Significance of Patient's Age as a Determinant and Vaccination Status in Assessing the Severity of COVID-19 Pneumonia Based on CT Severity Scoring System

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Abstract

Aims: To identify the significance of patient's age as a determinant and vaccination status in assessing the severity of COVID-19 pneumonia based on the CT severity scoring system.

Method: This study's methodology was an observational study conducted on 160 COVID-19 patients between September to December 2021 at the Department of Radiology at Pondicherry Institute of Medical Sciences, Puducherry, India. The COVID-19 pneumonia study patients were observed and investigated, and the results were recorded.

Results: A total of 160 COVID-19 pneumonia patients were checked for the severity score by CT scan using a 25-point scoring system, and 53 study patients were with mild diseases severity, among them 37 (69.8%) study patients were ≤50 years of age, and 16 (30.2%) were >51 years with statistical significance of (Chi-square-4.9150, p value-0.0266). 67 COVID-19 pneumonia patients were with moderate diseases severity, among them 39 (58.2%) study patients were ≤50 years of age, 28 (41.8%) were >51 years, and among the 40 COVID-19 pneumonia patients showed severe disease severity, 16 (40.0%) were ≤50 years of age, and 24 (60.0%) were >51 years with statistical significance of (Chi-square-6.684, p value-0.01).

Among the 160 study COVID-19 pneumonia patients, 80 study patients were vaccinated and 80 were un-

vaccinated. Among the 80 vaccinated patients, 52 (65.0%) were ≤50 years of age, and 28 (35.0%) were >51 years with statistical significance of (Chi-square-3.683, p value-0.0450). Among the 80 vaccinated COVID-19 pneumonia patients, 50 received single dosages, and 30 received double dosages of vaccines. Among the 80 un-vaccinated patients, 40 (50.0%) each was ≤50 years of age, and >51 years with statistical significance of (Chi-square-3.683, p value-0.0450).

Among the 160 COVID-19 pneumonia study patients, 98 patients had co-mobilities, among them 38 (38.8%) patients were ≤50 years of age, and 60 (61.2%) patients were >51 years with statistical significance of (Chi-square-36.28, p value-0.0001). Among the 38 COVID-19 pneumonia patients who did not have any co-morbidities 54 (87.1%) patients were ≤50 years of age, and 8 (12.9%) patients were >51 years with statistical significance of (Chi-square-36.28, p value-0.0001).

Among the 98 COVID-19 pneumonia patients, hypertension was found in 39 study patients, DM was found in 33 patients, CKD, and CAD each was found in 7 patients respectively, and all these 7 patients were in the age group of >51 years with statistical significance of (Chi-square-3.177, p value-0.0458). RA was also one of the co-morbidities in 5 COVID-19 pneumonia patients, and hypothyroidism was found in 7 patients.

Conclusions

Based on CT severity scoring system, we have categorized disease severity in patients with COVID-19 pneumonia into mild, moderate and severe categories. In our study, we found that the disease severity in vaccinated patients was low as compared to non vaccinated patients. Similarly, patients with co-morbid conditions possessed a greater risk as compared to those without them. However, irrespective of the vaccination status/presence of co-morbid conditions, the age of the patient was found to be an important determinant in predicting the course and complications of the illness, and hence, must be considered during initial patient assessment.

Keywords: COVID-19, Pneumonia, Vaccination, Diseases Severity, Computed Tomography (CT), Hypertension, Diabetes Mellitus (DM).

Introduction

In December 2019, a new pandemic infectious disease, called COVID-19 pneumonia occurred by a new coronavirus (SARS-CoV-2), in Wuhan, Hubei Province, China, and crossed his infection across the globe crossing boundaries[1]. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) caused the COVID-19 pandemic and strained the capacity of health systems all over the world[2]. Several studies reported that a significant percentage of COVID-19 patients have underlying diseases.

COVID-19 patients presented with various symptoms such as fever, fatigue, and dry cough are mild at 80%, but COVID-19 patients with respiratory failure were considered as very severe cases that require extensive intervention[6]. The severity and complications of COVID-19 diseases are related to how long COVID-19 diseases last, for mild cases, symptoms were present for 2 weeks, and in severe cases, the symptoms lasted for 3 to 6 weeks[7]. COVID-19 reports also show that the COVID-19 residual effects are fatigue, shortness of breath, cognitive impairment, joint pain, and learning impairment of life11[8,9].

For mild COVID-19 cases, treatment options were antibiotics, antipyretics, vitamins, and trace elements. For respiratory failure, oxygen therapy, ICU admission, ventilator, and personalized interventions are required[10]. Among COVID-19 patients who were admitted to the ICU, the COVID-19 disease was closely related to

age, co-morbidities, and frailty. Risk information related to different COVID-19 patient characteristics, such as co-morbidities will enable the healthcare providers to direct, and focus on those COVID-19 vulnerable patients and improve allocating healthcare resources for those who are in need[11].

Along with physical health issues, COVID-19 patients' psychological disorders also vary, according to socio-demographic factors such as age, location, gender, social media, religious beliefs, income, social support, and loss of a loved one due to COVID-19[12,13].

Along with the loss of loved ones, we were living in critical times, when the ICU was surrounded by COVID-19 patients around the world many of them with severe pneumonia leading to severe adult respiratory distress syndrome (ARDS). We are living in critical times when the ICU was surrounded by COVID-19 patients around the world many of them were with severe pneumonia leading to severe adult respiratory distress syndrome (ARDS) [14].

In COVID-19 patients, although the occurrence of pneumonia was peculiar showing the infection outside the lungs leading to the manifestation of fever, anemia, and liver dysfunction, leading to secondary infections[15].

One of the studies identified four risk factors: age $\leqslant 65$ years, preexisting cardiovascular or cerebrovascular disease, CD3+ CD8+ T lymphocytes $\leqslant 75$ cells·µL−1, and cardiac troponin I $\geqslant 0.05$ ng·mL−1[16]. The other researchers found that men aged 50 and older and women aged 80 and older are at the highest risk for serious lung disease in COVID-19 patients[17]. In the largest list of a series of reports from northern Italy, deaths in COVID-19 patients, aged 64 years and older were 36% whereas younger were 15%[18].

However, it has not yet been established whether the patient's gender, age, or co-morbidities are associated with the increased risk of adverse clinical outcomes leading to death, and the gender, age, and co-morbidities of the patients are predicted to make COVID-19 patients more susceptible to infection risking for mortality[19].

The explored literature stated that age can be a risk factor for COVID-19, hence we designed this present study to investigate whether age can be a predictive factor for COVID-19 pneumonia patients.

Ethical clearance

After the ethical committee approval, this study is conducted in the selected study subjects with the guidance of superiors.

Inclusion criteria

RT PCR-proven COVID-19 pneumonia patients.

Exclusion criteria

COVID-19 patients without pneumonia.

Materials and methods

Methodology

Study Setting

This study was conducted in the Department of Radiology at Pondicherry Institute of Medical Sciences, Puducherry, India.

Study Design

This study is designed as an observational study.

Study Participants and Study Duration

160 COVID-19 patients with pneumonia were recruited for this study based on inclusion and exclusion criteria from September to December 2021 to conduct this study.

Study Procedure

COVID-19 Test Confirmation and Vaccination Status

The study subject's diagnosis of COVID-19 was confirmed by Reverse Transcription-Polymer Chain Reaction (RT-PCR) [20, 21], and vaccination status (Covishield/COVAX in, single dose/double dose) of the study population was also recorded.

Confirmation of Pneumonia in COVID-19 Study Patients

For the confirmation of pneumonia in COVID-19 study patients, the subjects underwent HRCT chest examination using a Philips 128-slice CT scanner[23]. During chest examination by HRCT, each study patient was asked to be laid down in a supine position, asked to hold a breath, and performed scanning following sagittal and coronal reformatting of images. The scanning parameters used were the scan direction of craniocaudal, tube voltage 120kV, tube current 251mA, and 64×0.625 slice collimation. The images of chest HRCT were collected using the Picture Archiving and Communication System (PACS) [24].

HRCT Image Analysis and Biase Prevention in the Study

HRCT image analysis and biases were prevented by assessing for the presence of typical findings of COVID-19 pneumonia (bilateral, multilobar involvement, posterior peripherally distributed ground-glass opacities) by 2 radiologists to determine the disease severity score (CO-RAD Score- Coronavirus disease-2019 Reporting and Data System)[25] in each patient.

Scores of 1 to 5 were evaluated for individual lobar involvement of <5%, 5-25%, 26-49%, 50-75% and >75% respectively, and a cumulative score of all lobes was taken. The sum of the lobar scores indicates the overall severity of lung parenchymal involvement[26]:

- Mild grade was assigned to score ≤7
- Moderate grade was assigned to score 8-17
- Severe grade was assigned to score ≥18

Data Collection

160 COVID-19 with pneumonia study patients' demographic details such as age, clinical details like COVID-19 confirmed result, COVID-19 disease severity score, vaccination status, co-morbid conditions, data on infected with pneumonia, HRCT were collected, and recorded for further analysis.

Analysis

The data on demographic and clinical were analyzed to evaluate the association between age and COVID-19 pneumonia disease severity, vaccination status, and co-morbidities, and results were tabulated in the results section of this study.

Statistical analysis

The data was entered in Microsoft Excel 2010 and analyzed using SPSS 20.0 version software. The demographic and clinical characteristics of the study patients were described using percentages and the p-value was calculated using the Chi-square test. P <0.05 was considered statistically significant.

Results

A total of 160 COVID-19 pneumonia patients were selected for this study, the COVID-19 pneumonia disease severity was observed and based on the CT scan using a 25-point scoring system of severity, was graded as mild, moderate, and severe. The association of the COVID-19 pneumonia disease severity and the patient's age was analyzed and tabulated in Table 1.

Table 1: Association of the COVID-19 Pneumonia Diseases Severity based on CT scan using a 25-point scoring system, and the Patient's Age

Variables	Categories	≤50 years (n=92)	>51 years (n=68)	Chi-square	P value
COVID-19 Diseases Severity **A CT scan using a 25-point scoring system** (n=160)	Mild (n=53)	37 (69.8)	16 (30.2)	4.9150	0.0266*
	Moderate (n=67)	39 (58.2)	28 (41.8)	0.0237	0.8776
	Severe (n=40)	16 (40.0)	24 (60.0)	6.684	0.01*

*Statistically Significant

Out of 160 study COVID-19 patients, based on the CT scoring system, mild pneumonia was identified in 53 patients, and moderate, and severe were observed in 67, and 40 COVID-19 patients respectively. Among the 53 COVID-19 patients showing mild pneumonia, 37 (69.8%) were in the age group of ≤50 years and 16 (30.2%) were in the age group of >51 years with statistical significance of **(Chi-square-4.9150, p-value-0.0266)**. Among the 67 COVID-19 patients showing moderate pneumonia, 39 (58.2%) were in the age group of ≤50 years, and 28 (41.8%) were in the age group of >51 years. Among the 40 COVID-19 patients showing severe pneumonia, 16 (40.0%) were in the age group of ≤50 years and 24 (60.0%) were in the age group of >51 years with statistical significance of **(Chi-square-6.684, p-value- 0.01) (Table 1)**.

We also recorded the COVID-19 vaccination and unvaccinated patient's details such as whether vaccination was done or not, and single or double dosage. We further analyzed the association between the COVID-19 pneumonia patient's age, and COVID-19 vaccination, and tabulated in Table 2.

Table 2 : Association between the COVID-19 Pneumonia Patient's Age, and COVID-19 Vaccination

Variables	Categories	≤50 years (n=92)	>51 years (n=68)	Chi-square	P value
COVID 19-Vaccination (n=160)	Vaccinated (n=80)	52 (65.0)	28 (35.0)	3.683	0.0450*
	Unvaccinated (n=80)	40 (50.0)	40 (50.0)	3.683	0.0450*
Vaccine Dosage (n=80)	Single (n=50)	35 (70.0)	15 (30.0)	1.465	0.2266
	Double (n=30)	17 (56.7)	13 (43.3)	1.465	0.2266

*Statistically Significant

Out of 160 COVID-19 study patients, 80 COVID-19 patients were vaccinated, among them 52 (65.0%) were in the age group of ≤50 years and 28 (35.0%) were >51 years of age with statistical significance of **(Chi-square-3.683, p value-0.0450)**. Among 160 study COVID-19 patients, 80 COVID-19 patients did not receive the COVID-19 vaccine, and among them, 40 (50.0%) were in the age group of ≤50 years and 40 (50.0%) were >51 years of age with statistical significance of **(Chi-square-3.683, p value-0.0450) (Table 2)**.

Out of 160 COVID-19 study patients, 80 patients were vaccinated, among the 50 COVID-19 patients who received a single dose of COVID-19 vaccine, 35 (70.0%) were in the age group of ≤50 years, whereas 15 (30.0%) were in the age of >51 years. Out of 80 COVID-19 vaccinated patients, 30 patients received a double dose of vaccination, among the 30 COVID-19 patients received a double dose of COVID-19 vaccine, 17 (56.7%) were in the age group of ≤50 years, whereas 13 (43.3%) were in the age of >51 years **(Table 2)**.

We also recorded the co-morbidities of COVID-19 pneumonia patients and the association of co-morbidities with the age of the COVID-19 pneumonia patients were analyzed and tabulated in **Table 3**.

Out of 160 study patients, 98 patients were with co-morbidities, among them 38 (38.8%) COVID-19 patients were in the age group of ≤50 years, whereas 60 (61.2%) patients were in the age group of >51 years with the statistical significance of **(Chi-square-36.28, p-value-<0.0001)**. Out of 160 COVID-19 patients, 62 patients were without co-morbidities, among them 54 (87.2%) COVID-19 patients were in the age group of ≤50 years, whereas 8 (12.9%) patients were in the age group of >51 years with the statistical significance of **(Chi-square-36.28, p-value-<0.0001) (Table 3)**.

Table 3 Association of Co-morbidities with the Age of the COVID-19 Pneumonia Patients

Variables	Categories	≤50 years (n=92)	>51 years (n=68)	Chi-square	P value
Comorbidities Status(n=160)	With co-morbidities (n=98)	38 (38.8)	60 (61.2)	36.28	<0.0001*
	Without co-morbidities (n=62)	54 (87.1)	8 (12.9)	36.28	<0.0001*
Comorbidities (n=98)	HTN (n=39)	15 (38.5)	24 (61.5)	0.0027	0.9586
	DM (n=33)	14 (42.4)	19 (57.6)	0.279	0.5973
	CKD (n=7)	0 (0.00)	7 (100.0)	3.177	0.0458*
	RA (n=5)	4 (80.0)	1 (20.0)	2.164	0.1452
	CAD (n=7)	0 (0.00)	7 (100.0)	3.177	0.0458*
	HYPOTHYROIDISM (n=7)	5 (71.4)	2 (28.6)	2.066	0.1542

*Statistically Significant

Among the 98 COVID-19 pneumonia patients with co-morbidities, 39 COVID-19 pneumonia patients had HTN as a co-morbid condition, and among them, 15 (38.5%) were in the age group of ≤50 years, whereas 24 (61.5%) were in the age of >51 years. 33 COVID-19 pneumonia patients had DM as their co-morbid condition, and among them, 14 (42.4%) were in the age group of ≤50 years, whereas 19 (57.6%) were in the age of >51 years. 7 COVID-19 pneumonia patients had CKD as a co-morbid condition, and all 7 of them were in the age group of >51 years with a statistical significance of **(Chi-square-3.177, p-value-<0.0458)** (**Table 3**).

5 COVID-19 pneumonia patients had RA as their co-morbid condition, and among them, 4 (80.0%) were in the age group of ≤50 years, whereas 1 (20.0%) was in the age of >51 years. 7 COVID-19 pneumonia patients had CAD as a co-morbid condition, and all 7 of them were in

the age group of >51 years with a statistical significance of **(Chi-square-3.177, p-value-<0.0458)**. 7 COVID-19 pneumonia patients had Hypothyroidism as their co-morbid condition, and among them, 5 (71.4%) were in the age group of ≤50 years, whereas 2 (28.6%) were in the age of >51 years (**Table 3**).

Discussion

Research by Brodin, P [27] showed that COVID-19 diseases occurred as mild-moderate in most previously healthy people, but later caused potentially fatal disease, and in recent years, mild-severe Covid-19 infection not only diseases occur but retains long-term COVID-19 symptoms, whereas, in our present study, we found among the 53 COVID-19 patients showing mild pneumonia, 37 (69.8%) were in the age group of ≤50 years and 16 (30.2%) were in the age group of >51 years with statistical significance of **(Chi-square-4.9150, p-value- 0.0266)**, and among the 40 COVID-19 patients showing severe pneumonia, 16 (40.0%) were in the age group of ≤50 years and 24 (60.0%) were in the age group of >51 years with statistical significance of **(Chi-square-6.684, p-value- 0.01).**

Shrestha, S., et al[28] study showed the first dose of Covishield for 5591 COVID-19 patients, but this study did not provide the age association with the dosage of vaccination, whereas our study showed the age association, 80 COVID-19 patients received vaccines, among them 52 (65.0%) were in the age group of ≤50 years and 28 (35.0%) were >51 years of age with statistical significance of **(Chi-square-3.683, p value- 0.0450)**, and 80 COVID-19 patients did not receive COVID-19 vaccine, and among them, 40 (50.0%) were in the age group of ≤50 years, and 40 (50.0%) were >51 years of age with statistical significance of **(Chi-square- 3.683, p value-0.0450)** indicating that age is a

determinant in COVID-19 patients regardless of vaccination.

Baradaran, A. et al [29] reported that the co-morbidities do not appear to be prerequisites for COVID-19 infection, except for hypertension, whereas our present study was compatible with this study showing 98 patients with co-morbidities, among them 38 (38.8%) COVID-19 patients were in the age group of ≤50 years, whereas 60 (61.2%) patients were in the age group of >51 years with the statistical significance of **(Chi-square-36.28, p-value-<0.0001),** and 62 patients were without co-morbidities, among them 54 (87.2%) COVID-19 patients were in the age group of ≤50 years, whereas 8 (12.9%) patients were in the age group of >51 years with the statistical significance of **(Chi-square-36.28, p-value-<0.0001)** indicating whether the co-morbidities were present or absent, the age was a determinant in COVID-19 patients with co-morbidities, and without co-morbidities.

Menon, T et al [30] reported among the co-morbidities CKD in COVID-19 patients was presented as the commonest underlying disease with a poor prognosis leading to mortality, but Menon, T study did not report the age association with co-morbidities in COVID-19 patients, whereas our study was also compatible with Menon, T in co-morbidities, but also reported the age association with co-morbidities in COVID-19 patients; 7 COVID-19 pneumonia patients had CKD as a co-morbid condition, and all 7 of them were in the age group of >51 years with the statistical significance of **(Chi-square-3.177, p-value-<0.0458).**

Jardim, B. C. et al[31] stated that the excess mortality in COVID-19 patients was due to cancer and cardiovascular disease indicating that COVID-19 has had a significant impact in patients with co-morbidities, but did not show age association, whereas in our study, 7 COVID-19 pneumonia patients had CAD as a co-morbid condition,

and all 7 of them were in the age group of >51 years with the statistical significance of **(Chi-square-3.177, p-value-<0.0458)**, indicating, CAD as a underlying diseases, at the same time age in them was also a determinant in COVID-19 patients.

This present study concludes, that CT based on disease severity was accurate in COVID-19 pneumonia patients, whether the disease severity; was mild or severe, whether the COVID-19 patients were vaccinated or unvaccinated, or whether the presence of co-morbidities or not, the age of COVID-19 pneumonia patients plays a vital role being a determinant in COVID-19 pneumonia patients, hence clinicians require to learn the determinants of any diseases, as COVID-19 is an infectious disease, likewise, age can be a determinant for any infectious diseases.

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