MAK HILL Publications Research Journal of Medical Sciences

Research Article
doi: 10.59218/makrjms.2024.4.77.82

Respiratory Rate and Oxygenation Index in Morbidity and Mortality assessment of Covid-19 patient in Emergency Department

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OPEN ACCESS

Key Words
ROX index, pneumonia , emergency

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Received: 25 November 2023
Accepted: 31 December 2023
Published: 4 January 2024

Citation: H. Shananth Saravanan, A. Sirmela, S. Arthi Rajakantham and M. Abdussamad, 2024. Respiratory Rate and Oxygenation Index in Morbidity and Mortality Assessment of Covid 19 Patient in Emergency Department. Res. J. Med. Sci., 18: 77-82, doi: 10.59218/makrjms. 2024.4.77.82

ABSTRACT

The ROX index, a score that has been used to predict HFNC outcomes in COVID-19 patients. Several studies assessed the accuracy level of the ROX index for predicting HFNC failure but the results are inconsistent therefore generalizing requires further confirmation and verification by various studies in different settings. Thus, the following study has been conducted for evaluating the reliability of the ROX index in morbidity and mortality assessment of covid 19 patients. An observational study was done from the period of September 2020 to November 2020 among COVID-19 positive patients attending emergency OPD. individuals who are RT-PCR positive of COVID-19 and CT-chest CORADS classification 5 and 6 were included in the study. Those patients with non-COVID pneumonia and patients with the known pulmonary disease were excluded from the study. In our study, 534 individuals have participated. The mean age of the study participants was 53.26 years with a standard deviation of 14.615 years. Increasing values of age, CT-chest severity score, and respiratory rate have a highly, statistically, significant negative correlation with the ROX index ($p<0.001$). high respiratory values have a statistically significant positive correlation with duration of stay in the hospital ($p = 0.001$). The ROX index has a statistically significant association with severe COVID 19 disease and can be used as a reliable method in the emergency department for predicting the need for ventilation support.

INTRODUCTION

Coronavirus illness 2019 (COVID-19) has wreaked havoc on global socioeconomic situations and claimed the breaths of over 4.2 million individuals up to September 2020[1]. The treatment of COVID-19 patients with acute hypoxemic respiratory failure (AHRF) is important for their survival. High-flow nasal cannula therapy (HFNC) is a non-invasive procedure and becoming more common in the treatment of acute hypoxemic respiratory failure (AHRF) and during the COVID-19 pandemic[2]. Due to a scarcity of ICU beds, HFNC has been widely employed outside the ICU in this pandemic circumstance[3], especially in low-resource countries[4]. Unfortunately, several patients have experienced HFNC failure in the therapy of AHRF, which has resulted in symptoms worsening[5]. In individuals with ARF, failure of HFNC may result in delayed intubation and higher death rates[6]. As a result, early detection of HFNC failure during the acute phase of AHRF may improve clinical care and patient classification for effective treatments. The predictive efficacy of the Sequential Organ Failure Assessment (SOFA) score and the acute physiology and chronic health evaluation (APACHE II) score for anticipating HFNC failure has recently been investigated in a few studies[7-9]. The ROX index, a score that was used to predict HFNC outcomes in COVID-19 patients, is a metric that was used to manage pneumonia and acute respiratory distress syndrome (ARDS)[10]. The ratio of pulse oximetry/fraction of inspired oxygen (SpO2/FiO2) to respiratory rate is known as the ROX index (RR). When this score is 4.88 at 12 hrs, a study conducted by Roca *et al.*[11] concluded that the patients are at high risk of HFNC failure. The same threshold was also validated in COVID-19 patients, which can be applied for predicting the need for intubation[12]. Several studies assessing the accuracy level of this index for predicting HFNC failure have been reported during the COVID-19 pandemic but the results are inconsistent because to variances in the clinical environment, cut-off employed and diverse population, therefore generalizing about a threshold value of ROX index to forecast HFNC successfulness requires further confirmation and verification by various studies in different settings[13,14]. With this background, the following study has been conducted with the objective of evaluating the reliability of ROX index in morbidity and mortality assessment of covid 19 patient in Emergency Department.

MATERIALS AND METHODS

A cross-sectional observational study was done in Vinayaka Missions Kirupananda Variyar (VMKV) Medical College, Salem from the period of September 2020 to November 2020 among COVID-19 positive patients attending emergency OPD. Ethical clearance was obtained from the institutional ethical committee, V.M.K.V. Medical College and Hospital, Salem. After obtaining the informed consent, individuals show the result as RT-PCR positive of COVID-19 and CT-chest CORADS classification 5 and 6 were included in the study. Those patients with non-COVID pneumonia and patients with the known pulmonary disease were excluded from the study. Since the prevalence of critically ill patients among COVID-19 positive patients is 10.5 percent (according to the study conducted by Lian *et al.*[15] the minimum sample size required is 100 with a 95% confidence level and 6 percent absolute error. The ROX index was estimated by using the formula ROX = (SpO2/FiO2)/RR, where, FIO2 is calculated by using the formula FIO2 = 20% + (4 x O2 in Liter flow) in which 1 litre is considered as 24 percent. The data were entered in Microsoft excel and results were analyzed by using SPSS version 21.

RESULTS

In our study, totally, 534 individuals have participated. The mean age of the individuals was 53.26 years with a standard deviation of 14.615 years. Age distribution and gender distribution of the individuals were shown in fig. 1 and fig. 2 respectively. The distribution of individuals according to the RT-PCR report and CT-chest severity score category is shown in fig. 3 and fig. 4 respectively. The average SpO2 levels, respiratory rate and duration of hospital stay of the study participants are shown in Table 1. The distribution of the ROX index among the study participants is shown in fig. 5. The distribution of study participants according to the ventilator support in the treatment is shown in fig. 6. The prevalence of diabetes and hypertension among the study participants is 30.8 and 18.9 percent. The prevalence of comorbidity among the study participants is described in Table 2. Increasing values of age, CT-chest severity score and respiratory rate have a highly, statistically, significant negative correlation with the ROX index ($p<0.001$). high respiratory values have a statistically significant positive correlation with duration of stay in the hospital ($p = 0.001$). This correlation is shown in Table 3. Among the study participants having respiratory rate less than 26 beats per minute, about 93.3 percent of individuals don't need ventilatory support when compared to the participants having respiratory rate more than and equal to 26 beats per minute. This difference in the proportion is statistically significant ($p<0.001$) according to the chi-square test. Association between general characteristics and ventilator support among the study participants is shown in Table 4. When comes to the ROX index the mean difference between the individuals having respiratory rate below 26 bpm and individuals having respiratory rate more than and equal to 26 bpm was 5.759 and this difference is statistically significant by using an independent T-test

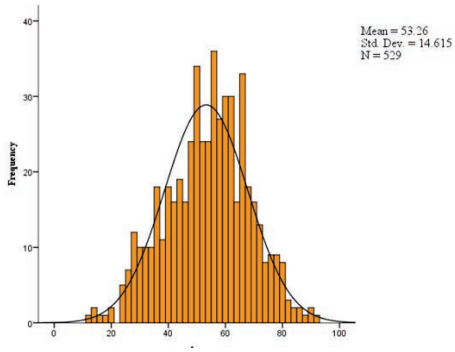

Fig. 1: Age distribution of the study participants (n = 53)

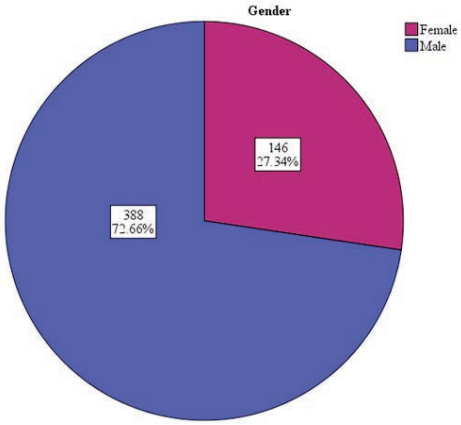

Fig. 2: Gender distribution of the study participants (n = 53)

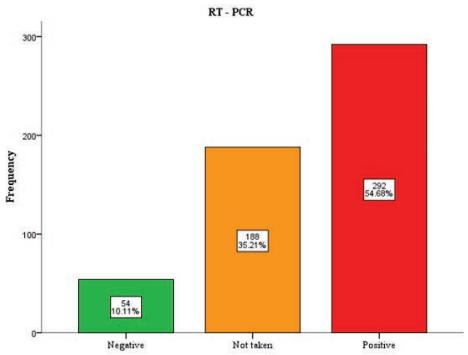

Fig. 3: Distribution of individuals according to the CT-chest severity score category (n = 534)

(p<0,001). Similarly, the mean difference between the individuals classified as not severe according to CTSS and individuals classified as severe was 4.06 and this difference is statistically significant by using the independent T-test (p<0,001). The association between general characteristics and ROX index among the study participants is shown in (Table 5).

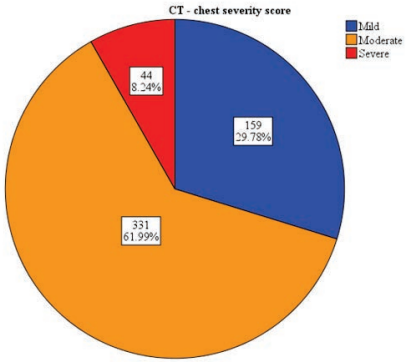

Fig. 4: Distribution of individuals according to the CT-chest severity score category (n =534)

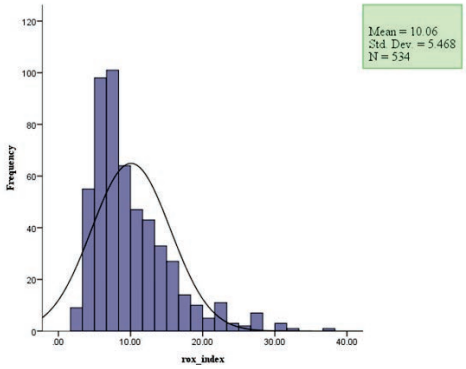

Fig. 5: Distribution of ROX index among the study participants: (n = 534)

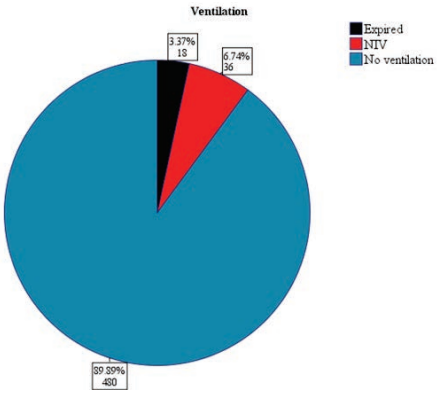

Fig. 6: Distribution of study participants according to the ventilator support

DISCUSSIONS

In our study, most of the participants were male (72.66%). Similarly, a study done by Beydogan *et al.*[16] among 974 COVID 19 patients, states that 58.7 percent of patients were males. This may be owing to the differences in the disease exposure in different gender. In our study, about 54.68 percent of individuals had identified as positive for COVID-19 by RT-PCR swab test. Similar results were given by Shalekamp *et al.*[17]

Table 1: Distribution of variables among the study participants: (n=534)

	Respiratory rate	Oxygen saturation	Duration of hospital stay
Mean	21.01	92.83	11.03
Std. deviation	4.954	5.730	3.670
Median	20.00	94.00	10.00
Inter quartile range	18 to 23	90 to 97	8 to 14
Mode	18	98	14
Minimum value	12	65	2
Maximum value	48	99	20

Table 2: Distribution of comorbidity among the study participants: (n=534) (multiple options)

Comorbidity	Frequency	Percentage
Bronchial asthma	7	1.3
Hypertension	101	18.9
Diabetes	165	30.8
Cardiovascular disease	16	2.9
Hypothyroid	10	1.8
Epilepsy	1	0.1
No comorbidity	303	56.7

Table 3: Correlation between risk factors and ROX index and Duration of hospital admission: (n=534)

Age	ROX index	Duration of hospital stay
Pearson Correlation	- 0.307	0.032
p-value	<0.001	0.459
CTSS		
Pearson Correlation	- 0.477	- 0.105
p-value	<0.001	0.015
Respiratory rate		
Pearson Correlation	- 0.520	0.143
p-value	<0.001	0.001

Table 4: Association between general characteristics and ventilator support among the study participants (n=534)

	Ventilation				
Variable	Expired n (%)	NIV n (%)	No ventilation n (%)	Chi-square test	p-value
Gender					
Female	7 (4.8)	11 (7.5)	128 (87.7)	1.505	0.471
Male	11(2.8)	25 (6.4)	352 (90.7)		
Comorbidity					
No	9 (3)	19 (6.3)	275 (90.8)	0.623	0.732
Yes	9 (3.9)	17 (7.4)	205 (88.7)		
RT-PCR					
Negative	2 (3.7)	5 (9.3)	47(87)	3.172*	0.523
Positive	8 (2.7)	16 (5.5)	268 (91.8)		
Not taken	8 (4.3)	15 (8)	268 (91.8)		
CTSS					
Mild	7(4.4)	8 (5)	144 (90.6)	6.222*	0.158
Moderate	10 (3)	28 (8.5)	293 (88.5)		
Severe	1(2.3)	0 (0)	43 (97.7)		
Respiratory rate					
Less than 26 BPM	11(2.5)	18 (4.1)	407 (93.3)	32.296	< 0.001
More than or equal to 26 bpm	7 (7.1)	18 (18.4)	73 (74.5)		

*Fischer exact test value

Table 5: Association between general characteristics and ROX index among the study participants (n=534)

		ROX index		
Variable	Total participants (n)	Mean	Mean difference	p-value
Sex				
Male	388	9.90	- 0.601	0.258
Female	146	10.50		
Comorbidity				
Yes	231	9.82	- 0.420	0.379
No	303	10.24		
Respiratory rate				
Less than 26 bpm	436	11.11	5.759	< 0.001
More than or equal to 26 bpm	98	5.36		
CT category				
Not severe	490	10.3947	4.06	<0.001
Severe	44	6.3355		

in a study done among 1070 patients, as the positive rate is 50 percent. This questions the reliability of RT-PCR in diagnosing COVID-19, especially in travel to foreign countries. The prevalence of severely ill patients according to CT-chest severity score in our study is 8.24 percent. In contrast to this study, a qualitative study done by Devie *et al.*[18] in France, among 108 individuals in April 2020, concluded that 36.7 percent were severe cases. Another study conducted by Li *et al.*[19] among 53 patients in November 2020, also conclude that the prevalence of severe cases was 66 percent. This could be due to the reduction in the severity of the disease in recent months. This may be due to the COVID-19 vaccination

drive worldwide. In our study, the prevalence of diabetes and hypertension was 30.8 percent and 18.9 percent. Similarly, a study done by Bhatt *et al.*[20] among 375 hospitalized patients in New jersey in march 2020, states that the prevalence of diabetes among COVID-19 patients was 34.9 percent. The same study concludes in contrast to our study in the prevalence of hypertension as 58.4 percent. But the comorbidities have a significant association with severe disease. Though, in our study, there is no statistical significance between comorbidity and ventilatory support or ROX index scores. These differences could be due to differences in the sample size and sampling method. This needs further research. A multicentric study done by Vega *et al.*[10] among patients under non-invasive ventilation, states that the ROX index is 96 percent specific and 62 percent sensitive when the threshold level is fixed at 5.99, and below that level, there is statistical significance for the failure of high flow nasal cannula (HFNC). In our study, there is a statistically significant association between CTSS severe category and ROX index and also there is a statistically significant negative correlation with CT severity sores. This indicates the predictive and prognostic nature of the ROX index for patients in non-invasive ventilation. Similarly, a systematic review done by Prakash *et al.*[21] in Jharkhand, India, concludes that the ROX index is 70 percent sensitive and 79 percent specific in predicting HNFC failure. Thus, the ROX index has good discriminating power in individuals having acute hypoxemic respiratory failure (AHRF). In our study, the minimum sample size was met. The data were collected by only the principal investigator, thus eliminating the interviewer bias. Though, this is a cross-sectional study so the associations found in the study cannot be considered as causative factors. This is a hospital-based study, thus the results cannot be generalized to the community due to the different rates of admission of patients in the hospital.

CONCLUSION

The ROX index has a statistically significant association with severe COVID 19 disease and can be used as a reliable method in the emergency department for predicting the need for ventilation support.

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