	9 (56.3)
Obesity (BMI≥30)	138 (44.5)	127 (44.7)	4 (40)	7 (43.8)
Diabetes mellitus	112 (36.1)	101 (35.6)	4 (40)	7 (43.8)
Chronic kidney disease	58 (18.7)	50 (17.6)	0 (0)	8 (50)
Asthma	39 (12.6)	37 (13)	0 (0)	2 (12.5)
Tobacco use (active)	31 (10)	28 (9.9)	1 (10)	2 (12.5)
Heart failure	28 (9.0)	26 (9.2)	1 (10)	1 (6.3)
Coronary artery disease	25 (8.1)	24 (8.5)	1 (10)	0 (0)
Cerebral vascular disease	19 (6.1)	18 (6.3)	1 (10)	0 (0)
COPD	16 (5.2)	14 (4.9)	1 (10)	1 (6.3)
Alcohol abuse (active)	16 (5.2)	15 (5.3)	0 (0)	1 (6.3)
Immunosuppression	12 (3.8)	9 (3.2)	0 (0)	3 (18.8)
Cancer (active)	12 (3.9)	10 (3.5)	1 (10)	1 (6.3)
ADL dependent	5 (1.6)	5 (1.8)	0 (0)	0 (0)
Other high risk	8 (2.6)	7 (2.5)	0 (0)	1 (6.3)
No. of comorbid conditions				
None	22 (7.1)	19 (6.7)	1 (10)	2 (12.5)
1	74 (23.9)	69 (24.3)	2 (20)	3 (18.8)
2	88 (28.4)	83 (29.2)	2 (20)	3 (18.8)
3	66 (21.3)	60 (21.1)	4 (40)	2 (12.5)
>3	60 (19.4)	53 (18.7)	1 (10)	6 (37.5)
Median (range) no. of comorbid conditions	2 (0–7)	2 (0–7)	2.5 (0–4)	2.5 (0–5)
Baseline oxygen needs				
Prior oxygen therapy	5 (1.6)	5 (1.8)	0 (0)	0 (0)

Abbreviations: BMI, body mass index; COPD, chronic obstructive pulmonary disease; ADL, activities of daily living.

3.2. Hospital course

Hospital course for all cohorts is summarized in Table 2. The median length of hospitalization for all patients was five days (range: 0–33). The majority of patients (224, 72.3%) received any duration of antibiotic therapy prior to discharge and 216 patients (69.7%) received new

Table 2
Hospital course of patients with COVID-19 who survived to discharge.

	No. (%)			
	All patients survived to discharge	Patients with no ED visits or readmissions	Patients with ED treat and release	Patients readmitted
Total no.	310	284	10	16
Hospital course				
Median (range) length of stay, days	5 (0–33)	5 (0–29)	6 (2–17)	6 (2–33)
Treatment				
Antibiotics	224 (72.3)	205 (72.2)	7 (70)	12 (75)
New oxygen therapy	216 (69.7)	198 (69.7)	7 (70)	11 (68.8)
Hydroxychloroquine	81 (26.1)	73 (25.7)	1 (10)	7 (43.8)
Remdesivir	39 (12.6)	35 (12.3)	3 (30)	1 (6.3)
Other experimental treatment[a]	7 (2.3)	6 (2.1)	1 (10)	0 (0)
Complications				
ICU	67 (21.6)	64 (22.5)	1 (10)	2 (12.5)
Intubation	42 (13.5)	39 (13.7)	0 (0)	3 (18.8)
Sepsis	55 (17.7)	51 (18)	2 (20)	2 (12.5)
Renal				
Electrolyte abnormalities	124 (40)	117 (41.2)	3 (30)	4 (25)
AKI	86 (27.7)	77 (27.2)	3 (30)	6 (37.5)
Cardiac				
Atrial arrhythmia	15 (4.8)	15 (5.3)	0 (0)	0 (0)
Ventricular arrhythmia	5 (1.6)	5 (1.8)	0 (0)	0 (0)
Heart failure	1 (0.3)	1 (0.4)	0 (0)	0 (0)
Acute coronary syndrome	1 (0.3)	1 (0.4)	0 (0)	0 (0)
Neurologic				
Delirium	27 (8.7)	24 (8.5)	0 (0)	3 (18.8)
CVA	3 (0.9)	3 (1.1)	0 (0)	0 (0)
Seizure	1 (0.3)	1 (0.4)	0 (0)	0 (0)
Infection				
UTI	16 (5.2)	14 (4.9)	1 (10)	1 (6.3)
Wound	4 (1.3)	3 (1.1)	0 (0)	1 (6.3)
C. diff	2 (0.6)	2 (0.7)	0 (0)	0 (0)
Flu	1 (0.3)	1 (0.4)	0 (0)	0 (0)
DVT/PE	8 (2.6)	7 (2.5)	1 (10)	0 (0)

Abbreviations: ICU, intensive care unit; AKI, acute kidney injury; CVA, cerebral vascular accident; UTI, urinary tract infection; C. diff, *Clostridium difficile* infection; flu, influenza virus infection; DVT, deep vein thrombosis; PE, pulmonary embolus.

[a] Lopinavir/ritonavir, darunavir/cobicistat, sarilumab.

oxygen supplementation. At some point during their hospital course, 67 patients (21.6%) were admitted to the intensive care unit (ICU) and 42 patients (13.5%) required invasive mechanical ventilation. The most common complications recorded in discharge documentation for all patients were electrolyte abnormalities (124, 40.0%), acute kidney injury (AKI, 86, 27.7%), and sepsis (55, 17.7%). Patients who were readmitted had overall similar hospital course in duration, treatments received, intensive care requirements, and complications recorded compared to the overall population (Table 2).

3.3. Post-discharge healthcare needs

Post-discharge needs are summarized in Table 3. The majority of patients (281, 90.6%) were discharged directly home. Twenty-five patients (8.1%) were discharged to a skilled nursing facility (SNF) and four patients (1.3%) were discharged to a Georgia Department of Public Health quarantine facility. Nine patients (2.9%) experienced placement issues including difficulty with SNF admissions and inability to return to independent living facilities due to COVID-19-status, with four (1.3%) resulting in prolonged hospitalization to finish a 14-day quarantine. Seventy-five patients (24.2%) required any home service at discharge, including physical or occupational therapy (42, 13.5%), nursing (16,

Table 3
Post-discharge needs of patients with COVID-19 who survived to discharge.

	No. (%)			
	All patients survived to discharge	Patients with no ED visits or readmissions	Patients with ED treat and release	Patients readmitted
Total no.	310	284	10	16
Home	281 (90.6)	257 (90.5)	10 (100)	14 (87.5)
Skilled nursing facility	25 (8.1)	23 (8.1)	0 (0)	2 (12.5)
Median age (range), years	74 (40–99)	75 (40–99)	NA	66 (66–66)
DPH facility	4 (1.3)	4 (1.4)	0 (0)	0 (0)
Placement issues	9 (2.9)	7 (2.5)	2 (20)	0 (0)
Unstable housing	5 (1.6)	5 (1.8)	0 (0)	0 (0)
AMA	1 (0.3)	1 (0.4)	0 (0)	0 (0)
Home health and home oxygen				
Any home service	75 (24.2)	68 (23.9)	2 (20)	5 (31.3)
PT/OT	42 (13.5)	38 (13.4)	2 (20)	2 (12.5)
Nursing	16 (5.2)	15 (5.3)	1 (10)	0 (0)
Home oxygen therapy	41 (13.2)	38 (13.4)	0 (0)	3 (18.8)
No. of home health services required				
1	55 (17.7)	49 (17.3)	1 (10)	5 (31.3)
2	16 (5.2)	15 (5.3)	1 (10)	0 (0)
3	4 (1.3)	4 (1.4)	0 (0)	0 (0)
Median age (range), years	64 (27–96)	64 (27–96)	75.5 (71–80)	61 (44–88)
Recommended Follow-Up appointments				
Primary care appointment	258 (83.2)	241 (84.9)	8 (80)	9 (56.3)
PCP identified at discharge	217 (70)	199 (70.1)	7 (70)	11 (68.8)
Specialist appointment[a]	90 (29)	80 (28.2)	3 (30)	7 (43.8)
Isolation instructions				
Isolation documented	225 (72.6)	208 (73.2)	6 (60)	11 (68.8)
Isolation duration specified	56 (18.1)	55 (19.4)	0 (0)	1 (6.3)
Median (range) days isolation remaining	14 (3–14)	14 (3–14)	NA	7 (7–7)
Caregiver				
Caregiver identified	162 (52.3)	149 (52.5)	8 (80)	5 (31.3)
High-risk caregiver identified[b]	3 (0.9)	2 (0.7)	1 (10)	0 (0)
New medications at discharge				
Short-term[c]				
Total patients	207 (66.8)	188 (66.2)	8 (80)	11 (68.8)
Mean (SD) no. of new medications	2.2 (1.3)	2.2 (1.3)	2.4 (1.2)	1.7 (1.0)
Long-term				
Total patients	72 (23.2)	65 (22.9)	3 (30)	4 (25)
Mean (SD) no. of new medications	1.6 (1.0)	1.5 (0.7)	1.3 (0.6)	3.5 (2.6)
Follow-up monitoring ordered				
Labs[d]	31 (10)	28 (9.9)	2 (20)	1 (6.3)
Imaging[e]	21 (6.8)	20 (7)	1 (10)	0 (0)
Ongoing symptoms at discharge				
Cough	138 (44.5)	128 (45.1)	5 (50)	5 (31.3)
SOB	137 (44.2)	124 (43.7)	7 (70)	6 (37.5)
Fatigue	28 (9)	23 (8.1)	3 (30)	2 (12.5)

(*continued on next page*)

Table 3 (*continued*)

	No. (%)			
	All patients survived to discharge	Patients with no ED visits or readmissions	Patients with ED treat and release	Patients readmitted
Weakness	24 (7.7)	20 (7)	2 (20)	2 (12.5)
Diarrhea	23 (7.4)	21 (7.4)	2 (20)	0 (0)
Fever	16 (5.2)	13 (4.6)	1 (10)	2 (12.5)
Headache	13 (4.2)	12 (4.2)	0 (0)	1 (6.3)
Loss of taste/ smell	11 (3.5)	10 (3.5)	0 (0)	1 (6.3)
Myalgia	10 (3.2)	9 (3.2)	0 (0)	1 (6.3)
Chest pain/ tightness	9 (2.9)	5 (1.8)	0 (0)	4 (25)
Total (≥1 symptom)	213 (68.7)	194 (68.3)	10 (100)	9 (56.3)

Abbreviations: DPH, department of public health; AMA, against medical advice; PT, physical therapy; OT, occupational therapy; NA, not applicable; PCP, primary care provider; SD, standard deviation; SOB, shortness of breath.

[a] Specialists: cardiology, nephrology, urology, pulmonology, rheumatology, oncology, endocrinology, infectious disease, gastroenterology, psychiatry, surgery, neurology, palliative care.

[b] High-risk caregiver: elderly or high-risk comorbidity specifically documented in the medical record.

[c] Short-term medications: anticipated endpoint within 6-months.

[d] Labs: complete blood count, complete metabolic panel, thyroid stimulating hormone, hemoglobin A1c, vitamin levels.

[e] Imaging: chest x-ray, echocardiogram, chest computed tomography.

5.2%), and new home oxygen therapy (41, 13.2%). The majority of patients (225, 72.6%) had documented advice to continue isolation at discharge, but only 56 (18.1%) patients had documentation of specific instructions on the duration of isolation, most often 14 days from discharge (median 14 days, range: 3–14). Only 162 patients (52.3%) had a caregiver or family support identified in the medical record.

The most common follow-up need was an appointment with a PCP (258 patients, 83.2%), yet only 83 patients (26.8%) had an appointment scheduled at discharge and 93 patients (30.0%) did not have a PCP identified at discharge. Ninety patients (29.0%) required follow-up with a specialist, with only 5 patients (1.6%) scheduled at discharge. Of all recommended follow-up appointments, telemedicine was specified for 73 (23.5%) PCP visits and 2 (0.6%) specialty visits. The most common specialties recommended were nephrology (23, 7.4%) and cardiology (14, 4.5%). Thirty-one patients (10.0%) required follow-up bloodwork and 21 patients (6.8%) required follow-up radiology testing. The majority of readmitted patients were discharged home (14 patients, 87.5%) with a similar need for home health services (5 patients, 31.3%) compared to the overall group. However, only 9 patients (56.3%) were told to follow-up with a PCP and only 5 patients (31.3%) had a caregiver identified at discharge.

Most patients (207, 66.8%) went home with new short-term medications (anticipated endpoint within 6 months), with an average of 2.2 (SD: 1.3) new prescriptions per patient. Short-term medications included antitussives (n = 95), bronchodilators (frequently albuterol, n = 52), and antipyretics (acetaminophen, n = 64). Due to Emory Healthcare COVID-19 algorithms, a high number were discharged on short-term anticoagulation (n = 62) and several on short-term statin for anti-inflammatory properties (n = 6). We observed a relatively small number discharged on antibiotics (n = 32). Seventy-two patients (23.2%) went home with new long-term medications, with an average of 1.6 (SD: 1.0) per patient, most commonly, antihypertensives (n = 46) and antidiabetic medications (n = 10). Small numbers of patients were started on new medications to manage new severe kidney disease or vascular events. Two hundred thirteen patients (68.7%) were documented to have at least one ongoing symptom at discharge with the most common being cough and shortness of breath (138 patients, 44.5%, and 137 patients, 44.2% respectively).

3.4. Outcomes

Post-discharge outcomes of interest included ED visits, readmissions, death, and hospice placement (Table 4). The post-discharge ED visit rate was 7.7% with 54.2% of these attributable to COVID-19. The post-discharge readmission rate was 5.2% with 68.8% of these attributable to COVID-19. The most common COVID-19 related reason for readmission was worsening pneumonia or bacterial superinfection, noted in four patients (1.3%). Only one patient (0.3%) was suspected to have a pulmonary embolism. Two patients (0.6%) died during rehospitalization, and both had sepsis present on readmission. One patient (0.3%) was placed on hospice after discharge.

4. Discussion

To our knowledge, this is the first cohort study aimed at describing transitions of care and post-discharge anticipatory guidance for ambulatory providers caring for COVID-19 patients. The majority were African American and 51.0% were female, both of which are consistent with the published report of COVID-19 cases from the state of Georgia.[12] Our study demonstrates a greater proportion of females than other reports.[3,5–8] Age and presenting comorbidities were consistent with other cohorts of hospitalized COVID-19 patients documented in the literature.[3,4,6,9] Hospital course, including rates of ICU admission, AKI, and treatments received were similar to other groups.[3–5] The readmission rate of 5.2% observed in our study is within the range of other reports.[3,13–15]

4.1. Medication changes

Our data highlight that the majority of hospitalized COVID-19 patients are not yet back to baseline health at the time of discharge and may require ongoing care for symptom management and/or supervision of functional recovery. The majority had at least one ongoing symptom and two-thirds were prescribed new short-term medications for symptom relief. Nearly one-quarter of patients were started on new long-term medications; however, due to incomplete documentation of home medications on admission for some patients, we were unable to

Table 4
Post-discharge outcomes of patients with COVID-19 who survived to discharge.

	No. (%)
ED visits	
Total	24 (7.7)
1 visit	20 (6.5)
2 visits	3 (1)
3 visits	1 (0.3)
COVID-related	13 (54.2)
Median (range) days to 1st visit	7.5 (0–28)
Readmissions	
Total	16 (5.2)
1 readmission	15 (4.8)
2 readmissions	1 (0.3)
COVID-related	11 (68.8)
Pneumonia	4 (1.3)
Sepsis	3 (1)
Subjective dyspnea	2 (0.6)
Pleurisy	2 (0.6)
Median (range) days to 1st readmission	7 (2–28)
Deaths post-discharge	2 (0.6)
Hospice post-discharge	1 (0.3)

Abbreviations: ED, emergency department; COVID, coronavirus disease 2019.
a. Outcomes measured for 30-days post discharge that occurred at an Emory facility or with specific documentation in the medical record of an event that occurred at an outside facility.
b. COVID-relatability determined by ED or readmitting team's clinical assessment documented in the medical record.

determine the number of new long-term prescriptions that represented a resumption of home medication or substitution for all patients (e.g. calcium channel blocker replacing other antihypertensive due to AKI or electrolyte abnormality). The new or altered medications recorded at discharge require reconciliation and monitoring, usually coordinated by the PCP.

4.2. Follow-up Services Needed and the Role of Telemedicine

Although most patients were instructed to follow-up with a PCP, a service typically provided within one or two weeks under current care transition payment models introduced by Centers for Medicare & Medicaid Services, three-quarters of patients were also instructed to continue isolation at home and only one-quarter had a PCP appointment scheduled prior to discharge. Additionally, 93 patients did not have a PCP identified at discharge, which is an important care gap to address when many offices are not open to new patients due to the pandemic. The isolation recommendations concurrent with the lack of scheduled follow-up care in a setting where clinics are being scaled back for social distancing may result in an increased burden on the patient.

Fifty-two patients in our cohort were told to receive follow-up bloodwork or radiology after discharge, yet the majority of these services were not ordered at discharge and therefore require PCP involvement in order to be completed. Telemedicine, recently authorized by many insurers for patients in home isolation, was specifically recommended for follow-up of one-quarter of patients and is a potential solution for care that does not require in-person service. However, this does not address laboratory monitoring, which requires in-person contact. During isolation, phlebotomy may be provided by home health or specific laboratory facilities (e.g. within a respiratory clinic). Clear guidelines for discontinuation of isolation and "return to medical facilities" are needed to plan outpatient laboratory or radiology testing for post-discharge patients. These pathways, if not clarified, will increase demands on the patient in the context of already elevated psychosocial stress due to the pandemic.[16] As an example, despite high rate of electrolyte abnormalities and AKI during hospitalization, only 31 patients were instructed to obtain follow-up bloodwork. Laboratory monitoring of renal function based on degree of AKI and renal recovery is an important area of consideration and follow-up for patients in isolation can be implemented with streamlined guidance for home health nurses in coordination with the PCP.

4.3. Home health and skilled nursing facility requirements

It has been previously recognized that many patients hospitalized with COVID-19 will require post-acute care. Inpatient rehabilitation facilities may not be capable of handling unpredictable volumes of patients with convalescent COVID-19 due to limited occupancy and changing infection-control measures, placing increased demands on hospital-at-home models.[17] Post-acute care needs for our cohort, including placement in SNF and need for in-home services were overall lower than prior reports for community acquired pneumonia (CAP)[18] with a higher proportion of home health (relative to SNF), which is expected based on a younger population and documented difficulty with SNF placement for our patients. Furthermore, patient preference to avoid SNF placement (due to restrictive visitor policies or other aspects unique to the pandemic) may have led to underutilization during the study period. For home health needs, a significant number of patients had new oxygen requirements at discharge and required two or more services. While the majority of patients in our cohort who required inpatient skilled services were admitted to SNF, a few were denied access due to COVID-19-status resulting in a prolonged hospital stay or home health services instead. A prior study of Medicare beneficiaries has shown an association of home health utilization with higher rates of readmission[19] raising concerns about access to SNF services when recommended but not available in the setting of this pandemic.[20] Utilization of inpatient beds for patients who cannot get admitted to SNF is also taxing an already overwhelmed medical system attempting to treat acute patients.

4.4. Readmission and emergency department visits

Despite a high prevalence of ongoing symptoms, post-discharge needs, and limited scheduling of appointments at the time of discharge in our cohort, the rates of ED visits and readmissions within our system were relatively low (7.7% and 5.2%, respectively). Our data may underestimate the actual number due to the limitation of the dataset to our network of hospitals and the non-integrated nature of the U.S. healthcare system. There were two deaths upon readmission and one post-discharge transition to hospice documented in the group.

Despite low readmission rates, the scale of the global pandemic will inevitably create a high volume of COVID-19 patient discharges and, therefore, high absolute cases of readmission. Transitions of care interventions following hospitalization are intended to reduce ED visits and readmissions, and it is well documented that lapses in post-discharge care may contribute to complications.[11] Studies in CAP have demonstrated a benefit to specific post-hospital care interventions such as telephone calls.[21] We are not aware of any studies evaluating post-hospitalization care management specific to COVID-19 and further research is needed. Given the uncertainties regarding access to outpatient services in the setting of this pandemic as well as anticipated loss or change of insurance,[22] patients who are discharged after COVID-19 hospitalization may benefit from streamlined transitions of care practices. Healthcare systems should study programs including nursing care management, standardized isolation instructions, and protocols for scheduling follow-up provider, phlebotomy, or radiology appointments. Telemedicine and remote monitoring programs may be utilized to provide virtual post-discharge needs.

4.5. Limitations

This study has several limitations. First, it was retrospective and conducted at a single academic center. This limits generalizability, as COVID-19 outbreaks have significant regional and temporal variation. We also are limited to the Emory-specific electronic medical record and therefore post-discharge visits and complications that occurred at outside facilities may have been missed. Second, with relatively low numbers of adverse outcomes, we are unable to assess risk factors for post-discharge complications. Further studies with larger sample sizes and integrated systems are needed to evaluate risk factors for ED visits and readmission after discharge in patients with COVID-19. Third, due to the nature of chart review, there is possible underreporting of symptoms at the time of discharge as well as other elements that are not mandatory in documentation such as the availability of a caregiver. Finally, because COVID-19 represents a novel disease for which the long-term care and recovery are not yet known, we cannot assess the actual need for post-discharge care, but instead used the recommended care by discharging providers as a surrogate for actual healthcare needs.

5. Conclusions

In a single center retrospective review of post-discharge care transition requirements of hospitalized patients with COVID-19, we have demonstrated that patients have significant recommended post-discharge care in the outpatient setting. There are specific transitions of care that must be anticipated and addressed by healthcare systems and the primary care community including post-hospital visits, home health supervision, monitoring of medications, discontinuation of isolation, and follow-up laboratory and radiology needs. In the context of increased psychosocial stress related to the pandemic and navigating an already complex medical system under duress, healthcare systems and patients may benefit from streamlined COVID-19 specific transitions

of care practices.

Author contributions

Leah Loerinc and James O'Keefe had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

- **Leah Loerinc:** conceptualization, data curation, formal analysis, methodology, writing – original draft, review & editing
- **Amy Scheel:** data curation, writing – review & editing
- **Sean Evans:** data curation, writing – review & editing
- **Julie Shabto:** data curation, writing – review & editing
- **Ghazala O'Keefe:** conceptualization, writing – original draft, review & editing
- **James O'Keefe:** conceptualization, data curation, formal analysis, methodology, supervision, writing – original draft, review & editing

Funding/support

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1 World Health O. *COVID-19 Weekly Epidemiological Update*. Geneva: World Health Organization; 2020, 10-25 2020.
2 Centers for Disease Control and P. *COVIDView Week 42, Ending October 17, 2020*. Atlanta: Centers For Disease Control and Prevention; 2020, 10-23 2020.
3 Richardson S, Hirsch JS, Narasimhan M, et al. Presenting characteristics, comorbidities, and outcomes among 5700 patients hospitalized with COVID-19 in the New York city area. *J Am Med Assoc*. 2020. https://doi.org/10.1001/jama.2020.6775.
4 Wang D, Hu B, Hu C, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *Jama*. 2020. https://doi.org/10.1001/jama.2020.1585.
5 Cao J, Tu WJ, Cheng W, et al. Clinical features and short-term outcomes of 102 patients with Corona virus disease 2019 in Wuhan, China. *Clin Infect Dis*. 2020. https://doi.org/10.1093/cid/ciaa243.
6 Wang D, Yin Y, Hu C, et al. Clinical course and outcome of 107 patients infected with the novel coronavirus, SARS-CoV-2, discharged from two hospitals in Wuhan, China. *Crit Care*. 2020;24(1):188. https://doi.org/10.1186/s13054-020-02895-6.
7 Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet*. 2020;395(10223):497–506. https://doi.org/10.1016/s0140-6736(20)30183-5.
8 Kim ES, Chin BS, Kang CK, et al. Clinical course and outcomes of patients with severe acute respiratory syndrome coronavirus 2 infection: a preliminary report of the first 28 patients from the Korean cohort study on COVID-19. *J Kor Med Sci*. 2020;35(13):e142. https://doi.org/10.3346/jkms.2020.35.e142.
9 Zhou F, Yu T, Du R, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *Lancet*. 2020;395(10229):1054–1062. https://doi.org/10.1016/s0140-6736(20)30566-3.
10 Guan W-j, Ni Z-y, Hu Y, et al. Clinical characteristics of coronavirus disease 2019 in China. *N Engl J Med*. 2020;382(18):1708–1720. https://doi.org/10.1056/NEJMoa2002032.
11 Kim CS, Flanders SA. In the Clinic. Transitions of care. *Ann Intern Med*. 2013;158. https://doi.org/10.7326/0003-4819-158-5-201303050-01003 (5 Pt 1):Itc3-1.
12 Gold JAW, Wong KK, Szablewski CM, et al. Characteristics and clinical outcomes of adult patients hospitalized with COVID-19 - Georgia, March 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(18):545–550. https://doi.org/10.15585/mmwr.mm6918e1.
13 McCarthy CP, Murphy S, Jones-O'Connor M, et al. Early clinical and sociodemographic experience with patients hospitalized with COVID-19 at a large American healthcare system. *EClinicalMedicine*. 2020;26:100504. https://doi.org/10.1016/j.eclinm.2020.100504.
14 Somani S, Richter F, Fuster V, et al. Characterization of patients who return to hospital following discharge from hospitalization for COVID-19. *medRxiv*. 2020. https://doi.org/10.1101/2020.05.17.20104604.
15 Atalla E, Kalligeros M, Giampaolo G, Mylona EK, Shehadeh F, Mylonakis E. Readmissions among patients with COVID-19. *Int J Clin Pract*. 2020, e13700. https://doi.org/10.1111/ijcp.13700.
16 Pfefferbaum B, North CS. Mental health and the Covid-19 pandemic. *N Engl J Med*. 2020. https://doi.org/10.1056/NEJMp2008017.
17 Grabowski DC, Joynt Maddox KE. Postacute care preparedness for COVID-19: thinking ahead. *J Am Med Assoc*. 2020. https://doi.org/10.1001/jama.2020.4686.
18 Jones CD, Ginde AA, Burke RE, Wald HL, Masoudi FA, Boxer RS. Increasing home healthcare referrals upon discharge from U.S. Hospitals: 2001-2012. *J Am Geriatr Soc*. 2015;63(6):1265–1266. https://doi.org/10.1111/jgs.13467.
19 Werner RM, Coe NB, Qi M, Konetzka RT. Patient outcomes after hospital discharge to home with home health care vs to a skilled nursing facility. *JAMA Intern Med*. 2019;179(5):617–623. https://doi.org/10.1001/jamainternmed.2018.7998.
20 Simpson R, Robinson L. Rehabilitation following critical illness in people with COVID-19 infection. *Am J Phys Med Rehabil*. 2020. https://doi.org/10.1097/phm.0000000000001443.
21 Domingo GR, Reyes FC, Thompson FV, Johnson PM, Shortridge-Baggett LM. Effectiveness of structured discharge process in reducing hospital readmission of adult patients with community acquired pneumonia: a systematic review. *JBI Libr Syst Rev*. 2012;10(18):1086–1121. https://doi.org/10.11124/01938924-201210180-00001.
22 Levitt L. COVID-19 and Massive Job Losses Will Test the US Health Insurance Safety Net. *J Am Med Assoc*. 2020;324(5):431–432.