





# New domiciliary supplemental oxygen therapy after hospitalisation for COVID-19 in metropolitan Chicago

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A knowledge gap exists in understanding the beneficial use and duration of domiciliary supplemental O<sub>2</sub> therapy among survivors of #COVID19 hospitalisation with persistent hypoxaemia upon discharge; hence, proper monitoring and evaluation are recommended <https://bit.ly/3HRIfxE>

Cite this article as: Kaul M, Gupta P, Kalra S, *et al.* New domiciliary supplemental oxygen therapy after hospitalisation for COVID-19 in metropolitan Chicago. *ERJ Open Res* 2022; 8: 00577-2021 [DOI: 10.1183/23120541.00577-2021].

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Received: 7 Oct 2021  
Accepted: 7 Feb 2022

## Abstract

**Background** A knowledge gap exists in understanding the beneficial use and duration of domiciliary supplemental oxygen (DSO) therapy among survivors of coronavirus disease 2019 (COVID-19) hospitalisations with persistent hypoxaemia upon discharge. The purpose of this single centre study was to begin to address this issue.

**Methods** In this retrospective study we report features of US military veterans residing in metropolitan Chicago with no prior DSO therapy who survived COVID-19 hospitalisation, were discharged on DSO and were followed for 6 months.

**Results** We found that the majority of the 65 elderly patients (median age, 70 years), predominantly obese Black males, who survived COVID-19 hospitalisations at the Jesse Brown VA Medical Center and were discharged on DSO did not undergo a formal 6-min walk test (6MWT) to re-assess ongoing ambulatory supplemental oxygen requirements (46 patients or 71%). Nonetheless, DSO therapy was discontinued in most patients predominantly within 8 weeks of hospital discharge (34 patients, 52%). In addition, a large proportion of patients, obese Black people in particular, who survived COVID-19 hospitalisations and were treated with DSO for at least 8 weeks thereafter developed post-acute sequelae of COVID-19 infection (PASC) (30 patients, 46%).

**Conclusions** Given these findings, we recommend that healthcare providers be appraised about proper monitoring and evaluation, including timely performance of 6MWT, of patients who survived COVID-19 hospitalisations and were treated with DSO for persistent hypoxaemia upon discharge. Whether obese Black males who survived COVID-19 hospitalisations and are treated with DSO thereafter have an elevated risk in developing PASC remains to be determined in larger, prospective studies.

## Introduction

It is well-established that long-term, domiciliary supplemental oxygen therapy is beneficial in some patients with distinct lung diseases [1–5]. To that end, a knowledge gap exists in understanding the attributes of domiciliary supplemental oxygen therapy among survivors of coronavirus disease 2019 (COVID-19) hospitalisations who were discharged with domiciliary supplemental oxygen therapy due to persistent hypoxaemia [6–9].

For instance, *CHOPRA et al.* [10] reported that only 32 out of 1250 survivors of COVID-19 hospitalisations in the State of Michigan (2.6%) required new domiciliary supplemental oxygen 60 days after discharge. *BANERJEE et al.* [11] found low 30-day all-cause mortality (1.3%) and hospital readmission rate (8.5%) among 621 patients with acute COVID-19 illness in the USA who were discharged from the hospital with



supplemental oxygen. However, the median follow-up of these patients was only 26 days thereby precluding assessment of long-term, domiciliary supplemental oxygen therapy. Moreover, whether these patients had new supplemental oxygen requirements upon hospital discharge was not addressed in this study. Finally, SHAH *et al.* [7] did not report new supplemental oxygen requirements among 60 patients prospectively followed for 12 weeks for respiratory outcomes after COVID-19 hospitalisations in Vancouver, Canada.

Given the paucity of studies addressing clinical management of new domiciliary supplemental oxygen therapy among survivors of COVID-19 hospitalisations with persistent hypoxaemia, the purpose of this single centre, retrospective study was to begin to address this knowledge gap. Here we report features of US military veterans residing in metropolitan Chicago with no prior domiciliary supplemental oxygen therapy who survived COVID-19 hospitalisations, were discharged with domiciliary supplemental oxygen therapy due to persistent hypoxaemia and were followed for 6 months.

## Methods

A retrospective review of VA Computerised Patient Record System (CPRS) of 285 veterans hospitalised at and discharged from the Jesse Brown VA Medical Center (JBVAMC) in Chicago, Illinois, between March 2020 and February 2021 for reverse transcriptase PCR-positive, acute COVID-19 illness was performed. These patients were identified using the JBVAMC registry of all patients tested at the JBVAMC for COVID-19 during this period. JBVAMC is a tertiary academic healthcare centre located in the near West Side neighbourhood of Chicago. It consists of a 220-bed facility (158 acute care beds) and four community-based outpatient clinics. The medical centre provides care to ~49000 veterans who reside in the City of Chicago and Cook County, Illinois, and in six counties in northwestern Indiana. It is a major teaching affiliate of Feinberg School of Medicine of Northwestern University and University of Illinois College of Medicine at Chicago. The study was approved by JBVAMC Institutional Review Board.

Patient data abstracted from CPRS comprised of demographics, comorbidities and hospital course. After hospital discharge, data collected from CPRS included flow rate and duration of domiciliary supplemental oxygen therapy, follow-up virtual and/or face-to-face clinic visits with healthcare providers, unscheduled visits to the emergency department, hospitalisations and documentation of post-acute sequelae of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection (PASC) symptoms (defined below) by healthcare providers at day 30, week 8, and from 8 weeks to 6 months thereafter. In each patient, the need for domiciliary supplemental oxygen upon hospital discharge was assessed by detailed medical history, clinical examination and pulse oximetry <88% at rest or during ambulation. Domiciliary supplemental oxygen, ancillary equipment, technical support, education, educational resources and regular home visits were provided to eligible patients by a single commercial vendor contracted by JBVAMC in accordance with Veterans Health Administration Directive 1173.13. Post-acute sequelae of SARS-CoV-2 infection was defined as symptoms and/or abnormalities associated with SARS-CoV-2 infection (*e.g.*, “brain fog” and shortness of breath) that persisted beyond 4 weeks of hospital discharge that were not present prior to the onset of SARS-CoV-2 and were not attributable to alternative diagnoses [12–16].

Descriptive statistics were used for primary analysis and are reported as mean $\pm$ SD, median with interquartile range (IQR) and per cent where appropriate.

## Results

### *Clinical course after hospital discharge*

We found that 65 of 285 patients (23%) with acute COVID-19 illness were discharged from JBVAMC with new domiciliary supplemental oxygen therapy during the study period. None had domiciliary supplemental oxygen therapy prescribed before contracting COVID-19 infection. Patient characteristics are depicted in table 1. They were elderly (median age, 70), obese, predominantly Black (69%) men (94%) (table 1). 68% had a history of smoking, and 19% reported smoking tobacco at the time of hospital admission. The predominant underlying comorbidities among this cohort were hypertension (83%), hyperlipidaemia (62%), diabetes mellitus Type 2 (49%), obstructive sleep apnoea (40%), COPD (29%) and gastro-oesophageal reflux disease (25%) (table 1).

During hospitalisation, two patients (3%) required invasive mechanical ventilation, seven (10%) noninvasive ventilation and 19 (29%) high-flow supplemental oxygen delivered with nasal cannulae. The remaining 37 patients required supplemental oxygen at flow rates  $\leq 5$  L $\cdot$ min $^{-1}$  or none. Mean length of hospital stay was 11 $\pm$ 10 days. All 65 patients were discharged from JBVAMC with a median supplemental oxygen flow rate of 2 L $\cdot$ min $^{-1}$  (IQR, 2–2 L $\cdot$ min $^{-1}$ ) either continually or during exertion (table 1).

**TABLE 1** Characteristics of patients discharged on new supplemental oxygen therapy (n=65)

<b>Baseline characteristics</b>	
Age years, median (IQR)	70 (62–74)
<b>Sex</b>	
Male	61 (94)
Female	4 (6)
<b>Race</b>	
African American	45 (69)
Caucasian	16 (25)
Other	4 (6)
<b>Smoking history</b>	
Current smoker	12 (19)
Previous smoker	32 (49)
Unknown	21 (32)
<b>Underlying comorbidities</b>	
Hypertension	54 (83)
Hyperlipidaemia	40 (62)
Obesity (BMI $\geq 30$ kg·m <sup>-2</sup> )	38 (59)
Diabetes mellitus Type 2	32 (49)
Obstructive sleep apnoea	26 (40)
Chronic obstructive pulmonary disease	19 (29)
Coronary artery disease	10 (15)
Gastro-oesophageal reflux disease	16 (25)
Chronic kidney disease	15 (23)
Non-lung cancer	9 (14)
Asthma	5 (8)
HFpEF	4 (6)
History of venous thromboembolism	4 (6)
HFrEF	3 (5)
Cirrhosis	3 (5)
Interstitial lung disease	2 (3)
Lung cancer	1 (2)
Solid organ transplant	1 (2)
Sarcoidosis	1 (2)
Connective tissue disease	1 (2)
<b>Index hospitalisation</b>	
Invasive mechanical ventilation	2 (3)
Noninvasive ventilation	7 (10)
High-flow nasal cannula	19 (29)
Length of stay days (mean $\pm$ sd)	11 $\pm$ 10
Supplemental oxygen on discharge L·min <sup>-1</sup> , median (IQR)	2 (2–2)

Data are presented as n (%) unless otherwise stated. IQR: interquartile range; BMI: body mass index; HFrEF: heart failure with reduced ejection fraction; HFpEF: heart failure with preserved ejection fraction.

All 65 patients were followed for 6 months after hospital discharge. Within 30 days of hospital discharge, 50 patients (77%) had at least one follow-up clinic virtual or face-to-face visit with a primary care physician (PCP) at JBVAMC. 18 patients (28%) had at least one unscheduled visit to the emergency department, and nine (14%) had at least one all-cause readmission to JBVAMC. No deaths were reported during this time frame (table 2).

Eight weeks after hospital discharge, 60 patients (92%) had at least one follow-up virtual or face-to-face clinic visit with a PCP at JBVAMC. 23 patients (35%) had at least one unscheduled visit to the emergency department, and 13 (20%) had at least one all-cause hospitalisation at JBVAMC during this time frame. Importantly, 43 patients (66%) reported PASC (table 2). No deaths were reported during this observation period.

From 8 weeks to 6 months after hospital discharge, 51 patients (79%) had at least one follow-up virtual or face-to-face clinic visit with a PCP, 31 (48%) had at least one unscheduled visit to the emergency department and nine (14%) had at least one all-cause hospitalisation at JBVAMC. At this time point, 17 patients (26%) had PASC-related visits to the emergency department or readmission at JBVAMC, and 29 (45%) had PASC

TABLE 2 Patient outcomes after hospital discharge (n=65)

Outcome	At 8 weeks n (%)		8 weeks to 6 months n (%)
	Within 30 days	30 days to 8 weeks	
<b>Healthcare utilisation and mortality</b>			
Primary care provider visits	50 (77)	60 (92)	51 (79)
Emergency department visits	18 (28)	23 (35)	31 (48)
Readmissions (all causes)	9 (14)	13 (20)	9 (14)
Mortality (all causes)	0 (0)	0 (0)	2 (3)
<b>Supplemental oxygen reassessment and utilisation</b>			
6-min walk test		4 (6)	15 (23)
Pulmonary clinic visit		26 (40)	15 (23)
Supplemental oxygen discontinued		34 (52)	10 (15)
Insufficient documentation		0	6 (9)
<b>PASC</b>			
Total with PASC (reported at PCP or ED visit)		nn (%%)	30 (46)
Reported during ED visits/readmissions		43 (66)	17 (26)
Reported to primary care provider		39 (60)	29 (45)

PASC: post-acute sequelae of COVID-19 infection; PCP: primary care physician; ED: emergency department; COVID-19: coronavirus disease 2019; nn (%%): aggregate not assessed for the group at 8 weeks.

reported to their PCPs (table 2). Two patients (3%) died during follow-up; both did not require high-flow nasal cannula or noninvasive or invasive ventilation during their index hospitalisation (table 2).

#### *New domiciliary supplemental oxygen therapy*

A 6-min walk test (6MWT) to assess ongoing requirement for domiciliary supplemental oxygen therapy was only performed in four patients prior to 8 weeks and 15 patients (23%) after 8 weeks from hospital discharge. Nonetheless, domiciliary supplemental oxygen therapy was discontinued in 34 patients (52%) within 8 weeks of hospital discharge (table 2), six of which had discontinuation of supplemental oxygen within 4 weeks of discharge. The number of patient referrals to the pulmonary clinic at JBVAMC during the 6-month observation period was <50% during each study period (table 2).

30 patients (46%), predominantly obese Black males with hypertension and hyperlipidaemia, who were discharged with domiciliary supplemental oxygen therapy reported PASC for at least 8 weeks after hospital discharge-reported PASC (table 3). Out of these, only 10 patients (33%) had documented supplemental oxygen discontinued by self or provider during the study period (from 4 weeks to 6 months of index COVID-19 hospitalisation). None required invasive mechanical ventilation during hospitalisation. 13 patients required supplemental high-flow oxygen therapy through nasal cannula or noninvasive ventilation. Nine patients (30%) were readmitted to JBVAMC within 30 days of hospital discharge, while 10 (33%) were readmitted within 8 weeks. Two patients who were treated with domiciliary supplemental oxygen and subsequently diagnosed with PASC died during follow-up (table 3).

#### **Discussion**

There are three new findings of this study. We found that the majority of elderly patients, predominantly obese Black males, residing in metropolitan Chicago who survived COVID-19 hospitalisations at JBVAMC, discharged on domiciliary supplemental oxygen due to persistent hypoxaemia, and followed for 6 months did not undergo 6MWT to re-assess the need for domiciliary supplemental oxygen. Nonetheless, oxygen therapy was discontinued in most patients predominantly within 8 weeks of hospital discharge. During this time frame, 92% of patients had at least one follow-up virtual or face-to-face clinic visit with a PCP. In addition, a large proportion of patients, obese Black men in particular, who survived COVID-19 hospitalisations and were treated with domiciliary supplemental oxygen for at least 8 weeks thereafter developed PASC. Given these data, we recommend that healthcare providers be appraised about proper monitoring and evaluation, including timely performance of 6MWT, of patients who survived COVID-19 hospitalisations and were treated with domiciliary supplemental oxygen for persistent hypoxaemia upon discharge. Whether obese Black males who survived COVID-19 hospitalisations and were treated with domiciliary supplemental oxygen thereafter are more prone to developing PASC remains to be determined in larger, prospective studies.

**TABLE 3** Characteristics of patients who reported PASC  $\geq 8$  weeks after hospital discharge (n=30)

Characteristics of patients with PASC	
Age years, median (IQR)	70 (63–76)
<b>Sex</b>	
Male	30 (100)
<b>Race</b>	
African American	21 (70)
Caucasian	6 (20)
Others	3 (10)
<b>Smoking history</b>	
Current smoker	8 (26)
Previous smoker	17 (56)
Unknown	5 (18)
<b>Comorbid conditions</b>	
Hypertension	25 (83)
Hyperlipidaemia	20 (66)
Obesity (BMI $\geq 30$ kg·m <sup>-2</sup> )	18 (60)
Diabetes mellitus Type 2	14 (46)
Obstructive sleep apnoea	12 (40)
Chronic obstructive pulmonary disease	10 (33)
Gastro-oesophageal reflux disease	10 (33)
Coronary artery disease	6 (20)
Chronic kidney disease	5 (16)
Non-lung cancer	4 (13)
HFpEF	3 (10)
Cirrhosis	3 (10)
Asthma	2 (6)
History of venous thromboembolism	2 (6)
HFrEF	2 (6)
Interstitial lung disease	1 (3)
Lung cancer	1 (3)
Solid organ transplant	1 (3)
Sarcoidosis	1 (3)
Connective tissue disease	1 (3)
<b>Index hospitalisation</b>	
Mean length of stay days (mean $\pm$ sd)	11 $\pm$ 10
Supplemental oxygen therapy	
In-hospital	
Noninvasive ventilation	3 (10)
High-flow nasal canula	10 (33)
Invasive mechanical ventilation	0
Flow rate (at hospital discharge) L·min <sup>-1</sup> , mean (IQR)	2 (2–3)
<b>Readmission and mortality outcomes</b>	
Readmission within	
30 days (all-cause)	9 (30)
30 days to 8 weeks (all-cause)	10 (33)
8 weeks to 6 months (all-cause)	5 (16)
Mortality (all-cause) <sup>#</sup>	2 (6)

Data are presented as n (%) unless otherwise stated. PASC: post-acute sequelae of COVID-19 infection; IQR: interquartile range; BMI: body mass index; HFrEF: heart failure with reduced ejection fraction; HFpEF: heart failure with preserved ejection fraction; COVID-19: coronavirus disease 2019. #: median time to death 130 days.

A recent large cohort study of US military veterans who survived COVID-19 hospitalisations found higher risk of persistent hypoxaemia 4 months after hospital discharge in comparison to veterans who survived influenza hospitalisations [14]. Because COVID-19 is a new disease entity, dedicated practice guidelines for managing domiciliary supplemental oxygen therapy in survivors of COVID-19 hospitalisations with persistent hypoxaemia have not been published as of yet [8, 17]. For instance, AYIOUBKHANI *et al.* [16] recently reported on 47780 patients with COVID-19 who were discharged from hospitals in the UK and followed for a mean of 140 days. Although the investigators found an increased rate of respiratory dysfunction in these patients compared with a matched control group, they did not address new domiciliary

supplemental oxygen therapy among them. Similar omissions are noted in recent large cohort studies of patients with COVID-19 conducted in China and Switzerland [9, 18].

A prospective, single site observational cohort study of 152 patients who survived COVID-19 hospitalisation in New York City, NY and were followed for a median of 37 days found that 52 (34%) had a new supplemental oxygen requirement at discharge [19]. 20 patients still required 1–2 L·min<sup>-1</sup> supplemental oxygen during the ensuing short follow-up. These figures are similar to those reported in the current study. Finally, LOERINC *et al.* [20] reported new domiciliary oxygen therapy in 41 out of 310 patients (13.2%) hospitalised for COVID-19 in an academic medical centre in Atlanta, GA within 30 days of discharge. However, no additional details about ongoing need for supplemental oxygen after this time point were provided. Taken together, these studies highlight the urgent need to establish a practice guideline for domiciliary supplemental oxygen therapy in survivors of COVID-19 hospitalisations with persistent hypoxaemia after discharge.

The limitations of our retrospective study are obvious, including single medical centre in metropolitan Chicago, small sample size, male predominance and no matched control group. This limits the generalizability of our observations and limits our ability to elucidate the possible roles of comorbid conditions and tobacco smoking as risk factors for developing PASC. We also recognise that most outpatient encounters reported in this study occurred remotely using telehealth-enabled technology due to the ongoing COVID-19 pandemic in metropolitan Chicago. This may have limited formal health assessment, including ongoing need for supplemental oxygen, of our patients. Nonetheless, we have addressed this issue, in part, by extending the study period to 6 months after hospital discharge thereby facilitating patient access to primary care providers at JBVAMC. In addition, interrogation of CPRS, JBVAMC-specific robust electronic health record, enabled us to capture all post-discharge clinic and virtual visits of our patients along with complications observed during this time frame. Moreover, the commercial vendor contracted by JBVAMC provided regular delivery of oxygen tanks or concentrators and supplies along with home visits to patients' residences thereby promoting adherence with prescribed supplemental oxygen therapy.

Finally, the results of this study underscore the need to develop, implement and disseminate cost-effective, wireless, telehealth-enabled technologies to monitor patients who survived COVID-19 hospitalisations with limited access to clinic visits after discharge for actual need for domiciliary supplemental oxygen therapy.

In summary, we recommend that healthcare providers be appraised about proper monitoring and evaluation, including timely performance of 6MWT, of patients who survived COVID-19 hospitalisations and were treated with domiciliary supplemental oxygen for persistent hypoxaemia upon discharge. Whether obese Black males who survived COVID-19 hospitalisations and treated with domiciliary supplemental oxygen thereafter are more prone to develop PASC and if use of domiciliary supplemental oxygen is associated with development or persistence of PASC remains to be determined in larger, prospective studies.

Provenance: Submitted article, peer reviewed.

Conflict of interest: None of the authors has declared any conflict of interest that may arise from being named as an author of this manuscript.

Support statement: This work was supported, in part, by grants I50 CU000179-01 (to I. Rubinstein) and IIR 12-050 (to H.S. Gordon) from the US Dept of Veterans Affairs, and by grant ILHHU0049-19 from the US Dept of Housing and Urban Development (I. Rubinstein). The views expressed in this article are those of the authors, and do not necessarily reflect the position or policy of the Depts of Veterans Affairs or Housing and Urban Development, or the US Government. Funding information for this article has been deposited with the Crossref Funder Registry.

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