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RESEARCH PAPER

Predictors of Duration and Demand of Oxygen Therapy in Hospitalized RT-PCR Positive COVID-19 Patients

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Abstract

Background: Among many unexplored and challenging areas of COVID-19, pathophysiology of hypoxia and its management requires special attention for the physicians. The current study aimed to find the predictors of duration and demand of oxygen therapy in RT-PCR positive, hospitalized, COVID-19 patients.

Methods: It was a prospective, multicentered, observational study conducted at Chattagram International Medical College (Isolation Ward, CIMC), Chattogram Medical College (COVID Red Zone) and Parkview Hospital Limited (COVID-19 Ward) from January to June 2021 on hospitalised, RT-PCR positive cases of COVID-19 patients of 18 yrs or above who required supplemental oxygen therapy and gave informed consent to be included in the study. All the participants underwent chest HRCT on initial presentation.

Results: In this study, 85 consecutive patients of confirmed COVID-19 were recruited under the study. Patients required oxygen for a median duration of 6 days and median value of the maximum oxygen requirement was 7 L/min with a range between 1-100 l/min. In patients with no co-morbidity, one co-morbidity and more than one comorbidity, the median duration of oxygen therapy were 4.5 (3.0-7.8) hours and 7.0 (5.0-14.3) hours respectively. Multiple regression was run to predict maximum oxygen duration and maximum oxygen required for the patients from gender, age, smoking pattern, number of comorbidity and HRCT score; only total number of comorbidity and HRCT severity score added statistically significantly to the prediction, $p < 0.05$.

Conclusion: The results of the study might be helpful in triage of COVID-19 patients, planning as well as clinical decision making.

Keywords: Oxygen therapy, duration and demand, hospitalized COVID -19 patients.

Introduction

Coronavirus disease 2019 (COVID-19) is a potentially fatal infection caused by the novel severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). The COVID-19 pandemic has been much more than a health crisis, creating tragic and devastating milestones in each sector with huge loss as well as long-standing impacts. [1-2] Among many unexplored and challenging areas of COVID-19, pathophysiology of hypoxia and its management requires special attention for the physicians.[3] The cut-off value of target oxygen requirement for COVID-19 is still a mystery and it varies from patient to patient. However; a target SpO_2 of 92% to 96% seems logical, some indirect evidence from patients without COVID-19 suggested that an SpO_2 of <92% or >96% might be harmful.[4,5] Initially oxygen was considered a low-cost, life saving therapy for COVID-19; however, inadequate availability of oxygen in face of rapidly expanding epidemic created the limitations in management of critical patients.[6-9] Due to SARS-CoV-2 mediated

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pathophysiological events partially explained by shunt or ventilation-perfusion mismatching, some of the patients were predicted to require a higher level of care with supplemental oxygen therapy in hospitals or intensive care units.[10,11]

A non-contrast High resolution CT (HRCT) chest imaging plays a pivotal and essential role in the early disease detection. Multiple studies have explored the pulmonary involvement on the chest CT images using both visual and software quantitative assessments.[12-14]

The COVID-19 was first identified in China on December 2019; it was declared to be a pandemic by world health organization on March 11, 2020.[15] In Bangladesh, the first case of coronavirus was identified on March 8, 2020 and as of December 2021, a total of 513510 cases were identified with 28072 deaths. [16] In poor resource setting, a measurement of duration of supplemental oxygen and its predictors might help in identifying the high risk patients who would need prolonged oxygen support; it would also assist in deciding on building infra-structure as well as need-based distribution of hospital resources.[17-20] The current prospective, multi-centred study aimed to find the association between duration and demand of oxygen therapy with co-morbidities and chest HRCT findings of confirmed COVID-19 patients.

Materials and Methods

It was a prospective, multicentered, observational study conducted at Chattagram International Medical College (Isolation Ward, CIMC), Chattogram Medical College (COVID Red Zone) and Parkview Hospital Limited (COVID-19 Ward) from January to June 2021. The objective of the study was to find out the predictors of duration and demand of oxygen therapy in hospitalized, RT-PCR positive COVID-19 cases. This study included hospitalized, RT-PCR positive cases of COVID-19 patients of 18 years or above who required supplemental oxygen therapy and gave informed consent to be included in the study. Pregnancy, present or past history of pulmonary tuberculosis and lung malignancy were excluded from the study. As per operational definition in this study, supplemental oxygen requirement was defined when oxygen saturation (Sp02) was d" 93% in room air and getting off supplemental oxygen was defined when oxygen saturation (Sp02) was > 93% in room air. Sample size was calculated 85.

$$n = \frac{(Z\alpha + Z\beta)^2}{C^2} + 3$$

$$C = 0.5 \times In\left[\frac{(1 + r)}{(1 - r)}\right]$$

Where,

Zá= Z- value of standard normal distribution for a level of confidence

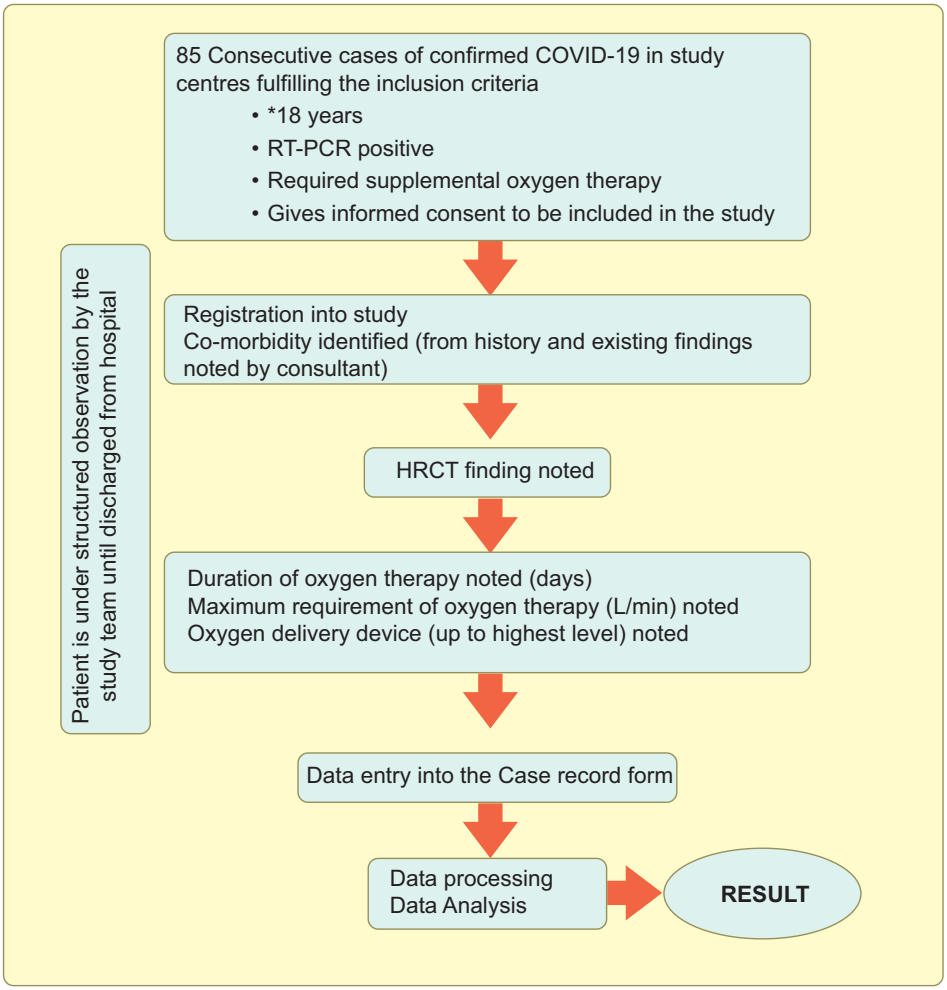
Zâ= Z- value of standard normal distribution at a given power

r = correlation coefficient between HRCT severity score and maximum level of oxygen requirement

Here, the calculated sample size came out 85.

So, 85 consecutive patients of confirmed COVID-19 in the participating centers who fulfilled the inclusion criteria were recruited under the study. The members of study team observed the patients to note the demographic information, co-morbidity, chest HRCT findings, maximum requirement of supplemental oxygen, oxygen delivery device and duration of oxygen therapy; the case record form was filled in accordingly. All the participants underwent chest HRCT on initial presentation using SIEMENS SOMATOM PERSPECTIVE 128 SLICES CT-SCAN machine. During the scan, patients were placed in a supine position with single breath held on inspiration. Scanning parameters were scan direction (craniocaudally), tube voltage (130KV), tube current (100MA) slice collimation (64 × 0.625 mm), width (52 × 512 mm), pitch (1), rotation time (1s, 0.6s, 0.48s), scan length (60.00 – I300.00 s). Two radiologists with more than 5 years of experience evaluated the images to determine the percentage of lung opacification, severity score, number of lobes affected and predominant radiological findings in each patient. In the case record form, the investigator also noted the day of symptom on the day of doing HRCT test. The case record forms were completed and signed after the patient got off supplemental oxygen or discharged from hospital with supplemental oxygen or died while with supplemental oxygen. After completion of all 85 case record forms, data entry, processing and analysis were performed by SPSS version 23.

Flow chart



Results

Among 85 participants, age of the patients ranged from 20 to 85 years with a mean age of 58.7±15.4 years. Around half of the patients (50.6%) were in the geriatric age group. Male were slightly more than female (55.4% and 44.7%). Duration and demand of oxygen therapy in the studied patients are presented in Table I.

Table I: Duration and demand of oxygen therapy of the patients (n=85)

Duration of oxygen therapy, days		
	Median (IQR)	6.0 (4.0-11.0)
	Range	1-26
Maximum requirement of Oxygen (L/min)		
	Median (IQR)	7 (3.8-15.0)
	Range	1-100
Oxygen Delivery Device		
	Nasal prong	41 (48.2)
	Face mask	27 (31.8)
	HFNC	16 (18.8)
	NIPPV	1 (1.2)
Discharged with supplemental oxygen	2 (2.4)	
Died with supplemental oxygen	7 (8.2)	

Data were expressed as frequency (%) if not mentioned otherwise.

It depicted that, patients required oxygen for a median duration of 6 days and median value of the maximum oxygen requirement was 7 L/min with a range between 1-100 l/min. Out of 85 patients, 7 (8.2%) patients expired in hospital and another 2 (2.4%) patients were discharged along with oxygen at home. Median (IQR) duration of oxygen therapy in patients with no comorbidity was 3.0 (3.0-4.0) hours. In patients with one and more than one comorbidity the corresponding values were 4.5 (3.0-7.8) hours and 7.0 (5.0-14.3) hours respectively. These differences were statistically significant (Figure 1).

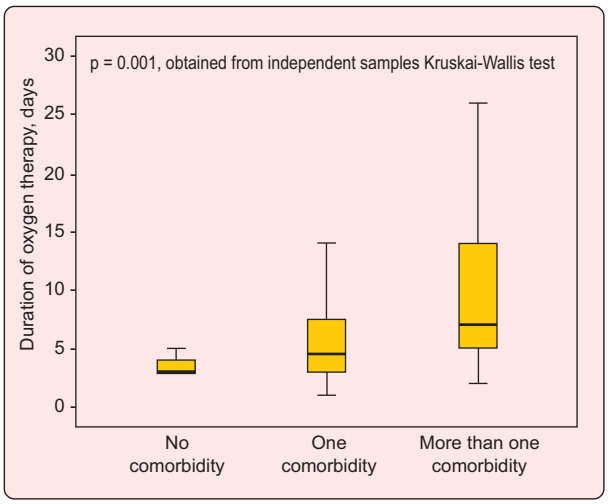


Figure 1: Relation between comorbidity pattern and duration of oxygen therapy

In this study there was a significant positive correlation between total percentage of lung involvement in HRCT and duration of oxygen requirement (r=0.462, p <0.001) (figure 2).

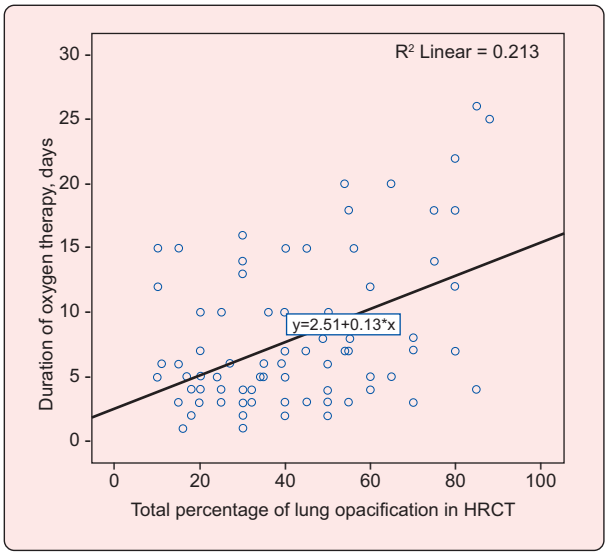


Figure 2: Correlation between total percentage of lung opacification in HRCT and duration of oxygen therapy

There was a significant positive correlation between total percentage of lung involvement in HRCT and maximum oxygen requirement (r=0.466, p <0.001). (Figure 3).

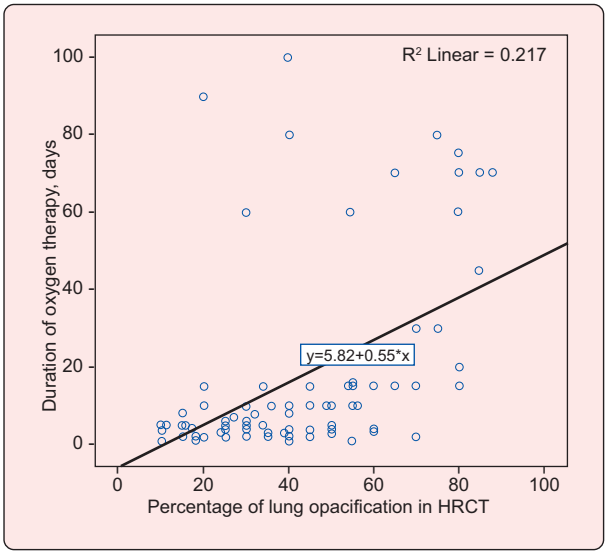


Figure 3: Correlation between total percentage of lung opacification in HRCT and maximum oxygen requirement

A multiple regression was run to predict duration of oxygen therapy required by the patients from gender, age, smoking pattern, number of comorbidity and HRCT score. These variables statistically significantly predicted duration of oxygen therapy required by the patients, $F(5, 79) = 8.804$, $p < 0.001$, $R^2 = 0.337$. However, out of five variables only total number of comorbidity and HRCT severity score added statistically significantly to the prediction, $p < 0.05$. (Table II).

A multiple regression was run to predict maximum oxygen required for the patients from gender, age, smoking pattern, number of comorbidity and HRCT score. These variables statistically significantly predicted maximum oxygen therapy required by the patients, $F(5, 79) = 8.456$, $p < 0.001$, $R^2 = 0.351$. However, out of five variables only total number of comorbidity and HRCT severity score added statistically significantly to the prediction, $p < 0.05$. (Table III)

Table II: Multiple regression analysis to determine the predictors for duration of oxygen therapy

Variables	Standardized Coefficients Beta	95.0% CI for Beta Lower Bound	95.0% CI for Beta Upper Bound	p value
Age in years	-0.027	-0.088	0.067	0.795
Female sex	-0.189	-4.491	0.085	0.059
Smoker	0.068	-2.318	4.780	0.492
Number of comorbidity	0.355	0.768	2.819	0.001
HRCT score, %	0.313	0.134	0.527	0.001

Dependent Variable: Duration of Oxygen therapy; CI: Confidence interval.

Table III: Multiple regression analysis to determine the predictors for maximum requirement of oxygen therapy

Variables	Standardized Coefficients Beta	95.0% CI for Beta Lower Bound	95.0% CI for Beta Upper Bound	P value
Age in years	-0.188	-0.621	0.022	0.068
Female sex	-0.104	-14.575	4.416	0.290
Smoker	0.060	-10.205	19.253	0.543
Number of comorbidity	0.370	3.583	12.092	<0.001
HRCT score, %	0.399	0.950	2.581	<0.001

Dependent Variable: Maximum Oxygen required; CI: Confidence interval.

Discussion

This study analyzed the data collected from RT-PCR positive COVID-19 patients of 18 years or above who required supplemental oxygen; the sample was representative from one government medical college hospital, one non-government medical college hospital and one private hospital of Chattogram, Bangladesh. The median of duration and maximum requirement of oxygen were higher in patients suffering from one or more co-morbidities. Multiple regression analysis to predict duration of oxygen therapy and total requirement of oxygen revealed that total number of comorbidity and HRCT severity score added statistically significantly to the prediction (p <0 .05). In a study performed on 172 Iraqi COVID-19 patients, strong positive correlation was seen between CT severity score and male gender (p value = 0.0002 and R2= 0). [21] In a retrospective study performed on 130 symptomatic SARS-CoV-2 patients in Rome, Italy, CT score was significantly higher in severe and critical disease the in mild disease (p< 0.0001). [22] In a retrospective study conducted on COVID-19 patients at Abu Dhabi, UAE, significant correlation was found between CT severity score and male gender, maximum oxygen requirement, length of hospital stay, raised inflammatory marker .[23] All the above studies reflect higher CT severity score in more critical patients. The results of the current study might be helpful in triage of COVID-19 patients, better understanding of clinical outcome as well as clinical decision making.

Acknowledgement

This study was funded by Chittagong Medical University

Conclusion

Hypoxia and its management is one of the mysterious as well as challenging areas of COVID 19. The current paper described a prospective, multicentered, observational study conducted on 85 consecutive patients of confirmed COVID-19 admitted in the participating centers who required supplemental oxygen and fulfilled the inclusion criteria. The results of the study might be helpful in triage of COVID-19 patients, better understanding of clinical outcome, clinical decision making as well as future research on a broader scale.

Conflict of Interest: The authors did not have any conflict of interest.

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Ethical approval: Chittagong Medical College, Chattogram, Bangladesh.

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