

Noninvasive Oxygen Strategies to Manage Confirmed COVID-19 Patients in Indian Intensive Care Units: A Survey

Ashwin Subramaniam¹, Jumana Y Haji², Prashant Kumar³, Kollengode Ramanathan⁴, Arvind Rajamani⁵

ABSTRACT

Background: About 5% of hospitalized coronavirus disease 2019 (COVID-19) patients will need intensive care unit (ICU) admission for hypoxemic respiratory failure requiring oxygen support. The choice between early mechanical ventilation and noninvasive oxygen therapies, such as, high-flow nasal oxygen (HFNO) and/or noninvasive positive-pressure ventilation (NPPV) has to balance the contradictory priorities of protecting healthcare workers by minimizing aerosol-generation and optimizing resource management. This survey over two timeframes aimed to explore the controversial issue of location and noninvasive oxygen therapy in non-intubated ICU patients using a clinical vignette.

Materials and methods: An online survey was designed, piloted, and distributed electronically to Indian intensivists/anesthetists, from private hospitals, government hospitals, and medical college hospitals (the latter two referred to as first-responder hospitals), who are directly responsible for admitting/managing patients in ICU.

Results: Of the 204 responses (125/481 in phase 1 and 79/320 in phase 2), 183 responses were included. Respondents from first-responder hospitals were more willing to manage non-intubated hypoxemic patients in neutral pressure rooms, while respondents from private hospitals preferred negative-pressure rooms ($p < 0.001$). In both the phases, private hospital doctors were less comfortable to use any form of noninvasive oxygen therapies in neutral-pressure rooms compared to first-responder hospitals (low-flow oxygen therapy: 72 vs 50%, $p < 0.01$; HFNO: 47 vs 24%, $p < 0.01$ and NPPV: 38 vs 28%, $p = 0.20$).

Interpretation: Variations existed in practices among first-responder and private intensivists/anesthetists. The resource optimal private hospital intensivists/anesthetists were less comfortable using noninvasive oxygen therapies in managing COVID-19 patients. This may reflect differential resource availability necessitating resolution at national, state, and local levels.

Keywords: Conservative oxygen therapy, COVID-19, High-flow nasal cannula oxygen therapy, Hypoxemia, Indian intensive care unit, Low-flow nasal oxygen, NIV: Noninvasive mechanical ventilation, SARS-COV-2.

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INTRODUCTION

About 5% of hospitalized coronavirus disease 2019 (COVID-19) patients need intensive care unit (ICU) admission for hypoxemic respiratory failure.^{1,2} Before the COVID-19 pandemic, noninvasive oxygen therapies, such as, high-flow nasal oxygen (HFNO) and/or noninvasive positive-pressure ventilation (NPPV), were increasingly used in hypoxemic patients due to their proven benefits on minimizing the need for endotracheal intubation.³ However, HFNO/NPPV has been avoided in the early phase of the COVID-19 pandemic due to concerns of their aerosol-generation,⁴ potentially increasing healthcare worker (HCW) infections. The consequent high rates of endotracheal intubation caused rapid depletion of ICU resources and potentially increased mortality.⁵

However, new research shows that HFNO may not be as aerosol-generating as initially thought.^{6–10} Moreover, COVID-19 management guidelines give contrary statements on its use.^{11–13} Therefore, the choice between early mechanical ventilation and HFNO/NPPV has to balance the contradictory priorities of protecting HCWs by minimizing aerosol-generation vs optimizing resource management. This may be particularly difficult in India, which has low numbers of ventilator beds and intensivists *per capita*,^{14,15} and has already seen high numbers of HCWs infections even before the surge.^{16,17}

There is no literature on the oxygen-therapy practices for non-intubated COVID-19 patients used by critical care physicians in India. Hence, we surveyed Indian intensivists, over two timeframes, to systematically explore this issue.

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MATERIALS AND METHODS

The detailed methodology of the survey is published elsewhere.^{18,19} The survey was distributed to HCWs from private hospitals, government hospitals, and medical college hospitals in two phases—Phase 1 between 25/03/2020 and 06/04/2020 and

phase 2 between 20/04/20 and 30/04/20. As this article primarily deals with clinical management issues, we only included the responses from intensivists/anesthetists with direct responsibility of admitting/managing patients in ICU. To explore their approach to noninvasive oxygen therapy in non-intubated ICU patients, we presented a case vignette of a hypoxemic COVID-19 patient who was not sick enough to require invasive mechanical ventilation and sought a response on the proposed modality and location of treatment (Supplementary Fig. 1). The Government Hospitals and Medical College Hospitals were designated as first responders by the Ministry of Health.²⁰ The responses from first-responder hospitals were compared with the responses from private hospitals. Categorical data are reported as percentages of valid responses and comparative analysis of responses between the two phases using Fisher's exact test with a two-tailed alpha-error of 5% ($p < 0.05$) using SPSS™ v.26.

RESULTS

In total, 204 responses were received (25% response rate), with 125/481 in phase 1 (26%) and 79/320 (25%). Respondents comprised of intensivists (82%), anesthetists (8%), ICU nurses (8%), and emergency HCWs (2%). For the final analysis, 183 responses from intensivists/anesthetists were included. Most respondents were from Private Hospitals ($n = 137$; 75%). The remainder were from Government Hospitals ($n = 23$; 12%) and Medical Colleges ($n = 24$; 13%). There were interstate variations (Supplementary Fig. 2).

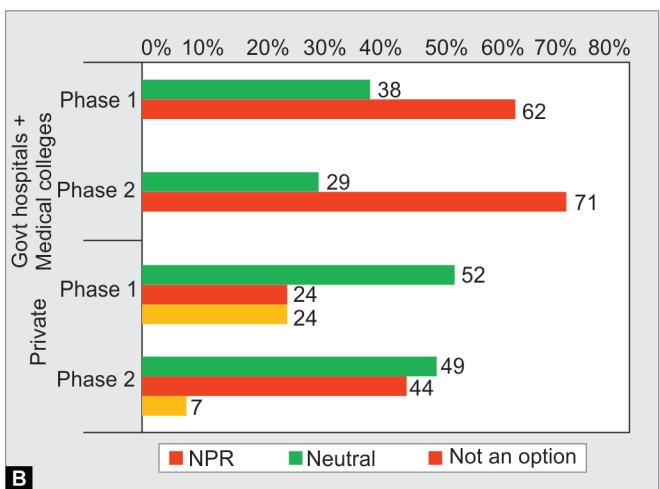
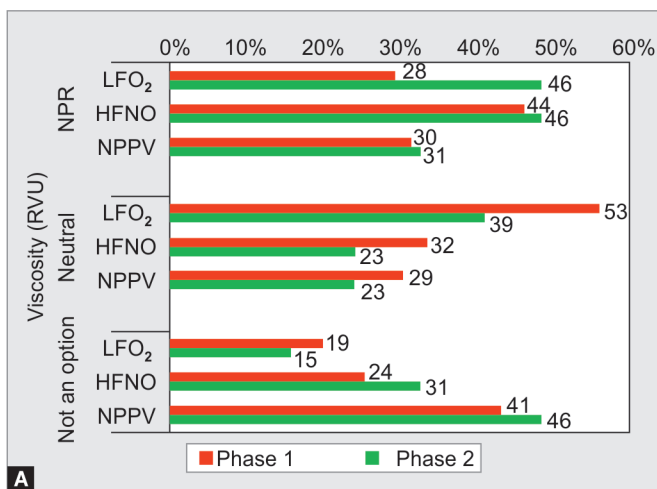
More than 60% of respondents did not prefer a neutral-pressure room in managing the non-intubated hypoxemic COVID-19 patient in the clinical vignette (Fig. 1). Respondents from first-responder hospitals were more willing to manage such patients in neutral pressure rooms, while respondents from private hospitals preferred negative-pressure rooms ($p < 0.001$). There was a significant increase in the proportion of private hospital intensivists/anesthetists who reported that they would not use any form of noninvasive oxygen therapy for COVID-19 patients (7% in phase 1 vs 24% in phase 2; $p < 0.001$). Significantly more respondents reported that they would not use HFNO (24 vs 31%; $p = 0.02$) and NPPV (41–46%; $p = 0.70$) in phase 2 compared to phase 1.

When specifically explored about oxygen therapies, significant variations emerged between phases 1 and 2 for all forms of noninvasive oxygen therapies (Fig. 2). In both the phases, private hospital intensivists/anesthetists were less comfortable to use any form of noninvasive oxygen therapies in neutral-pressure rooms compared to first-responder hospitals (LFO₂—72 vs 50%, $p < 0.01$; HFNO—47 vs 24%, $p < 0.01$ and NPPV—38 vs 28%, $p = 0.20$). The proportion of respondents who reported that LFO₂ was either not an option at all or unwilling to use LFO₂ in neutral pressure rooms increased from 54% in phase 1 to 73% in phase 2; $p = 0.02$. Correspondingly, the proportion of those who were unwilling to use HFNO in neutral-pressure rooms also reduced from 32 to 23% ($p = 0.20$). Only 25% of respondents were comfortable in managing NPPV in neutral-pressure rooms, which reduced from 29 to 23% from phase 1 to phase 2 ($p = 1.00$). Figure 2B demonstrated that the respondents had a negative trend in comfort levels with the increasing complexity of oxygenation therapies in neutral-pressure rooms.

DISCUSSION

This survey identified interesting results that are relevant in managing non-intubated COVID-19 patients with hypoxemic respiratory failure. Regarding the mode of oxygen therapy, fewer clinicians seemed comfortable in using HFNO/NPPV compared to LFO₂. Regarding the location of managing non-intubated COVID-19 patients, fewer clinicians were comfortable to offer any form of noninvasive oxygen therapy in neutral-pressure rooms (including LFO₂), especially in phase 2. This tendency was significantly higher in private hospitals compared to first-responder hospitals.

These results assume relevance in the setting of controversies and concerns of SARS-CoV-2 being transmitted as aerosols.^{21–23} Recently, 239 scientists from 32 countries wrote an open letter urging the World Health Organization (WHO) and other bodies to address the potential for airborne transmission of the coronavirus.²¹ In response, the WHO has reaffirmed its original position that although SARS-CoV-2 transmission occurs primarily through contact or droplets, the airborne transmission may occur with aerosol-generating procedures in healthcare settings.²³ Therefore,



Figs 1A and B: Proposed location to treat confirmed COVID patients requiring ICU admission: (A) Comfort levels of doctors with different noninvasive oxygenation therapies based on negative pressure room (NPR), neutral pressure room and not an option* for the two phases; (B) Represents distribution based on the type of institution (First-responder** and Private Hospitals) based on phases 1 and 2 refer Supplementary Figure 1 for the statewide distribution and variation among them (presented as actual numbers). *Not an option—implies that there is no role for the type of oxygenation therapy and patients intubated early; **First-responder Hospitals—Government Hospitals and Medical College Hospitals



Figs 2A and B: Oxygenation management preferences: (A) The respondents' comfort levels for different noninvasive oxygenation therapies based on the type of hospitals they worked; (B) The proportion of respondents' discomfort logarithmically dropped, more so in phase 2 with the increasing complexity of oxygenation therapies in neutral pressure room in the two phases. NPR, negative pressure room. *First-responder Hospitals—Government Hospitals and Medical College Hospitals

the choice of noninvasive oxygen therapies and/or patient cohorts may directly impact HCW-infection risk.

In India, concerns from the early phase of the pandemic, namely shortages of hospital beds, personal protective equipment (PPE), and ventilators may have been addressed by the creation of new COVID-19 hospitals and increased domestic manufacturing of PPE²⁴ and ventilators.²⁵ However, there may still be a lack of negative-pressure rooms and skilled personnel for complex COVID-19 ICU management. Therefore, noninvasive oxygen therapies may have an important role, provided ICUs employ safe PPE practice and engineering solutions as outlined in a comprehensive position statement by the Indian Society of Critical Care Medicine (ISCCM).²⁶ We urge that all ICUs, both existing and new makeshift hospitals/ICUs follow the principles outlined in that statement.^{27,28} The variation in practices among different states and private vs first-responders may reflect differential resource availability. This may need resolution at national, state, and local levels.

To the best of our knowledge, this study was the first to evaluate the oxygen-therapy practices in Indian ICUs for COVID-19 patients. It reflects the opinions of senior clinicians in a decision-making capacity with a good geographical spread across India. It was done

in two time periods, from the early phase of the pandemic and also during the initial surge. The use of a case vignette made the question clinically relevant.

We acknowledge the following limitations. Given that the study was conducted in late March to April, the opinions of the respondents may have further evolved over time. Currently, India is stage 3 with community transmission. However, when this survey was performed, India was still in stage 2. Inherent to any surveys, there may be a likely bias among the sample of respondents. In addition, we did not evaluate other emerging therapies for non-intubated patients, such as, the use of non-rebreathing masks,²⁹ helmet NPPV masks,³⁰ ICU-bed ventilation hoods,^{8,31} or adopting awake self-prone positioning.³²⁻³⁶

CONCLUSION

In the setting of controversies surrounding SARS-CoV-2 transmission, this survey of Indian intensivists/anesthetists from 24 states demonstrated that doctors predominantly preferred managing noninvasive oxygen therapies in negative-pressure rooms. There was variability in the location of proposed therapy between private hospitals and first-responder hospitals. Since societal guidelines

advocate a role for noninvasive oxygen therapy in managing the early stages of COVID-19 pneumonia, while rigorously conforming to the ISCCM position statement on safe PPE practice, while more data on the spread of COVID-19 pneumonia emerges.

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Supplementary Figure 1: The 2 questions in the Survey, discussed in this article.

1 What is the proposed location to treat confirmed COVID patients requiring ICU admission? *

More than one answer may be chosen

Check all that apply.

- Negative-pressure room
- Negative flow room
- Neutral pressure single room in a general pod with other non-COVID patients
- Cohorted with other COVID patients in a dedicated COVID pod

Other: _____

2 A young well-functioning patient has confirmed COVID. His resp. rate is 30/min with Sats ~80-85% on room air. Other systems are normal. What O₂ therapy is considered appropriate in your hospital? *

More than one answer may be chosen

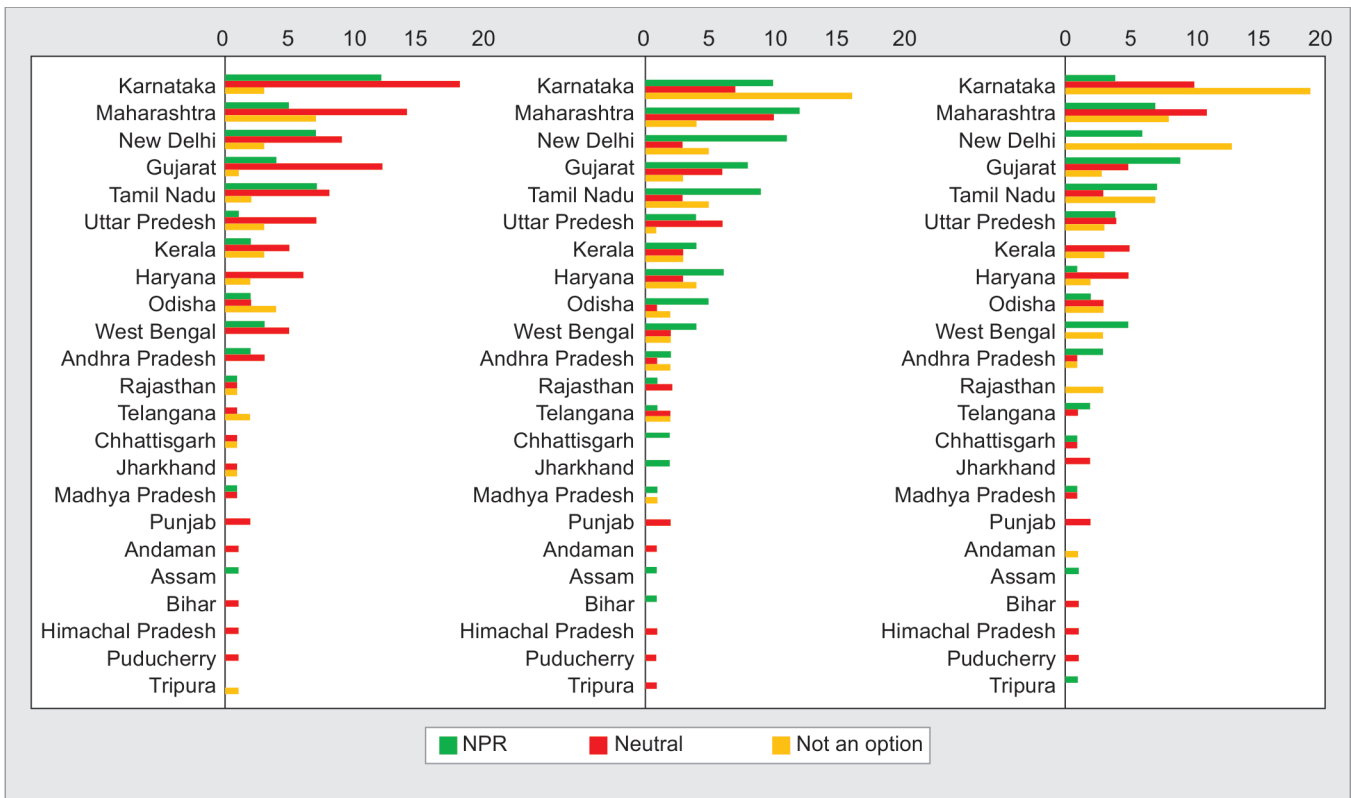
Check all that apply.

	Not an option in COVID	In negative pressure room	Neutral-pressure single room	Ward or Dedicated ICU pod of cohorted COVID patients
Low-flow nasal prongs (<6 L/min)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
High-flow nasal prongs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CPAP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3



Oxygen Therapies in Indian ICUs



Supplementary Fig. 2: Variation in comfort levels of intensivists/anesthetists from different states and territories in using noninvasive oxygenation therapies in managing the patient described in the clinical vignette