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Characteristics and Outcomes of 360 Consecutive COVID-19 Patients Discharged From the Emergency Department With Supplemental Oxygen

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Study objective: To describe characteristics and outcomes of coronavirus disease (COVID-19) patients with new supplemental oxygen requirements discharged from a large public urban emergency department (ED) with supplemental oxygen.

Methods: This observational case series describes the characteristics and outcomes of 360 consecutive COVID-19 patients with new supplemental oxygen requirements discharged from a large urban public ED between April 2020 and March 2021 with supplemental oxygen. Primary outcomes included 30-day survival and 30-day survival without unscheduled inpatient admission. Demographic and clinical data were collected through a structured chart review.

Results: Among 360 patients with COVID-19 discharged from the ED with supplemental oxygen, 30-day survival was 97.5% (95% confidence interval (CI) 95.3 to 98.9%; n=351), and 30-day survival without unscheduled admission was 81.1% (95% CI 76.7 to 85.0%; n=292). A sensitivity analysis incorporating worst-case-scenario for 12 patients without complete follow-up 30 days after index visit yields 30-day survival of 95.5% (95% CI 92.5 to 97.2%; n=343), and 30-day survival without unscheduled admission of 78.9% (95% CI 74.3 to 83.0%; n=284). Among study patients, 32.2% (n=116) had a nadir ED oxygen saturation of <90%, among these 30-day survival was 97.4% (95% CI 92.6 to 99.4%; n=113), and 30-day survival without unscheduled admission was 76.7% (95% CI 68.8 to 84.1%; n=89).

Conclusion: COVID-19 patients with new supplemental oxygen requirements discharged from the ED had survival comparable to COVID-19 ED patients with mild exertional hypoxia treated with supplemental oxygen in other settings, and this held true when the analysis was restricted to patients with nadir ED index visit oxygen saturations <90%. Discharge of select COVID-19 patients with supplemental oxygen from the ED may provide a viable alternative to hospitalization, particularly when inpatient capacity is limited. [Ann Emerg Med. 2023;81:14-19.]

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INTRODUCTION

Background

Traditionally, emergency department (ED) patients with new supplemental oxygen requirements are hospitalized. To preserve inpatient capacity during the coronavirus disease (COVID-19) pandemic, the Los Angeles County Department of Health Services introduced an Expected Practice which recommended discharge of ED patients with COVID-19 requiring up to 3 liters per minute of supplemental oxygen with return precautions, pulse oximeters, supplemental oxygen, and telehealth follow-up.1

Importance

Discharge of COVID-19 patients from the ED with supplemental oxygen for a new oxygen requirement is a relatively novel process that avoids hospitalization, preserving inpatient resources for patients requiring more intensive care and potentially avoiding risks of iatrogenic complications of hospitalization. Although home monitoring using pulse oximetry has been studied, as has discharge of hospitalized patients with supplemental oxygen, discharge of COVID-19 patients directly from the ED with supplemental oxygen appears to be relatively novel.1-3 Protocols for and preliminary outcomes of COVID-19 patients discharged from the ED with supplemental oxygen have recently been reported.1,4,5,6 A study of 194 patients with mild exertional hypoxia discharged from New York EDs with oxygen concentrators early in the pandemic found relatively low 30-day ED returns and mortality rates.6 Outcomes of
Editor’s Capsule Summary

What is already known on this topic
New supplemental oxygen for many COVID-19 patients commonly is done in a hospital setting.

What question this study addressed
Can COVID-19 patients be discharged from the emergency department (ED) safely on new supplemental home oxygen therapy?

What this study adds to our knowledge
In this single-center case series of 360 patients discharged from the ED, 30-day survival was 97.5% and survival without hospital admission was 81.1%. Results were similar in those with higher (>90%) and lower (<90%) ED oxygen saturation.

How this is relevant to clinical practice
Select COVID-19 patients in a system with appropriate follow-up and monitoring may be adequately managed with home oxygen therapy.

patients treated at home with supplemental oxygen have been reported; however, these studies appear to include primarily patients discharged from inpatient hospitalizations or for whom supplemental oxygen was implemented by a physician at home.1,7 However, characteristics or outcomes of a large group of supplemental oxygen-requiring COVID-19 patients discharged from an ED in the United States that include varying levels of resting or exertional hypoxia have not been reported in detail in the peer-reviewed literature.

Goals of Investigation
This investigation aimed to report the characteristics and outcomes of COVID-19 patients with new supplemental oxygen requirements discharged from the ED with supplemental oxygen. Specifically, we estimate 30-day survival as well as 30-day survival without unscheduled hospital admission. In addition, understanding the safety profile of discharging COVID-19 patients with new supplemental oxygen requirements from the ED could inform the viability of future use of this practice, particularly when inpatient resources are limited.

MATERIALS AND METHODS

Study Design and Setting
This observational case series describes adults with COVID-19 discharged from the Los Angeles County + University of Southern California (LAC+USC) Medical Center ED between April 2020 and March 2021. We adhered to Strengthening the Reporting of Observational Studies in Epidemiology guidelines for reporting observational studies (https://www.strobe-statement.org/).

Selection of Participants
All patients were discharged from the ED with new order for supplemental oxygen per the expected practice model described in Figure, and (Exhibits E1 and E2, available online at http://www.annemergmed.com), were included. In brief, emergency physicians referred patients to the program based on clinical criteria as well as physician gestalt. Therefore, the ED visit resulting in discharge without inpatient admission with a new order for outpatient supplemental oxygen will be referred to as the index visit.

Data Collection and Processing
Demographic information, as well as clinical parameters during the index visit, were recorded. The clinical characteristics, including history of diabetes, hypertension, and obesity, were extracted from the electronic medical record through structured chart review, including review of consolidated problem lists, ED notes, primary care notes, or

| Patient Selection Criteria | Interventions |
|----------------------------|---------------|
| Oxygen requirements are 1-3L/min to maintain SpO2 ≥94% or improving clinical trajectory with SpO2 ≥92% and without accessory muscle use | ED dispenses oxygen tank, pulse oximeter, and contracts vendor to deliver an oxygen concentrator |
| Comfortable at rest and with minimal exertion | Facility-based nurse and physician follow up phone call within 12-18 hours |
| Heart rate ≤110 and respiratory rate ≤22 | Facility-based nurse or physician perform phone follow-up until no longer clinically necessary |
| No other medical issues requiring continued acute inpatient care | Durable medical equipment vendor follows-up within 24 hours to ensure equipment working properly |
| Refer to Supplemental Exhibit 1 for additional details | |

Figure. Patient selection and intervention steps for SAFE @ HOME O2 expected practice. Refer to Exhibit E1, available online at http://www.annemergmed.com for additional details.
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Outcome Measures

Primary outcomes were 30-day survival and 30-day survival without unscheduled hospital admission. The patient was considered to have survived if there were a clinical encounter >30 days after the index visit or, absent this, the patient indicated that supplemental oxygen had been discontinued because of clinical improvement at their final clinical encounter. Mortality was established if electronic medical record documentation indicated the patient had expired. Patients were considered lost to follow-up if there was no documented death, survival beyond 30 days, or the resolution of supplemental oxygen requirement within 30 days. Additionally, because a prior study included patients with oxygen saturations of 90% to 91% discharged on supplemental oxygen, a subanalysis of patients with nadir oxygen saturation at the index ED visit <90%, who would have been hospitalized per that study protocol was included. Finally, we conducted a worst-case scenario sensitivity analysis where all patients without 30-day follow-up were presumed to have died (for worst-case survival) and/or been hospitalized (for worst-case survival without hospitalization) regardless of whether supplemental oxygen had been discontinued at the final entry in the electronic medical record.

Primary Data Analysis

Demographic and clinical characteristics were described. Statistical analyses were performed using Stata/MP15 (StataCorp College Station, TX). Ten percent of charts were reviewed for concordance in the identification of the primary outcome, in which perfect (100%) agreement was observed. Records were reviewed through February 14th, 2022, for confirmation of survival past 30 days from the index visit. This study was approved by the University of Southern California Institutional Review Board.

RESULTS

Characteristics of Study Subjects

Characteristics of the 360 COVID-19 patients discharged from the LAC+USC Medical Center ED with supplemental oxygen during the study period are summarized in Table 1. Discharges peaked in December 2020 and January 2021 (Exhibit E3, available at http://www.annemergmed.com), corresponding with peak COVID-19 rates in Los Angeles. Sample patient characteristics are largely consistent with the characteristics of unique ED patients from the study site (Exhibit E4, available at http://www.annemergmed.com).

Main Results

The outcomes of study patients are summarized in Table 2. The 30-day survival rate was 97.5% (95% confidence interval (CI) 95.3 to 98.9%; n=351), and the rate of 30-day survival without unscheduled inpatient admission rate was 81.1% (95% CI 76.7 to 85.0%; n=292). A sensitivity analysis incorporating worst-case-
scenario for 12 patients without complete follow-up 30 days after index visit estimates a 30-day survival rate of 95.5% (95% CI 92.5 to 97.2%; n=343), and a 30-day survival without unscheduled admission of 78.9% (95% CI 74.3 to 83.0%; n=284). Characteristics of patients who died within 30 days of index visit are summarized in Exhibit E5 (available at http://www.annemergmed.com). Characteristics of patients with unscheduled hospital admissions within 30 days of the index ED visit are summarized in Exhibit E6 (available at http://www.annemergmed.com). Overall, 63 (17.5%) patients had an unscheduled hospital admission within 30 days of the index visit, including 12 (19.0%) hospitalized at non-Department of Health Services facilities. Three patients admitted within 30 days expired after more than month-long hospitalizations yielding an overall inpatient mortality rate of 11.1% (95% CI 4.6 to 21.6%) among the subset of patients requiring hospital admission.

Characteristics and Outcomes of Patients with Nadir ED Oxygen Saturation Under 90%

Among the 360 study patients, 32.2% (n=116) had a nadir ED oxygen saturation of <90%, and among these 30-day survival was 97.4% (95% CI 92.6 to 99.4%; n=113), and 30-day survival without unscheduled admission was 76.7% (95% CI 68.8 to 84.1%; n=89). Characteristics and outcomes of these patients are summarized in Exhibits E7-E9 (available at http://www.annemergmed.com). In a worst-case scenario sensitivity analysis where all patients without 30-day follow-up were presumed to have died and/or been hospitalized, 30-day survival would have been as low as 95.7% (95% CI 90.2 to 98.6%, n=111), and 30-day survival without unscheduled hospital admission would have been as low as 75.0% (95% CI 66.1 to 82.6%; n=87).

LIMITATIONS

Although this is the largest study of COVID-19 patients discharged from the ED with supplemental oxygen to date and the only 1 in the United States including patients with resting hypoxia, there are several limitations worth noting. First, the generalizability of findings may be limited for this single-site study. Nonetheless, LAC+USC Medical Center is one of the largest hospitals in the country, and the study population, which generally reflects the population served by the ED (primarily Latino, with high rates of diabetes, hypertension, and obesity), is one with high risk for adverse outcomes from COVID-19. Second, findings may be limited because of inconsistencies inherent to the chart review process. However, we used a piloted structured review method and verified interrater reliability for collecting primary outcomes. Third, our study included some patients with mild hypoxia (92% to 94%) who

### Table 1. Demographic and clinical characteristics of 360 patients.

| Patients, No. (%) (n=360) |
|---------------------------|
| Age, y | Median (IQR) 51 (42-60) |
| Sex | Female 140 (39) Male 220 (61) |
| Ethnicity | Hispanic 320 (89) Non-Hispanic 28 (8) Unknown 11 (3) |
| Language | Spanish 268 (74) English 80 (22) Other 12 (3) |
| Insurance | Medicaid 272 (76) Private 28 (8) Medicare 13 (4) Other 36 (10) No insurance 11 (3) |
| Comorbid Conditions | Diabetes 128 (35) Hypertension 110 (30) Obesity 145 (40) None of above 127 (35) |
| Lowest SpO2 in ED, median (IQR) | 91 (89.0-92.5) |
| Maximum respiratory rate, median (IQR) | 26 (23-30) |
| Maximum oxygen flow rate median (IQR), L/min | 2.0 (0.0-2)* |
| Steroids prescribed at index visit among 291 visits after June 2020 | 96 (33.0)† |

ED, Emergency department; IQR, Interquartile range.

*Some patients who demonstrated an oxygen requirement only with the trial of ambulation were discharged from the ED with supplemental oxygen though not treated in the ED with oxygen. It is possible that some of these patients might have been discharged from the ED if supplemental oxygen was unavailable in an outpatient setting. However, most of these patients (87 of 96; 90.62%) had oxygen saturations of 94% or lower during their ED visit, with more than 3 quarters (n=73; 76.04%) of these having oxygen saturations of 92% or lower during the index visit. A review of the 9 charts for patients without documented oxygen saturations less than 95% or supplemental oxygen administered in the ED found that 6 (66.6%) had notable tachypnea (range, 26 to 40) during their ED visit; 2 had hypoxia recorded prior to the ED visit, and 1 had notable tachycardia and tachypnea with ambulation.
might have been discharged with or without supplemental oxygen in other ED settings; however, we found similar outcomes among 116 study patients with nadir saturation in the ED <90%, who generally would have been otherwise admitted at most hospitals.4 Fourth, some patients may have received care outside of Department of Health Services or LANES-affiliated systems. Although we sought to identify references to external hospitalizations in clinical documentation, this remains a limitation. Fifth, it is possible that primary outcomes could have been over or underestimated depending on outcomes of patients without 30-day follow-up. However, to account for potential underestimates, we provided worst-case scenario estimates of both primary outcomes. Additionally, because overestimation of pulse oximetry in non-White individuals has been reported, it is possible that our methods would have underestimated hypoxia.9 Additional Food and Drug Administration communications addressing this matter are included with Exhibit E1 (available at http://www.annemergmed.com). Finally, 3-quarters of patients were discharged before COVID-19 vaccines, or outpatient treatments became widely available and prior to the emergence of seemingly less virulent COVID-19 strains, potentially limiting the generalizability of findings to current conditions.

## DISCUSSION

For COVID-19 patients with a new supplemental oxygen requirement discharged from our ED, 30-day mortality (1.4%) compares favorably to the 30-day mortality rate

### Table 2. Outcomes and status at follow-up of 360 patients.

| Outcome                                                                 | Patients, No. (%) (n=360) | 95% CI     |
|------------------------------------------------------------------------|---------------------------|------------|
| 30-day survival*                                                       | 351 (97.5)                | (95.3-98.9) |
| 30-day survival without unscheduled hospital admission†                | 292 (81.1)                | (76.7-85.0) |
| 30-day unscheduled hospital admission                                  | 63 (17.5)                 | (13.7-21.8) |
| 30-day unscheduled hospital admission related to COVID-19 respiratory complications‡ | 57 (15.8)                 | (12.2-20.0) |
| 30-day return to ED                                                    | 83 (23.1)                 | (18.8-27.7) |
| 30-day mortality§                                                      | 5 (1.4)                   | (0.5-3.2)  |
| Inpatient mortality, overall, among 63 patients admitted within 30 days of index ED visit† | 7 (11.1)                  | (4.6-21.6)  |
| Deaths, overall§                                                       | 9 (2.5)                   | (1.2-4.7)  |

§Four deaths occurred in the inpatient setting, including 3 at the study site and 1 at another hospital under unknown circumstances. A fifth death occurred a week after the index visit was reported by the oxygen vendor, but the location and circumstances of that death are unknown.

†In the worst-case scenario sensitivity analysis where all patients without 30-day follow-up were presumed to have died and/or been hospitalized, the 30-day rate of survival without unscheduled hospital admission would have been 78.9% (95% CI 74.3-83.0; n=284).

‡Although COVID-related respiratory complications were responsible for most hospitalizations; this category excludes 6 patients with unscheduled admissions within 30 days of the index ED visit for diagnoses not related to COVID-19, including cholecystitis, cholecystolithiasis, gallstone pancreatitis, dehydration, and angina (n=2).

*Patients were considered to have survived if there was documentation of a health care visit more than 30 days after the index ED visit (n=343) or, absent this, there was documentation that the patient had clinical improvement to the point that supplemental oxygen was discontinued at the time of their final documented follow-up (n=8). This calculation excluded the population lost to follow-up (n=4) in the numerator but included them in the denominator to provide a conservative survival estimate. In the worst-case scenario sensitivity analysis where all patients without 30-day follow-up were presumed to have died, the 30-day survival rate would have been 95.5% (95% CI 92.5 to 97.2; n=343).

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(1.9%) that Steel et al⁴ reported for a cohort of 677 patients with mild exertional hypoxia in New York. In addition, the proportion of patients in our study hospitalized within 30 days of the index visit (17.5%) is higher than the 12.7% observed by Steel et al; however, only 194 (28.7%) patients in the Steele study met the criteria for ED discharge with supplemental oxygen,⁵ and all had exertional oxygen saturations of ≥90%. In contrast, 1-third of patients in our study had nadir ED oxygen saturations of <90% and would have been admitted at the index visit per Steel’s study’s protocol. In addition, the observed inpatient mortality of 11.1% among the patients subsequently hospitalized compares favorably to the reported mortality of 15.8% for 20,736 hospitalized COVID-19 patients in the United States over a period overlapping the first 3-quarters of our study period, suggesting that patients subsequently requiring hospitalization may not have fared worse than if they had not been discharged at the index ED visit.⁶

Department of Health Services operationalized this program in a public safety-net hospital within a month of local pandemic onset utilizing existing resources and staff, suggesting that this program could reasonably be replicated in other systems. Discharging patients from the ED on supplemental oxygen prevented hospitalizations during a period of critical shortages of inpatient beds and increased ED and inpatient length of stays. For select patients, management of patients with COVID-19 and a new supplemental oxygen requirement from the ED may provide a viable option when inpatient capacity is limited, such as during pandemic surges or critical staffing shortages. Further investigation is needed to assess the effectiveness of the practice in other populations, as well as for novel variants, and in the current era where most people have been immunized or incurred natural immunity from prior COVID-19 infection.

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