Retrospective evaluation of patients with and without 14-day readmissions following hospitalization for COVID-19

Kavitha Subramoney [1] Omar Elsheikh,[2] Saira Butt,[2] Daniel Romano,[2] Lindsey Reese,[2] Areeba Kara[2]

[1]Internal Medicine, Indiana University School of Medicine, Indianapolis, Indiana, USA
[2]Indiana University School of Medicine, Indianapolis, Indiana, USA

Correspondence to
Dr Kavitha Subramoney, Internal medicine, Indiana University School of Medicine, Indianapolis, IN 46202, USA; ksubramoney@iuhealth.org

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ABSTRACT

Hospitalized patients with COVID-19 must have a safe discharge plan to prevent readmissions. We assessed patients with COVID-19 admitted to hospitals belonging to a single health system between April 2020 and June 2020. Demographics, vitals and laboratory data were obtained by electronic data query and discharge processes were reviewed by manual abstraction. Over the study period, 94 out of 912 (10.3%) patients were readmitted within 14 days of discharge. Readmitted patients were older and spent more time in the intensive care unit (p<0.01). Statistical differences were noted in discharge-day heart rates, temperatures, platelet counts, and neutrophil and lymphocyte percentages between the readmitted and non-readmitted groups. Readmitted patients were less likely to be discharged home and to receive complete discharge instructions or home oxygen (p<0.01). Age, duration of intensive care unit stay, disposition destinations other than home, incomplete discharge planning and no arrangement for home oxygen may be associated with 14-day readmissions in patients with COVID-19. Certain clinical parameters on discharge day, while statistically different, may not reach clinically discriminant thresholds. Structured discharge processes may improve outcomes.

INTRODUCTION

The transition home from the hospital is a period of vulnerability for patients. Patients discharged from the hospital encounter a variety of problems, including self-care deficits, difficulties in coordinating follow-up care and complex medication changes after being discharged. Many of these issues contribute to readmissions.[1] Inpatient resources have been stretched to the limit during the COVID-19 pandemic, further highlighting the importance of preventing readmissions.[2] Studying readmission post discharge has special relevance during the pandemic due to its potential to overwhelm hospital systems.[3] Most institutions have comprehensive discharge planning protocols including multidisciplinary huddles, case management and social work support. Ineffective discharge planning may contribute to hospital readmissions.[4]

In terms of clinical features, discharge criteria following hospitalization for COVID-19 have not been evaluated for their associated outcomes. Early readmissions may be more preventable than later ones. In this work we seek to identify the demographic, clinical and discharge process characteristics associated with 14-day readmissions in patients hospitalized for COVID-19.

METHODS

Data from the index hospitalization of patients ≥18 years admitted between April and June 2020 to any of the 17 hospitals across the state of Indiana belonging to a single health system with the diagnosis of COVID-19 (International Classification of Diseases (ICD-10) code U07.1) were analyzed.

Demographic data, vital signs and laboratory data were retrieved by electronic medical record query. Vitals included the lowest recorded blood pressure and oxygen saturation and the highest recorded temperature and heart rate value for each patient on the day of discharge. There were no missing data on discharge-day vital signs. Blood counts and electrolytes resulting on discharge day were retrieved (when available), while the last measured procalcitonin and D-dimer values were retrieved. As not every patient had laboratory evaluation performed on the day of discharge, these were recorded as missing data. Comorbidities were retrieved using ICD codes (428.0 for congestive heart failure, 121 for myocardial infarction, 148 for atrial fibrillation, 149.9 for cardiac arrhythmia, J44.9 for chronic obstructive pulmonary disease, J84.9 for interstitial lung disease, J45.909 for asthma, K51.90 for inflammatory bowel disease, K21.9 for gastro esophageal reflux disease, K57.30 for diverticulosis, E11.9 for type 2 diabetes and E10.9 for type 1 diabetes, C18.9 for colon cancer, C34.9 for lung cancer, C50.01 for breast cancer, C64.9 for renal cancer and C80.1 for malignancy).

Chart review determined whether COVID-19-specific discharge education was included in the discharge paperwork. The 'completeness' of the discharge instructions was defined by the presence of discharge diagnoses, medication reconciliation and a follow-up appointment.

Statistical analysis

Analyses were performed in R.[5] The characteristics of patients with and without readmission were compared using t-test and χ^2 test for continuous and categorical data, respectively. Statistical significance was set at $p<0.05$.

RESULTS

Over the study period, 1020 patients were admitted with COVID-19. Of these, 108 patients (10.6%) died. Among the 912 discharged, 94 (10.3%) were readmitted to the hospital within 14 days. Readmitted patients were older, had longer stays in the intensive care unit (ICU) and had pulmonary comorbidities compared with those without readmission. Gender and length of stay were similarly distributed between the two groups. A higher proportion of those with body mass index (BMI) >40 were readmitted. However, BMI was missing in 37.8% of the sample, with a higher proportion of missing data noted in those who did not have subsequent readmissions (table 1).

The mean highest recorded heart rate, respiratory rate and temperature on discharge day were higher in readmitted patients. Among readmitted patients, the mean discharge-day platelet counts and lymphocyte percentages were lower while the mean neutrophil percentages were higher compared with those not readmitted. The last measured mean D-dimer and procalcitonin values were similar between groups.

The proportion of patients who received complete discharge instructions and COVID-19-specific discharge education and had follow-up appointments and home oxygen arranged was lower among those who were readmitted. A higher proportion of those readmitted were discharged to facilities (table 2).

To assess whether the quality of discharge planning was unequally distributed based on discharge disposition, we compared the completeness of discharge instructions between those discharged home and those discharged to facility. Discharge instructions were noted to be complete in 93% of those discharged to home and in 65.4% of those discharged to facilities ($p<0.00001$). The proportion of those with complete discharge instructions was similarly distributed between those with and without 14-day readmissions whether they were discharged to home or to facility (table 3).

Table 1 Demographics and hospitalization characteristics of patients discharged following COVID-19 hospitalization based on subsequent 14-day readmission status

	Patients without 14-day readmission	Patients with 14-day readmission	P value
Total	818	94	
Mean age (years)	58.4	68.1	<0.0001
SD	16.5	19.6	
Gender, n (%)			0.12
Female	417 (51.1)	40 (42.5)	
Male	401 (49.3)	54 (57.5)	
Body mass index (kg/m^2), n (%)			
Non-obese (<26)	102 (12.5)	12 (12.7)	0.9
Overweight (26–29.9)	106 (12.9)	16 (17.0)	0.23
Class 1 (30–34.9)	114 (13.9)	11 (11.7)	0.55
Class 2 (35–39.9)	86 (10.5)	15 (15.9)	0.11
Class 3 (>40)	86 (10.5)	17 (18.9)	0.02
Missing data	322 (40.1)	23 (24.7)	0.004
Comorbidities, n (%)			
Diabetes mellitus	426 (52.1)	33 (35.1)	0.002
Cardiovascular	389 (47.6)	34 (36.2)	0.03
Gastrointestinal	356 (43.5)	12 (12.8)	<0.00001
Pulmonary	232 (28.4)	36 (38.3)	0.04
Malignancy	109 (13.3)	10 (10.6)	0.46
Mean LOS (days)	8.6	10.8	0.09
SD	8.57	10.21	
ICU stay during index hospitalization, n (%)	565 (69)	71 (75.5)	0.23
Mean ICU stay (days)	7.9	10.7	0.002
SD	7.82	8.62	

International Classification of Diseases codes were used to assess comorbidities. The following codes were used: 428.0 for congestive heart failure, 121 for myocardial infarction, 148 for atrial fibrillation, 149.9 for cardiac arrhythmia, J44.9 for chronic obstructive pulmonary disease, J84.9 for interstitial lung disease, J45.909 for asthma, K51.90 for inflammatory bowel disease, K21.9 for gastro esophageal reflux disease, K57.30 for diverticulosis, E11.9 for type 2 diabetes and E10.9 for type 1 diabetes, C18.9 for colon cancer, C34.9 for lung cancer, C50.01 for breast cancer, C64.9 for renal cancer and C80.1 for malignancy.
ICU, intensive care unit; LOS, length of stay.

DISCUSSION

Identifying the risk factors for readmissions and safe discharge parameters for patients with COVID-19 will improve the management of this novel disease and the utilization of resources constrained by the pandemic. Structured multicomponent interventions at discharge have been shown to reduce readmissions.[6] We noted a 10.3% 14-day readmission rate, a rate similar to outcomes reported by the Center for Disease Control.[7] Our data extend beyond the first surge in our state, and it is uncertain if readmission rates were impacted by hospital capacity or changed as management evolved. Similar to previously reported data, we also noted increased readmission risk associated with older age and longer ICU stays. Interestingly, in our sample, pulmonary comorbidities appeared to be the only category of chronic illnesses associated with 14-day readmissions. As our work is observational and retrospective, this finding requires further study. Patients with pre-existing pulmonary diseases may require further support to prevent readmissions following COVID-19.

In terms of clinical parameters, we found statistically significant differences in highest heart rates, respiratory rates and temperatures recorded on the day of discharge between readmitted and non-readmitted patients. While COVID-19 severity has been linked to thrombocytopenia and lymphopenia at admission, our findings suggest that lower platelet counts and lymphocyte values on discharge day may be associated with 14-day readmissions.[8] While

Table 2 Vital sign, laboratory and discharge planning parameters of patients discharged following COVID-19 hospitalization based on subsequent 14-day readmission status

	Patients without 14-day readmission	Patients with 14-day readmission	P value
Total	818	94	
Mean vital signs on discharge day			
Lowest systolic blood pressure (mm Hg)	127.8	130.2	0.07
Lowest diastolic blood pressure (mm Hg)	72.9	72.2	0.4
Highest heart rate (beats per minute)	85.2	88.7	0.04
Highest respiratory rate (breaths per minute)	19.4	20.5	0.01
Lowest recorded oxygen saturation (%)	93	95	0.14
Highest temperature (°C)	36.7	36.9	0.001
Mean laboratory values on discharge day			
Serum sodium (mEq/L)	138.2 (n=599)	137.9 (n=72)	0.49
Serum potassium (mEq/L)	3.9 (n=599)	3.9 (n=72)	0.06
Platelet count (10^3/µL)	315 (n=546)	253 (n=68)	<0.0001
White cell count (109/µL)	7.9 (n=544)	8.6 (n=68)	0.39
Neutrophil percentage	64.2 (n=387)	71.7 (n=44)	0.009
Lymphocyte percentage	24.1 (n=387)	16.7 (n=44)	0.004
Mean last measured values during hospitalization			
D-dimer (ng/mL)	1276 (n=730)	1492 (n=66)	0.22
Procalcitonin (ng/mL)	1.1 (n=742)	1.13 (n=72)	0.06
Discharge planning and disposition characteristics, n (%)			
Discharge instructions complete	766 (88.4)	31 (32.9)	<0.0001
COVID-19-specific discharge instructions provided	570 (65.8)	34 (36.2)	<0.0001
Follow-up appointment made	568 (58.3)	30 (31.9)	0.002
Home oxygen arranged	128 (14.8)	3 (3.2)	0.0001
Discharged to facility	142 (14.5)	46 (50)	<0.0001

these differences were statistically significant, the values noted are unlikely to raise clinical alarm nor may they be modifiable. Our findings may help develop scoring systems that predict readmissions for patients hospitalized with COVID-19 using these subtle indicators uncovered by our work.

A study by Baker and Greiner[9] showed that successful discharge planning included the delivery of discharge teaching. In our univariate analysis, readmitted patients were less likely to have received COVID-19-specific discharge education or complete discharge instructions. Structured discharge processes improve outcomes posthospital discharge, and the lower proportion of readmitted patients receiving COVID-19-specific discharge education, complete discharge instructions or follow-up reiterates the importance of robust discharge planning. However, we noted differences in the proportion of patients receiving complete discharge instructions based on their discharge disposition, with significantly fewer patients discharged to facilities receiving complete instructions. Stratified by discharge disposition, the completeness of discharge instructions was similarly distributed between those with and without subsequent 14-day readmission, raising the possibility that the association noted between the completeness of discharge instructions and readmission risk was largely related to discharge disposition.

Similar to the CDC's report, we also noted that patients discharged to facility rather than home were significantly more likely to be readmitted.[7] The univariate nature of the analysis however precludes our ability to determine differences in the severity of illness between those discharged to facility versus home. Readmissions from skilled nursing facilities are likely to reflect the performance of both the discharging hospital and the receiving facility.[10 11] In the face of a novel illness with rapidly evolving knowledge and management, the transitions between acute care and facilities may require closer examination to promote patient safety.

Patients discharged with home oxygen were less likely to be readmitted, suggesting that those who are discharged

Table 3 Distribution of completeness of discharge instructions based on discharge disposition and subsequent 14-day readmission

	Discharged home			Discharged to facility		P value
Discharge instructions complete, n (%)	674 (93)			123 (65.4)		<0.00001
	Without 14-day readmission	**With 14-day readmission**	**P value**	**Without 14-day readmission**	**With 14-day readmission**	**P value**
Discharge instructions complete, n (%)	623 (89.1)	25 (96)	0.2	130 (80)	19 (73)	0.4

after the point in their illness that supplemental oxygen was required were protected against readmission compared with those who may be at a different point in the trajectory of their illness at discharge.

Notable limitations in our study include the univariate nature of the analysis. With fewer than 100 patients with 14-day readmissions, multivariate regression was not possible. Our findings should be considered exploratory and hypothesis-generating, deserving of further validation in larger multivariate analysis. Missing data are also an important limitation of our work, specifically for BMI values and laboratory data on discharge day. We did not investigate the causes of readmissions, and while multiple sites were included all belonged to the same health system, which may limit generalizability.

CONCLUSIONS

It may be difficult to predict readmissions in patients with COVID-19 based on each individual patient's discharge-day clinical vitals and laboratory values alone. However, in aggregate, subtle differences in temperature, respiratory rate, platelet count and white cell count distributions exist that may be used to guide our readmission reduction efforts. Patients of older age, with longer duration of ICU stay or discharged to a facility may be at an increased risk of readmission and deserving of further efforts. Patients who may be later in the trajectory of their illness at discharge and already requiring oxygen supplementation may be at a lower risk of readmission. Improving discharge processes, including structured discharge instructions and disease-specific education, may play a role in preventing readmissions.

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ORCID iD

Kavitha Subramoney http://orcid.org/0000-0001-5229-8273

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