

A QUESTIONNAIRE BASED SUEVEY OF THE IMPACT OF COVID-19 ON DEVELOPMENT OF SPONTANEOUS PNEUMOTHORAX IN PATIENTS ON VENTILATOR.

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Abstract:

Background : Covid 19 a contagious illness caused by SARS corona virus 2. One of the newly emerging respiratory concerns is the emergence of spontaneous pneumothorax (PNX) in patients on mechanical ventilation as well as patients not on any form of ventilations. Surveys primary objective was to evaluate if Covid 19 patients on mechanical ventilation are more prone for development of spontaneous Pneumothorax. The secondary goal was to determine whether spontaneous pneumothorax is a standalone risk factor for COID 19 mortality.

Methodology : Anaesthesiologists, Pulmonologists, Physicians, and Intensivists who were involved in the treatment of COVID 19 patients were invited to participate in the survey. A google form, with twenty questionnaires were provided with four options in each question. Participants were asked to tick the appropriate option. To determine whether spontaneous pneumothorax is a standalone risk factor for Covid-19 mortality, the chi-square test of

association and Fisher's Exact test were used. Statistical significance is taken at a p-value of <0.05.

Results : 42.9% reported on an average 0-5 patients were on IPPV (intermittent positive pressure ventilation, 49.5% reported on an average 0-5 patients were on NIV (non-invasive ventilation), 49.45% of the respondents agreed on an average >10 number of patients on invasive ventilation developed spontaneous pneumothorax and 29.47% reported on an average >10 number of patients on non-invasive ventilation developed spontaneous pneumothorax. On an average ,patients who needed ICD insertion after developing spontaneous pneumothorax, the incidence was 6.6% .Most of the respondents reported on an average patients recovered after developing spontaneous pneumothorax , incidence was 76.9%. Average number of patients who succumbed to Covid 19 after developing spontaneous pneumothorax was 50.5%.

Conclusion : Dreaded complication of COVID 19 viral pneumonia is spontaneous pneumothorax . Both IPPV as well as NIV increases the risk of developing spontaneous pneumothorax. This cannot be attributed only to barotrauma caused due to use of higher PEEP during ventilation, as there are multiple contributing factors. Lung protective ventilator settings should be used for better outcome of the patient.

Key words: Pneumothorax, Covid -19, Mechanical ventilation.

Introduction:

Covid 19 is an infectious illness brought on by the SARS COV2 (severe acute respiratory syndrome corona virus 2). It started in Wuhan, China, in December 2019, and on January 6, 2020, the virus was first discovered. Since then, COVID has spread globally, causing the pandemic. One of the emerging pulmonary complications of Covid 19 viral pneumonitis is the development of spontaneous pneumothorax. Individuals receiving mechanical ventilation (IPPV and NIV) as well as individuals not receiving any sort of ventilation have both experienced this complication.

Although barotrauma in COVID-19 patients has not been extensively studied, the reported barotrauma rate (15%) is higher than that of the non-COVID-19 mechanically ventilated population.⁽¹⁾ Proposed mechanism includes marked inflammatory response, fibrosis, high airway pressure delivered by ventilators also spontaneous rupture of tiny, vulnerable airways infected with the virus and direct invasion and necrosis of lung tissue including the pleura by the microorganism itself.⁽²⁻⁴⁾ According to Macklin, the pathophysiology for spontaneous pneumomediastinum is caused by a pressure gradient between the alveoli and the lung interstitium, which leads to alveolar rupture.⁽⁵⁾ Air builds up in the interstitium and circulates to the mediastinum via the venous sheaths.⁽⁶⁻⁷⁾ Recent radiographic studies have demonstrated that COVID-19 infection is related with lung parenchyma architectural distortion and cyst formation, which may predispose the lung to the development of pneumothorax.⁽⁸⁻⁹⁾ Though the exact number of patients developing spontaneous Pneumothorax is not there, few study articles have reported different numbers. One of the possible causes of spontaneous pneumothorax in Covid 19 patients could be increased intrathoracic pressure brought on by frequent and vigorous coughing.

Asthma, chronic obstructive pulmonary disease, and interstitial lung disease are underlying lung conditions that have been linked to PNx/pneumomediastinum (PNM) . Low BMI individuals may have uneven physical growth, which could lead to negative chest pressure increasing the risk of bulla formation, and PNx. ⁽¹⁰⁾ PNM, tension pneumothorax, PNM, pneumopericardium and subcutaneous emphysema are uncommon clinical manifestations in patients with COVID-19. ⁽¹¹⁾

The survey's primary goal was to determine whether Covid 19 patients receiving mechanical ventilation (IPPV and NIV) are more likely to develop spontaneous pneumothorax. Determine whether spontaneous pneumothorax is a standalone risk factor for COID 19 mortality was the secondary objective.

Methods:

Anaesthesiologists, Pulmonologists, Physicians, and Intensivists who were involved in the treatment of patients with COVID 19 were invited to participate in the survey. A google form, with twenty questionnaires (supplement file 1) were provided with four options in each question. Participants were asked to tick the appropriate answer from the options. The survey was conducted during the period from December 2021 to June 2022. This google form questionnaire was circulated and their responses were recorded. The aim was to achieve maximum responses from all over India but unfortunately, we could not receive maximum response. We could receive responses from 99 participants in the time frame of six months.

Data from the completed survey was extracted and anonymized for analysis, analysis was performed using version 26 of SPSS. Means and standard deviations (SD) were used to present continuous data, while frequencies and percentages were used to present categorical data. The chi-square test of association and Fisher's Exact test was performed to evaluate if spontaneous pneumothorax is an independent risk factor for Covid-19 mortality. Statistical significance is taken at a p-value of <0.05.

Results

Table1: Sociodemographic Characteristics of Participants

	Mean ±SD
Age (Years)	35.37 ±8.78
	N (%)
Gender	
No response	1(1.1)
Male	49 (53.8)
Female	41(45.1)
Profession	
Anaesthesiologist	77(84.6)
Intensivist	5(5.5)
Physician	5(5.5)
Pulmonologist	4(4.4)
No. of years of experience	

0-3	42(46.2)
3-6	16(17.6)
6-9	6(6.6)
>9	27(29.7)
Workplace	
Corporate	11 (12.1)
Medical College	73 (80.2)
Private practice	7 (7.7)
Designation of your hospital	
No response	1(1.1)
Covid care centre	12(13.2)
Covid health centre	11 (12.1)
Designated Covid hospital	67 (73.6)
No. of hospital beds	
No response	3(3.3)
50-100	16(17.6)
100-200	13(14.3)
>200	59(64.8)
Number of beds in covid ICU	
No response	1(1.1)
10-20	32(35.2)
20-30	29(31.9)
>30	29(31.9)
Number of beds in non -covid ICU	
No response	1(1.1)
10-20	45(49.5)
20-30	23(25.3)
>30	22(24.2)
Number of beds reserved for Covid19 patients	
No response	2 (2.2)
0-25	30(33.0)
25-50	10(11.0)
50-75	14(15.4)
>75	35(38.5)
The average number of patients	

on invasive ventilation	
No response	3(3.3)
0-5	39(42.9)
5-10	34(37.4)
>10	15(16.5)
The average number of patients on non-invasive ventilation	
No response	1(1.1)
0-5	13(14.3)
5-10	32(35.2)
>10	45(49.5)
The average number of patients on invasive ventilation developed a spontaneous pneumothorax	
No responses	5 (5.5)
0-5	6 (6.59)
5-10	35(38.46)
>10	45(49.45)
The average number of patients on non-invasive ventilation developed a spontaneous pneumothorax	
No responses	4(4.4)
0-5	36 (39.5)
5-10	26(28.57)
>10	25 (27.47)
The average number of patients who needed ICD insertion after developing spontaneous pneumothorax	

No responses	4 (4.4)
0-5	70(76.9)
5-10	11(12.1)
>10	6(6.6)
The average number of Covid 19 patients recovered after developing spontaneous pneumothorax	
No responses	5(5.5)
0-5	70(76.9)
5-10	10(11.0)
>10	6 (6.6)
The average number of patients who succumbed to Covid 19 after developing spontaneous pneumothorax	
No responses	7(7.7)
0-5	46(50.5)
5-10	16(17.58)
>10	22(24.17)

Table 2: Spontaneous pneumothorax patients associated with covid19 mortality

**p-value* <0.005 significant.

	pneumothorax				<i>p-value</i>
	No response N (%)	0-5 N (%)	5-10 N (%)	>10 N (%)	
Patients on invasive ventilation who developed a spontaneous pneumothorax					
No response	4(80)	0(0)	0(0)	1(20)	0.012*
0-5	3(50.0)	3(50.0)	0(0.00)	0(0)	
5-10	0(0)	35(100)	0(0)	0(0)	
>10	0(0)	8(17.8)	16(35.6)	21(46.7)	
Patients on non-invasive ventilation who developed a spontaneous pneumothorax					
No response	4(100)	0(0)	0(0)	0(0)	0.004*
0-5	3(8.3)	33(91.7)	0(0)	0(0)	
5-10	0(0)	13(50.0)	13(50.0)	0(0)	
>10	3(12)	7(28)	5(20)	10(40)	

The responses of 91 participants were evaluated. The sociodemographic characteristics and variables related to covid 19 pneumothorax are shown in **Table 1**. The mean age of the participants was 35.37 ± 8.78 years. The study included 53.8% males and 41% of females. Most of the participants (84.6%) were anaesthesiologists by profession. 46.2% of them had 0-3 years of experience and 29.7% of them had more than 9 years of experience. Most of them worked at medical college (80.2%) and 73.6% worked at the covid designated hospital. 64.8% participants reported that there were more than 200 hospital beds, 35.2% responded they had 10-20 beds in covid ICU, 10-20 beds in non -covid ICU, 38.5% responded more than 75 beds were reserved for covid19 patients, 42.9% reported on an average 0-5 patients were on NIV, 49.5% reported on an average 0-5 patients were on non -invasive ventilation, 49.45% of the respondents agreed on an average >10 number of patients on invasive ventilation developed spontaneous pneumothorax and 29.47% reported on an average >10 number of patients on non-invasive ventilation developed spontaneous pneumothorax. On an

average ,patients who needed ICD insertion after developing spontaneous pneumothorax, the incidence was 6.6% .Most of the respondents reported on an average patients recovered after developing spontaneous pneumothorax , incidence was 76.9%. Average number of patients who succumbed to Covid 19 after developing spontaneous pneumothorax was 50.5%.

Factors associated with covid19 mortality

The characteristics of Covid19 mortality compared with patients on invasive and non-invasive ventilation who developed spontaneous pneumothorax are in **Table 2**. Patients on invasive ventilation, who developed spontaneous pneumothorax, on an average > 10 patients succumbed to Covid 19 after developing spontaneous pneumothorax with incidence of 46.7% and **patients** {on non-invasive ventilation who developed spontaneous pneumothorax on an average >10patients succumbed to Covid 19 after developing spontaneous pneumothorax, the incidence was 40% which was more in invasive as shown in **fig1 and fig2**. Hence the patients who succumbed to covid 19 were the majority of patients on invasive ventilation. There was a significant association found with a p-value<0.05. Hence spontaneous pneumothorax was an important factor in covid19 mortality.

Figure1: Comparison of patients on invasive ventilation and covid19 mortality

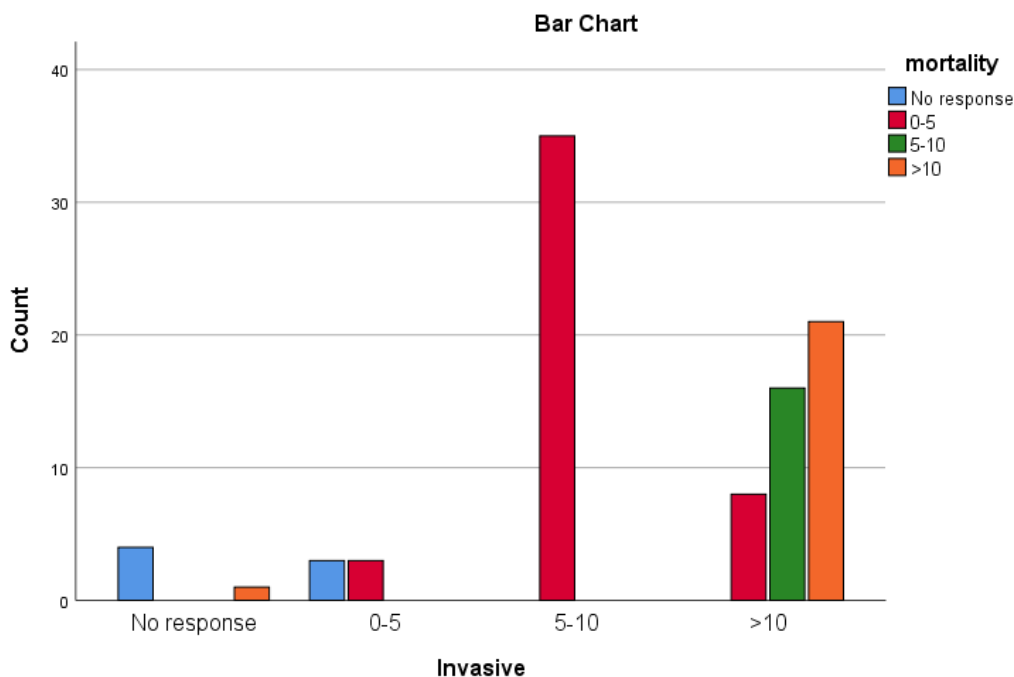
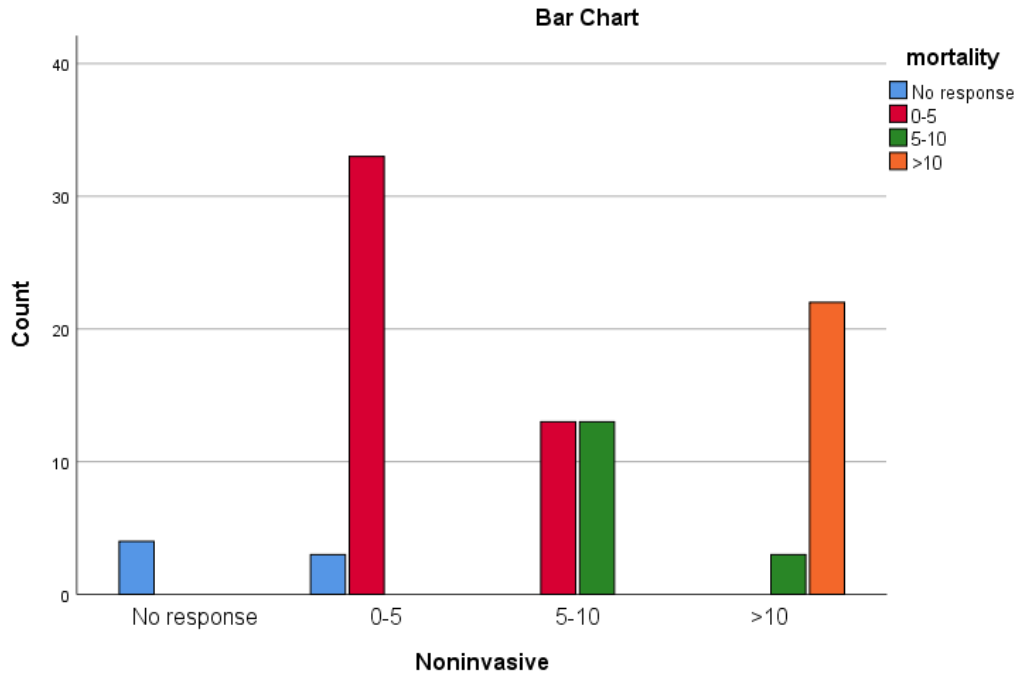


Figure2: Comparison of patients on non-invasive ventilation and covid19 mortality



Discussion:

COVID 19 Pneumonia may result in a cystic characteristic in the lung parenchyma, which may resolve and proceed to massive blebs. Till date studies on spontaneous Pneumothorax in COVID 19 has been published from the western countries. In India, still the exact incidence and adequate literature on this topic is not available.

Till date only one study is published by Anshul Singh⁽¹²⁾ pertaining to information on the frequency of pneumothorax and pneumomediastinum in COVID 19 patients from the Indian subcontinent. Retrospective analysis of 912 patients by the author revealed an incidence of 1.9% for the development of pneumothorax/pneumomediastinum in 18 cases. 18 patients were involved; 13 were receiving non-invasive ventilation, 4 were receiving IPPV, and one was not receiving oxygen therapy. Patients who developed pneumothoraxes or pneumomediastinum had a mortality rate of 72.2%.

A series of three occurrences of primary spontaneous pneumothorax/pneumomediastinum in COVID 19 patients were described by Mansoor Hameed, Wasim Jamal, Muhammad Yusuf, *et al*⁽¹³⁾ in Respiratory Medicine Case Report, Vol. 31,2022. None of the patients in this case series needed positive pressure breathing, and none had any prior lung conditions. Alvaro Quincho Lopez, Danial, Fernando – D *et al*⁽¹⁴⁾ presented two cases of COVID 19 patients with Pneumothorax and Pneumomediastinum not on any form of mechanical ventilation.

In almost 3000 patients admitted to their hospital with suspected COVID 19, Massa Zantah, Eduardo Dominguez Casillo, Jerard J. Criner, *et al*⁽¹⁵⁾ (Respiratory research 21, Article 236, 2020) examined the incidence and result of pneumothorax. They conducted a retrospective review of COVID 19 cases that occurred at their institution between March 1 and June 8, 2020. Of the 902 patients who tested positive on the Nasopharyngeal Swab, 6 patients

(0.66%) spontaneously developed pneumothoraxes, and 4 of the 6 instances included mechanical ventilation.

The statistics of Covid 19 patients who were admitted to the Inova health System (USA) between February 2020 and May 2020 were released by Emmanuel Ekanem, Shreya Poddar, Mehul Desai, *et al*⁽³⁾ 22 patients (1.4%) out of 1619 patients experienced a spontaneous pneumothorax while hospitalised. 50% of the patients in their research were not on mechanical ventilation.

Youmna Abdelghany *et all*⁽¹⁶⁾ retrospectively analysed the records of confirmed Covid-19 patients hospitalised to 2 hospitals in New York City between early March and mid-May. 386 patients out of 1866 were intubated. Pneumothoraxes were found in 36 of the patients.

497 individuals were examined by Nardi, Tetaz, *et al*⁽¹⁷⁾ to determine the prevalence of barotrauma, including pneumothorax and pneumomediastinum, in Covid-19 patients who were hospitalised within a year of the pandemic and had moderate to severe ARDS. According to their findings, the overall incidence of barotrauma in all COVID-19 patients during that year was 1.6%, and non-invasive respiratory assistance was linked to a 9.1% incidence of barotrauma. 5.8% of the 19 patients in the ICU who were using an invasive ventilator had barotrauma. Compared to the non-barotrauma group, the mortality in the former was higher [47.2%]. [37%]. McGuinness G *et al.*, concluded that barotrauma has been linked to a longer hospital stay and is an independent risk factor for death in the COVID-19 and patients without COVID-19 infection had lower rates of barotrauma than patients with COVID-19 infection and invasive mechanical ventilation.⁽¹⁸⁾

According to Bonato M *et al.*, these complications occurred most frequently in patients who were non-invasively ventilated (35.8%) and in patients who were invasively ventilated (32.1%), but they also happened in patients who were only given oxygen support (17% of patients treated with HFNC and 15.1% treated with conventional oxygen support). These complications cannot be attributed solely to the severity of acute respiratory failure and/or the need for respiratory support.⁽¹⁹⁾

In our survey, we too found Covid -19 was associated with the development of spontaneous Pneumothorax. The incidence and mortality were found to be slightly more in patients on Intermittent positive pressure ventilation than in patients on non-invasive positive pressure ventilation. Though the sample size was small, our study also reflects the findings from other previous studies.

Limitations of the survey- After repeated requests, many professionals did not respond to the survey. The respondents {> 90%} are from South India, notably Karnataka. Hence the real incidence of Spontaneous Pneumothorax as a complication of Covid- 19 is still unclear. To have a clear picture of this, further surveys or retrospective studies need to be done from other parts of India. Other factors including conditions like COPD, Asthma, any other lung parenchymal disease which can lead to pneumothorax, were not taken into consideration.

Conclusion:

Dreaded complication of COVID 19 viral pneumonia is spontaneous pneumothorax, which can happen at any point in the illness. Spontaneous pneumothorax is a dreaded complication of COVID 19 viral pneumonia, it may occur at any time during the disease. Participants in our survey were of the opinion that both invasive as well as non-invasive ventilation increases the risk of developing spontaneous pneumothorax, with higher risk in invasive ventilation. Respondents also opined that majority of the patients who succumbed to Covid 19 after developing spontaneous pneumothorax were on invasive than on non-invasive ventilation. This cannot be attributed only to barotrauma caused due to use of higher PEEP during ventilation, as there are other attributing factors like cyst or pneumatocele formation, persistent coughing resulting in increased intrathoracic pressure, alveolar damage due to COVID 19 pneumonia related inflammation or ischaemic parenchymal damage. Other associated factors like COPD, smoking, lung parenchymal diseases should be taken into consideration with lung protective ventilator settings.

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Conflicts of interest: Nil

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supplement file 1: Survey Questionaries

1. Name:
2. Age:
3. Gender:
4. Qualification:
5. Designation:
6. Profession:
7. Number of years of experience:
 - a) 0-3years
 - b) 3-6yrs.
 - c) 6-9 yrs.
 - d) >9 yrs
8. Work place:
9. Designation of your hospital for covid-19 management –
Covid care hospital,
covid Health centres,
designated covid 19 hospitals,

10. number of hospital beds –

- a) 50-150
- b) 150-300.
- c) 300-450.
- d) >450.

11. Number of beds in covid ICU –

- a) 10-20,
- b) 20-30,
- c) c)> 30.

12. Number of beds in non- covid ICU –

- a) 10-20,
- b) 20-30
- c) >30.

13. Number of beds reserved for covid -19 patients-

- a) 20-40
- b) 40-60,
- c) >60.

14. Average number of patients on Invasive ventilation-

- a) 0-5,
- b) 5-10,
- c) >10.

15. Average number of patients on non-Invasive ventilation –

- a) 0-5,
- b) 5-10,
- c) >10.

16. Average number of patients on Invasive ventilation who developed spontaneous pneumothorax –

- a)0-5,
- b)5-10,
- c)>10.

17. Average number of patients on non- invasive ventilation who developed spontaneous pneumothorax-
 - a)0-5,
 - b)5-10 ,
 - c)>10.

18. Average number of patients who needed ICD insertion after developing spontaneous pneumothorax
 - a)0-5,
 - b)5-10,
 - c)>10.

19. Number of patients recovered from covid-19 after developing spontaneous pneumothorax –
 - a)0-5,
 - b) 5-10,
 - c)>10.

20. The average number of patients succumbed to covid 19, after developing spontaneous pneumothorax-
 - a)0-10,
 - b)10-20,
 - c)>20.