ISSN 2515-8260 Volume 10, Issue 05, 2023

Scoping Review of the Effectiveness of Noninvasive Ventilation in the Management of COVID-19 Patients

Ahmad Alessa
alessarrt@gmail.com, Respiratory Specialist, Respiratory Therapy Administration, King Abdullah Medical City, Makkah, Kingdom of Saudi Arabia
Mahmoud Yassin
Dryassin1@gmail.com, Intensive care units department, Anesthesia & Critical care consultant, King Abdullah Medical City, Makkah, Kingdom of Saudi Arabia.
Dalya Abudawood
dabudawood22@gmail.com, Respiratory Specialist, Respiratory Therapy Administration, King Abdullah Medical City, Makkah, Kingdom of Saudi Arabia
Abdullah Aloraini
Aloraini.Abdullah.M@gmail.com, Respiratory Specialist, Respiratory Therapy Administration, Al-Noor Specialist Hospital, Makkah, Kingdom of Saudi Arabia
Nawar Almuntashiri
nawar3306@gmail.com, Respiratory Specialist, Respiratory Therapy Administration, Al-Noor Specialist Hospital, Makkah, Kingdom of Saudi Arabia.
Abdulaziz Fattani
Abdulazizfattani@outlook.com, Respiratory Specialist, Respiratory Therapy Administration, Al-Noor Specialist Hospital, Makkah, Kingdom of Saudi Arabia.
Yousef Alanazi
yo77yo77@gmail.com, Radiology Technologist, Hafer Albaten central hospital esterin , Hafer albaten, kingdom of Saudi Arabia.

Abstract

In 2020, COVID-19 caused a global pandemic that caused healthcare professionals to be on the frontline. Due to respiratory failures associated with this condition, strategies were needed to improve the respiration of patients diagnosed with COVID-19 disease. An intervention that was extensively adopted as a substitute for invasive ventilation is noninvasive ventilation (NIV). However, there is limited evidence on the effectiveness and safety of this intervention. The aim of this scoping review was to map the existing literature on the use of NIV for COVID-19 patients and identify gaps in knowledge. A systematic search using appropriate keywords was conducted on three selected electronic databases; PubMed, Cochrane Library, and CINAHL by two independent reviewers. After applying the inclusion and exclusion criteria, a total of 30 studies were used for the scoping review. Data was extracted from the studies and the results were presented and discussed. The results of the scoping review showed that some studies presented evidence that supported the effectiveness of NIV. However, some other studies could not provide strong evidence for the efficiency of NIV based on statistical grounds. Also, no negative consequences were identified from the studies regarding the use of NIV in managing patients with COVID-19. Hence, the findings from this study suggest that even though NIV

improved the conditions of patients, more studies of high-level and high-quality ratings are needed to provide strong evidence regarding its efficiency.

Introduction

The year 2020 was a year when COVID-19 became a global pandemic and healthcare workers were on the frontline, utilizing different methods and strategies to provide care for patients. Patients diagnosed with the disease were known to exhibit some symptoms. Acute respiratory failures type 1 were one of the characteristic symptoms experienced by patients with COVID-19 (Yaroshetskiy et al., 2022). The pandemic resulted in a significant increase in the number of patients requiring respiratory support more than the available resources (Ogawa et al., 2021). Therefore, healthcare workers took measures to improve the respiration of patients diagnosed with the condition in an effort to improve their health.

To support these patients, early invasive ventilation was utilized as an intervention during the first year of the pandemic (Kallet, 2021). However, there were controversies regarding its efficiency and other strategies were considered in providing respiratory care. Non-invasive ventilation (NIV) was adopted as one of the strategies for managing respiratory failures in patients diagnosed with COVID-19 (Schifino et al., 2022). Consequently, NIV was used extensively as a substitute for invasive ventilation (Dargent et al., 2022). However, there is limited evidence on the effectiveness and safety of NIV in this population. Hence, the objective of this scoping review was to map the existing literature on the use of NIV in COVID-19 patients and identify gaps in knowledge. The justification for the conduct of this scoping review is that the impact of the pandemic is still being felt in many parts of the world. The availability of strong evidence in providing respiratory care to patients with COVID-19 can provide valuable information for healthcare workers. These findings can help to effectively manage patients diagnosed with the disease. It will also help in making adequate preparation for other potential health risks.

Methods

In conducting this scoping review, a systematic search was conducted on selected electronic databases for available studies that were relevant to the topic. Three databases were consulted namely; PubMed, Cochrane Library, and CINAHL. For each of the databases, the following keywords were used for an advanced search: “COVID-19”, “noninvasive ventilation”, “respiratory failure”, and “critical care”. Since the pandemic started in 2020, there was no use searching for articles that were related to the topic of interest in this scoping review earlier than 2020. Hence, the time criteria during the search were set from January 2020 to May 2023. The returned articles were screened by two independent reviewers using their titles and articles with titles that related to the topic of interest in this review were included in the study.

Furthermore, the articles were screened using their abstract to exclude studies that did not focus on COVID-19 patients as the population of interest and those that did not have a full text available. Finally, the articles from both reviewers were compared, and the articles present in the selection of both reviewers were used for the scoping review. For each of the selected articles, data extraction was completed in Microsoft Excel containing relevant information including

study design, patient characteristics, intervention details, outcome measures, and results. Finally, the results from the data extraction were presented and described in this review, identifying the findings, knowledge gaps and areas for future research.

Results

A total of 303 studies were screened from the three electronic databases. After applying the inclusion and exclusion criteria already mentioned, a total of 30 studies were selected and used for the scoping review. The following Table 1 shows the study selection process with details from each database and the final number of studies selected for the scoping review.

Table 1

The Study Selection Process

Database Source	Articles Returned	Articles Included	Articles Excluded	Articles Selected
PubMed	267	78	55	23
CINAHL	5	5	0	5
Cochrane Library	31	3	1	2
Total	**303**	**86**	**56**	**30**

The results from the data extraction showed that 10% of the studies were published in 2020 (n = 3), 43% of the studies were published in 2021 (n = 13), 43% of the studies were published in 2022 (n = 13), and 3% of the studies were published in 2023 (n =1). The details of intervention used often by the researchers from the selected studies included awake prone positioning, helmet NIV, a high-flow nasal cannula (HFNC), and Continuous Positive Airway Pressure (CPAP). Moreover, the variables of outcome measures often adopted in the studies included mortality rate, intubation rate, length of stay in the intensive care unit (ICU), duration of respiratory failure, rate of NIV failure and improvement in patient's conditions. There was no issue regarding the safety of NIV for patients with COVID-19 from the results.

Furthermore, the results showed that the number of studies used in this scoping review based on research design fell into one of six different designs namely reviews (Crimi et al., 2021; Cumpstey et al., 2020; Kallet, 2021; Lewis et al., 2021; Ogawa et al., 2021; Pelosi et al., 2022; Sullivan et al., 2022; Wu & Shkolnik, 2023) systematic reviews with meta-analysis (Cammarota et al., 2021; Fazzini et al., 2022; Li et al., 2022; Papoutsi et al., 2021; Peng et al., 2022), observational studies (Dargent et al., 2022; Garcia et al., 2022; Garner et al., 2021; Yaroshetskiy et al., 2022), case studies (Andrade Filho et al., 2021; Rajamani et al., 2020; Simioli et al., 2021), randomized clinical trials (Adly et al., 2021; Alhazzani et al., 2022; Grieco et al., 2021; Nair et al., 2021; Perkins et al., 2022; Schifino et al., 2022), and cohort studies (Coppo et al., 2020; Costa et al., 2022; Goel et al., 2022; Kovačević et al., 2021). The following Figure 1 shows the number of studies used in this scoping review based on the different research designs.

ISSN 2515-8260 Volume 10, Issue 05, 2023

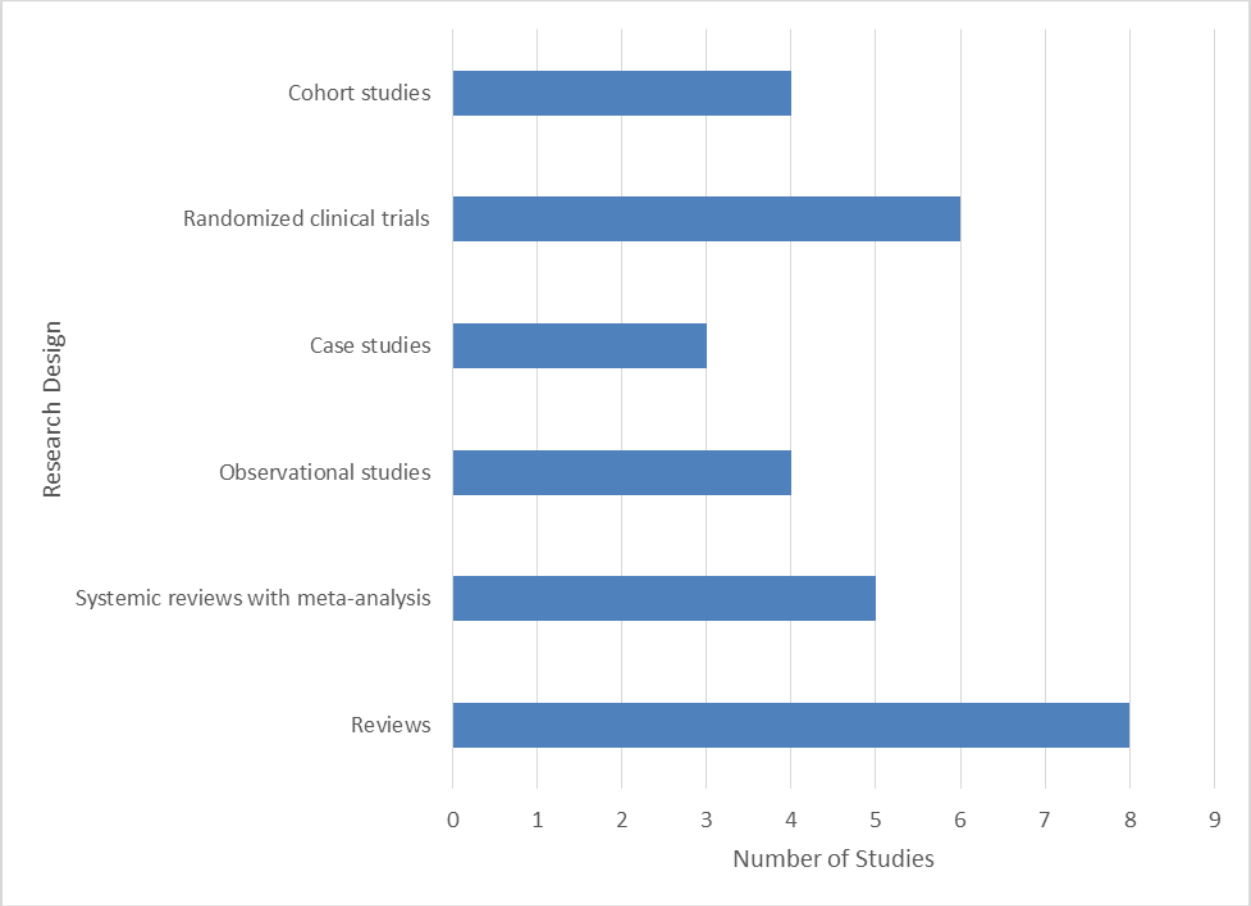

Figure 1

Number of Studies Based on Research Design

Regarding the results from each of the studies selected for this scoping review, some of the studies reported that NIV was effective in the management of respiratory problems in COVID-19 patients (Alhazzani et al., 2022; Kallet, 2021; Schifino et al., 2022). However, some other findings reported no convincing evidence as there was no significant difference between NIV and the compared intervention (Grieco et al., 2021; Nair et al., 2021; Peng et al., 2022).

Discussion

From the results of this scoping review, it was clear that there was an increase in the number of studies focused on improving the respiratory problems of patients faced with COVID-19. The number of studies following the year of the pandemic and the subsequent year had the same number of studies included in this scoping review. Even though there is a little ease regarding the pandemic and things have gone back to normal relatively, some scholars are still conducting studies on this topic of interest. Hence, there was a study published this year that relates to the topic of interest (Wu & Shkolnik, 2023).

Interestingly, quite several studies were literature reviews, but the number of the original research was still higher than the reviews (including those with meta-analysis), occupying about 57% percent. This trend shows a potential gap and calls for the need for more original studies

with high levels of evidence, especially those involving randomized controlled trials. Nevertheless, it cost implications of conducting such studies are high and researchers would require funding to carry out such a high level of work.

From the findings of this scoping review, there seems to be no strong evidence supporting the effectiveness of NIV. Even though some of the studies reported that NIV was effective in managing the respiratory problems of patients with COVID-19, there were other studies that could not infer such based on statistical ground. Consequently, the need for more quantitative studies with larger sample sizes could help in providing findings that could be applied to professional practices. Another suggestion for further studies to extend this work could be the conduct of another scoping review that utilizes only Level I and Level II evidence for the review. However, the number of available studies meeting such criteria may end up too small to make meaningful inferences and conclusions.

Nevertheless, some important findings that this scoping review shows include the fact that NIV is still being used by healthcare professionals and it has merits in helping COVID-19 patients experiencing moderate to severe respiratory failures type 1. The use of prone positioning and HFNC were also highlighted in the findings of this study. Overall, the scoping review shows that the use of NIV for managing respiratory failures type 1 in patients with COVID-19 is helpful in improving the patient's condition. However, other factors such as timing, duration, and physiological condition of the patients should also be considered. These factors ultimately impact the effectiveness of the use of NIV for patients with COVID-19.

It is worth mentioning that this scoping review is not without limitations. There are some limitations to this study. Firstly, the review covered different kinds of studies, including articles that are considered to provide a low level of evidence such as literature reviews. Nevertheless, it also contained those with high levels of evidence such as randomized controlled trials. Perhaps, another study utilizing only research with a high level of evidence and ratings could be conducted as a future study ad it may present stronger evidence regarding the use of NIV for the management of COVID-19 patients. Another limitation of this study was the fact that some articles which were earlier identified were excluded due to the unavailability of the full article. It is possible that access to the full content of such studies could help in providing more data that was used in the scoping review which might have affected the results and findings from this study.

However, there is also a strength in the methodology adopted for this scoping review. The use of two independent reviewers helped in reducing potential research bias from the investigator. Hence, it helps in validating the data used for this scoping review as the reviews performed their search and screening independently using the keywords mentioned. Another strength in the methodology adopted in this scoping review is the mapping out of data extracted from each of the studies in Microsoft Excel. The approach helped in presenting the data easily which enabled easy identification of areas that stood out.

Conclusion

In conclusion, this scoping review was conducted to provide information regarding the use of NIV in the management of COVID-19 patients. Based on the findings from this review, healthcare workers can continue to utilize NIV in managing respiratory problems in patients with COVID-19. From the review, there was no issue regarding the safety of NIV for patients with COVID-19. Furthermore, the study was able to highlight some areas that could be considered for future studies. As healthcare professionals continue to provide respiratory care to patients in this population, the other factors mentioned that could influence the success and effectiveness of NIV should also be considered.

References

Adly, A. S., Adly, M. S., & Adly, A. S. (2021). Telemanagement of home-isolated COVID-19 patients using oxygen therapy with noninvasive positive pressure ventilation and physical therapy techniques: Randomized clinical trial. *Journal of Medical Internet Research*, *23*(4), e23446. https://doi.org/10.2196/23446

Alhazzani, W., Parhar, K. K., Weatherald, J., Al Duhailib, Z., Alshahrani, M., Al-Fares, A., Buabbas, S., Cherian, S. V., Munshi, L., Fan, E., Al-Hameed, F., Chalabi, J., Rahmatullah, A. A., Duan, E., Tsang, J. L., Lewis, K., Lauzier, F., Centofanti, J., Rochwerg, B., … Idrees, K. (2022). Effect of awake prone positioning on endotracheal intubation in patients with COVID-19 and acute respiratory failure. *JAMA*, *327*(21), 2104–2113. https://doi.org/10.1001/jama.2022.7993

Andrade Filho, P. H., Brasil, E. S., Costa, L. G., M Sousa, D. E., Pereira, T. S., & Silva, J. M. (2021). Prediction of extubation failure in COVID-19. *Respiratory Care*, *66*(8), 1323–1329. https://doi.org/10.4187/respcare.08564

Cammarota, G., Esposito, T., Azzolina, D., Cosentini, R., Menzella, F., Aliberti, S., Coppadoro, A., Bellani, G., Foti, G., Grasselli, G., Cecconi, M., Pesenti, A., Vitacca, M., Lawton, T., Ranieri, V. M., Di Domenico, S. L., Resta, O., Gidaro, A., Potalivo, A., … De Robertis, E. (2021). Noninvasive respiratory support outside the intensive care unit for acute respiratory failure related to coronavirus-19 disease: A systematic review and meta-analysis. *Critical Care*, *25*(1), 1–14. https://doi.org/10.1186/s13054-021-03697-0

Coppo, A., Bellani, G., Winterton, D., Di Pierro, M., Soria, A., Faverio, P., Cairo, M., Mori, S., Messinesi, G., Contro, E., Bonfanti, P., Benini, A., Valsecchi, M. G., Antolini, L., & Foti, G. (2020). Feasibility and physiological effects of prone positioning in non-intubated patients with acute respiratory failure due to COVID-19 (pron-COVID): A prospective Cohort Study. *The Lancet Respiratory Medicine*, *8*(8), 765–774. https://doi.org/10.1016/s2213-2600(20)30268-x

Costa, W. N., Miguel, J. P., Prado, F. dos, Lula, L. H., Amarante, G. A., Righetti, R. F., & Yamaguti, W. P. (2022). Noninvasive ventilation and high-flow nasal cannula in patients with acute hypoxemic respiratory failure by covid-19: A retrospective study of the feasibility, safety and outcomes. *Respiratory Physiology & Neurobiology*, *298*(103842), 1–7. https://doi.org/10.1016/j.resp.2022.103842

Crimi, C., Pierucci, P., Renda, T., Pisani, L., & Carlucci, A. (2021). High-flow nasal cannula and COVID-19: A clinical review. *Respiratory Care*, *67*(2), 227–240. https://doi.org/10.4187/respcare.09056

Cumpstey, A. F., Oldman, A. H., Smith, A. F., Martin, D., & Grocott, M. P. (2020). Oxygen targets in the intensive care unit during mechanical ventilation for acute respiratory distress syndrome: A rapid review. *Cochrane Database of Systematic Reviews*, *2020*(10), 1–24. https://doi.org/10.1002/14651858.cd013708

Dargent, A., Hombreux, A., Roccia, H., Argaud, L., Cour, M., & Guérin, C. (2022). Feasibility of non-invasive respiratory drive and breathing pattern evaluation using CPAP in COVID-19 patients. *Journal of Critical Care*, *69*(154020), 1–4. https://doi.org/10.1016/j.jcrc.2022.154020

Fazzini, B., Page, A., Pearse, R., & Puthucheary, Z. (2022). Prone positioning for non-intubated spontaneously breathing patients with acute hypoxaemic respiratory failure: A systematic review and meta-analysis. *British Journal of Anaesthesia*, *128*(2), 352–362. https://doi.org/10.1016/j.bja.2021.09.031

Garcia, M. A., Johnson, S. W., Sisson, E. K., Sheldrick, C. R., Kumar, V. K., Boman, K., Bolesta, S., Bansal, V., Bogojevic, M., Domecq, J., Lal, A., Heavner, S., Cheruku, S. R., Lee, D., Anderson, H. L., Denson, J. L., Gajic, O., Kashyap, R., & Walkey, A. J. (2022). Variation in use of high-flow nasal cannula and noninvasive ventilation among patients with covid-19. *Respiratory Care*, *67*(8), 929–938. https://doi.org/10.4187/respcare.09672

Garner, O., Dongarwar, D., Salihu, H. M., Barrantes Perez, J. H., Abraham, J., McBride, C., Mathew, S., Antony, P., Collins, K., Richards, K. L., & Howard, C. M. (2021). Predictors of failure of high flow nasal cannula failure in acute hypoxemic respiratory failure due to COVID-19. *Respiratory Medicine*, *185*(106474), 1–3. https://doi.org/10.1016/j.rmed.2021.106474

Goel, N. N., Eschbach, E., McConnell, D., Beattie, B., Hickey, S., Rozehnal, J., Leibner, E., Oldenburg, G., & Mathews, K. S. (2022). Predictors of respiratory support use in emergency department patients with COVID-19-related respiratory failure. *Respiratory Care*, *67*(9), 1091–1099. https://doi.org/10.4187/respcare.09772

Grieco, D. L., Menga, L. S., Cesarano, M., Rosà, T., Spadaro, S., Bitondo, M. M., Montomoli, J., Falò, G., Tonetti, T., Cutuli, S. L., Pintaudi, G., Tanzarella, E. S., Piervincenzi, E., Bongiovanni, F., Dell'Anna, A. M., Delle Cese, L., Berardi, C., Carelli, S., Bocci, M. G., … Zaccone, C. (2021). Effect of helmet noninvasive ventilation vs high-flow nasal oxygen on days free of respiratory support in patients with COVID-19 and moderate to severe hypoxemic respiratory failure. *JAMA*, *325*(17), 1731–1743. https://doi.org/10.1001/jama.2021.4682

Kallet, R. H. (2021). 2020 year in review: Mechanical ventilation during the first year of the COVID-19 pandemic. *Respiratory Care*, *66*(8), 1341–1362. https://doi.org/10.4187/respcare.09257

Kovačević, M., Rizvanović, N., & Adilović, A. Š. (2021). Predictive factors for noninvasive mechanical ventilation failure among COVID-19 critically ill patients - a retrospective cohort study. *Med Glas (Zenica)*, *18*(2), 362–369. https://doi.org/10.17392/1385-21

Lewis, S. R., Baker, P. E., Parker, R., & Smith, A. F. (2021). High-flow nasal cannulae for respiratory support in adult Intensive Care Patients. *Cochrane Database of Systematic Reviews*, *2021*(3), 1–162. https://doi.org/10.1002/14651858.cd010172.pub3

Li, J., Luo, J., Pavlov, I., Perez, Y., Tan, W., Roca, O., Tavernier, E., Kharat, A., McNicholas, B., Ibarra-Estrada, M., Vines, D. L., Bosch, N. A., Rampon, G., Simpson, S. Q., Walkey, A. J., Fralick, M., Verma, A., Razak, F., Harris, T., … Pacheco, A. (2022). Awake prone positioning for non-intubated patients with COVID-19-related acute hypoxaemic respiratory failure: A systematic review and meta-analysis. *The Lancet Respiratory Medicine*, *10*(6), 573–583. https://doi.org/10.1016/s2213-2600(22)00043-1

Nair, P. R., Haritha, D., Behera, S., Kayina, C. A., Maitra, S., Anand, R. K., Ray, B. R., Soneja, M., Subramaniam, R., & Baidya, D. K. (2021). Comparison of high-flow nasal cannula and noninvasive ventilation in acute hypoxemic respiratory failure due to severe COVID-19 pneumonia. *Respiratory Care*, *66*(12), 1824–1830. https://doi.org/10.4187/respcare.09130

Ogawa, K., Asano, K., Ikeda, J., & Fujii, T. (2021). Non-invasive oxygenation strategies for respiratory failure with COVID-19: A concise narrative review of literature in pre and Mid-covid-19 era. *Anaesthesia Critical Care & Pain Medicine*, *40*(100897), 1–9. https://doi.org/10.1016/j.accpm.2021.100897

Papoutsi, E., Giannakoulis, V. G., Xourgia, E., Routsi, C., Kotanidou, A., & Siempos, I. I. (2021). Effect of timing of intubation on clinical outcomes of critically ill patients with covid-19: A systematic review and meta-analysis of non-randomized cohort studies. *Critical Care*, *25*(1), 1–9. https://doi.org/10.1186/s13054-021-03540-6

Pelosi, P., Tonelli, R., Torregiani, C., Baratella, E., Confalonieri, M., Battaglini, D., Marchioni, A., Confalonieri, P., Clini, E., Salton, F., & Ruaro, B. (2022). Different methods to improve the monitoring of noninvasive respiratory support of patients with severe pneumonia/ARDS due to COVID-19: An update. *Journal of Clinical Medicine*, *11*(6), 1–21. https://doi.org/10.3390/jcm11061704

Peng, Y., Dai, B., Zhao, H., Wang, W., Kang, J., Hou, H., & Tan, W. (2022). Comparison between high-flow nasal cannula and noninvasive ventilation in COVID-19 patients: A systematic review and meta-analysis. *Therapeutic Advances in Respiratory Disease*, *16*, 175346662211136. https://doi.org/10.1177/17534666221113663

Perkins, G. D., Ji, C., Connolly, B. A., Couper, K., Lall, R., Baillie, J. K., Bradley, J. M., Dark, P., Dave, C., De Soyza, A., Dennis, A. V., Devrell, A., Fairbairn, S., Ghani, H., Gorman, E. A., Green, C. A., Hart, N., Hee, S. W., Kimbley, Z., … Bentley, A. (2022). Effect of noninvasive respiratory strategies on intubation or mortality among patients with acute hypoxemic respiratory failure and COVID-19. *JAMA*, *327*(6), 546–558. https://doi.org/10.1001/jama.2022.0028

Rajamani, A., Subramaniam, A., Ramanathan, K., & Haji, J. Y. (2020). Non-invasive oxygen strategies to manage confirmed COVID-19 patients in Indian Intensive Care Units: A survey. *Indian Journal of Critical Care Medicine*, *24*(10), 926–931. https://doi.org/10.5005/jp-journals-10071-23640

Schifino, G., Vega, M. L., Pisani, L., Prediletto, I., Catalanotti, V., Comellini, V., Bassi, I., Zompatori, M., Ranieri, M. V., & Nava, S. (2022). Effects of non-invasive respiratory supports on inspiratory effort in moderate-severe COVID-19 patients. A randomized physiological study. *European Journal of Internal Medicine*, *100*, 110–118. https://doi.org/10.1016/j.ejim.2022.04.012

Simioli, F., Annunziata, A., Langella, G., Martino, M., Musella, S., & Fiorentino, G. (2021). Early prone positioning and non-invasive ventilation in a critical COVID-19 subset. A single centre experience in Southern Italy. *Turkish Thoracic Journal*, *22*(1), 57–61. https://doi.org/10.5152/turkthoracj.2021.20158

Sullivan, Z. P., Zazzeron, L., Berra, L., Hess, D. R., Bittner, E. A., & Chang, M. G. (2022). Noninvasive respiratory support for COVID-19 patients: When, for whom, and how? *Journal of Intensive Care*, *10*(1), 1–10. https://doi.org/10.1186/s40560-021-00593-1

Wu, G. P., & Shkolnik, B. (2023). Noninvasive ventilation alone cannot solve COVID-19 respiratory failure. *Annals of Emergency Medicine*, *81*(2), 159–161. https://doi.org/10.1016/j.annemergmed.2022.09.006

Yaroshetskiy, A. I., Merzhoeva, Z. M., Tsareva, N. A., Trushenko, N. V., Nuralieva, G. S., Konanykhin, V. D., Krasnoshchekova, A. P., & Avdeev, S. N. (2022). Breathing pattern, accessory respiratory muscles work, and gas exchange evaluation for prediction of NIV failure in moderate-to-severe covid-19-associated ards after deterioration of respiratory failure outside ICU: The Covid-Niv Observational Study. *BMC Anesthesiology*, *22*(1). https://doi.org/10.1186/s12871-022-01847-7