NON-INVASIVE VENTILATION OF PATIENTS WITH COVID-19 PNEUMONIA

Laura Kozina, Vesna Bratić, Slobodan Mihaljević
Clinic for Anesthesiology, Resuscitation, Intensive Care Medicine and Pain Therapy,
University Hospital Centre Zagreb, 10 000 Zagreb, Croatia
Received on 29. 8. 2024. *Reviewed on 10. 10. 2024.* *Accepted on 7. 4. 2025.*

ABSTRACT

Introduction: In difficult clinical scenarios, non-invasive ventilation has become a ubiquitous therapeutic option, providing vital respiratory support without the need for invasive endotracheal intubation. It is necessary to emphasize the importance of researching the use of non-invasive ventilation in the context of coronavirus disease 2019 (COVID-19) pneumonia, analyzing its role, effectiveness, and clinical outcomes. The method of non-invasive ventilation began to be used in intensive care units, and its peak of use was in wards during the COVID-19 pandemic.

Objective: To present the results of the success of the use of non-invasive ventilation in patients in whom the use of this type of ventilation was required in comparison with the use of oxygen and high-flow oxygen.

Subjects and methods: A retrospective study was conducted in the period between January 2021 and January 2023. 17 patients treated in the COVID ward of KBC Zagreb were included. The collected data is anonymous for research purposes, which means that all data is protected and processed in the BIS (hospital information system) system.

Results: The type of ventilation affected the outcome of treatment, as shown in the following results: patients who received oxygen completed their treatment successfully (75%), while one patient died. Of the 9 patients who received high-flow oxygen therapy, only 4 (44%) survived, and of the 4 patients who received non-invasive ventilation (NIV), one died.

Conclusion: The use of NIV in the treatment of patients with COVID-19 pneumonia has been shown to be effective. This study showed that patients with comorbidities (hematological disease) very rarely or never died.

Keywords: non-invasive ventilation, COVID-19 pneumonia

Correspondence: Vesna Bratić, PhD, MA of Nursing; vesna.bratic@kbc-zagreb.hr

INTRODUCTION

According to the definition of the World Health Organization, the coronavirus disease 2019 (COVID-19) is defined as: "Viral disease (COVID-19) which is an infectious disease caused by the SARS-CoV-2 virus" (1). Over time, non-invasive ventilation has become a key therapeutic option in the treatment of most patients with COVID-19 pneumonia, and it enables ventilatory support without the need for invasive endotracheal intubation. One of the key complications that has emerged as a challenge in the treatment of patients suffering from COVID-19 is acute respiratory insufficiency. Non-invasive ventilation became a better solution, enabling ventilatory support through masks and nasal catheters, thus reducing the need for invasive treatment methods. Ventilator placement, i.e. applied oxygenation, selection of appropriate patients and proper monitoring of ventilation parameters are key to successful treatment. Patients with severe pneumonia can develop various complications such as acute respiratory distress syndrome (ARDS), respiratory failure, septic shock and multiorgan dysfunction. It is important to emphasize that early diagnosis, monitoring, and appropriate treatment can improve the clinical outcome in these patients. Noninvasive ventilation (NIV) is ventilator support provided to patients without the use of an endotracheal tube (2). Instead of inserting an endotracheal tube into the airway, NIV is delivered through various interfaces.

This type of ventilation allows patients to breathe independently, but at the same time provides additional support in maintaining adequate ventilation and oxygenation. It is often used in the treatment of acute respiratory failure of various causes, including pulmonary edema, COVID-19 pneumonia, chronic obstructive pulmonary disease (COPD), and neuromuscular disorders. The advantages of such ventilation include fewer complications, shorter intensive care unit stays, increased quality of life, better survival, and reduced risk of potential infections (3). The main goal of NIV is to lower the partial pressure of carbon dioxide in arterial blood (PaCO2) to achieve normocapnia (4-7). The need for mechanical ventilation should be considered whenever spontaneous breathing cannot achieve adequate minute ventilation necessary to maintain Pa02 and PaCO2 and acid-base balance.

The aim of the research was to present the results of the success of the application of non-invasive ventilation in patients in whom the application of this type of ventilation was necessary in relation to the application of oxygen and high-flow nasal cannula therapy (High-Flow Nasal Cannula - HFNC).

SUBJECTS AND METHODS

A retrospective analysis was conducted in the period between January 2021 and January 2023. Patients who were hospitalized in the COVID Department of the KBC (Clinical Hospital Center) Zagreb and who received a certain type of non-invasive ventilation during hospitalization were included.

The exclusion criterion for subjects was that the therapy did not require oxygen therapy, high-flow therapy via nasal cannula, and non-invasive ventilation.

The collected data are anonymous for the purposes of the research, which means that all data are protected and processed in the BIS (hospital information system) system,

and access to the system requires the use of a unique and personal username and password. Each finding and the patient's medical history were regularly updated in the system under the insured person's identification number.

Statistical analysis

The data were processed in the Microsoft Office Professional Plus 2021 program. Descriptive statistics methods were used. The data are presented in absolute and relative numbers.

Ethical statement

The use of data for research purposes was approved by the Ethics Committee of the Zagreb Clinical Hospital, under the number (02/013 AG). All data are relevant and were obtained from the BIS, in available medical histories, and were used exclusively for research purposes.

RESULTS

This study included 17 patients with a mean age of 72 years, of whom 10 were male and 7 were female. The remaining demographic data obtained in this study are presented in the table (Table 1).

Table 1. *Patient demographics*

Age	51-99
Gender	Male – 10 (59%) Female – 7 (41%)
Fatal outcome of treatment	8 (47,05%)
Continuation of treatment in the intensive care unit	5 (29,41%)
Discharge home after hospitalization	4 (23,52%)
Number of patients with hematological disease	4 (23,52%)
Number of patients with respiratory failure	3 (17%)
Number of patients with pneumonia	12 (70,59%)
Total patients	17

In female patients, only O2 was administered more often, and in male patients, HFNC and NIV (Figure 1).

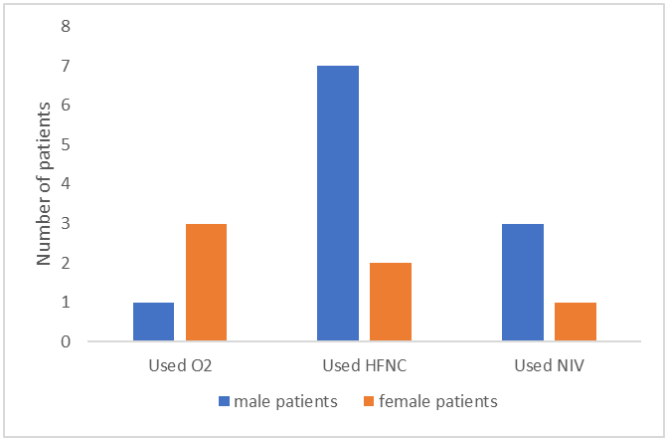

Figure 1. *Gender and ventilation used*

In older patients, mortality was more frequent than in other younger patients (Figure 2).

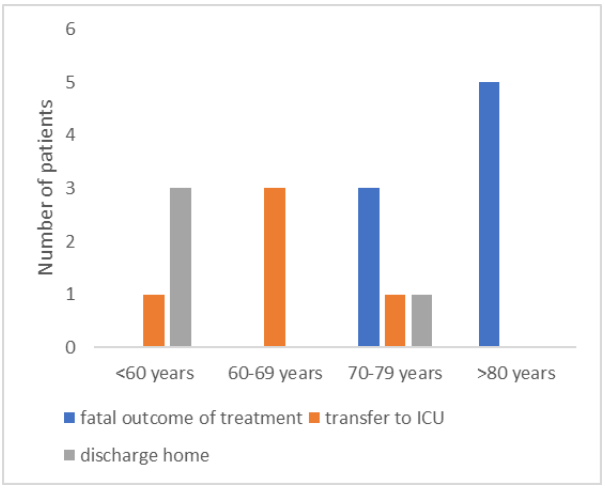

Figure 2. *Treatment outcome in relation to patient age*

HFNC therapy was most commonly used, while NIV and O2 were equally frequently used (Figure 3).

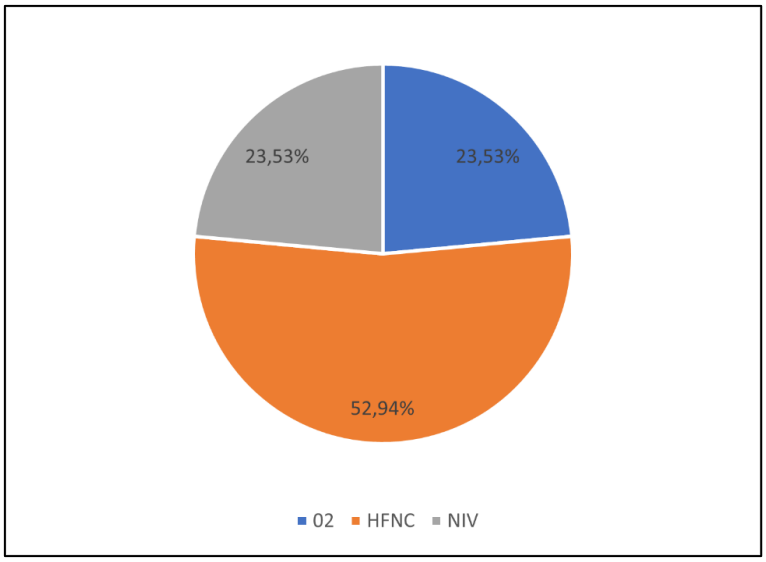

Figure 3. *Type of ventilation applied*

In the conducted study, the highest percentage of patients ended in death (Figure 4).

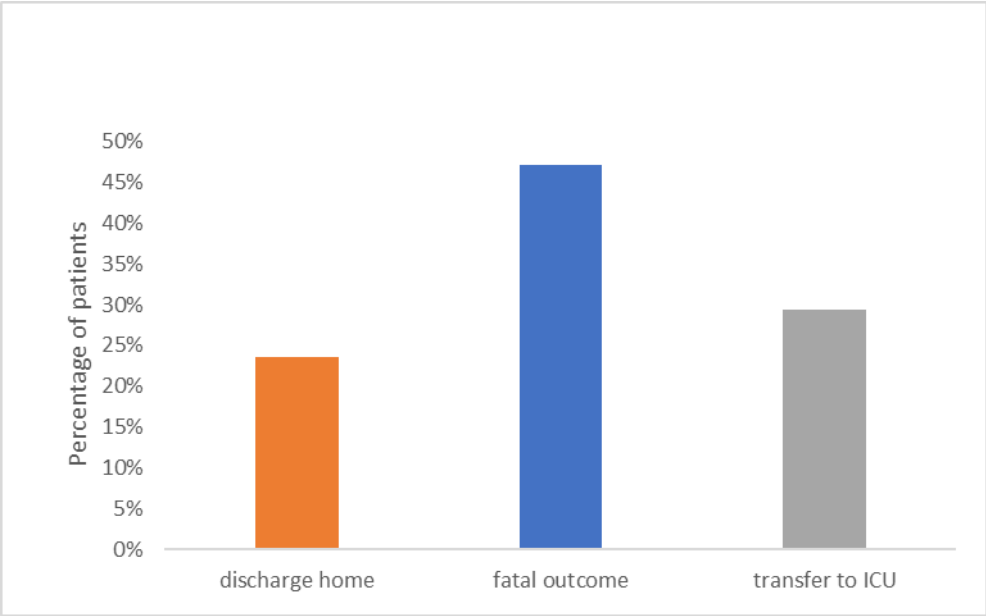

Figure 4. *Comparison of data for patients discharged home, transferred to the Intensive Care Unit (ICU), and those with a fatal outcome*

The data obtained from the study showed that 4 patients were recorded as suffering from hematological diseases, while the remaining 13 did not have any type of comorbidity. It was also shown that patients suffering from hematological diseases (23.52%) did not have a fatal outcome, but those patients who developed pneumonia (41.17%) and respiratory failure (5.88%) were significantly fewer (Figure 5).

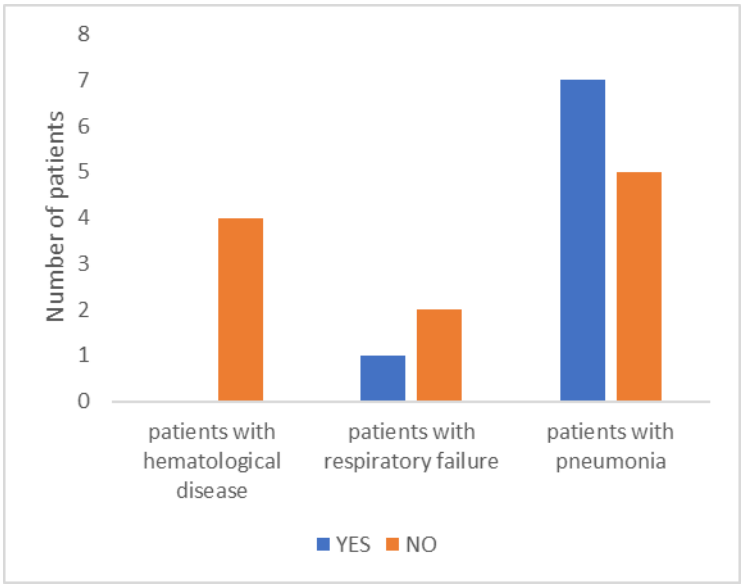

Figure 5. *Mortality due to hematological disease, respiratory failure, and pneumonia*

The type of ventilation affected the outcome of treatment, as shown in the following results: patients who received 02 completed their treatment successfully (75%), while one patient died. Of the 9 patients who received HFNC therapy, only 4 (44%) survived, and of the 4 patients

who received NIV, 3 (75%) survived (Figure 6).

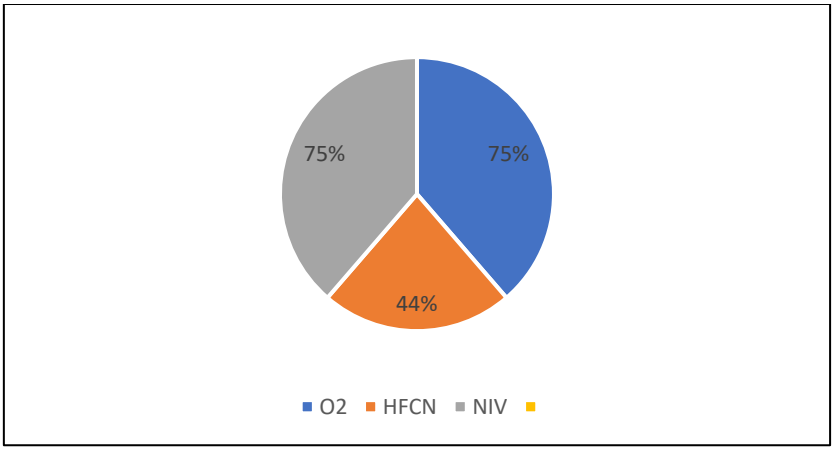

Figure 6. *Treatment outcome according to type of ventilation*

DISCUSSION

The use of noninvasive ventilation in the treatment of COVID-19 pneumonia has significantly impacted patient outcomes during the pandemic. One of the key advantages of NIV is the ability to preserve spontaneous breathing, which helps maintain lung function and reduce disease progression. A study from China by Wang et al. showed a mortality rate of 97% among intubated patients; the median duration of ventilation was 4 days (8). In another study also from China by Meng et al. from China, only 3.2% of a total of 80,409 patients with COVID-19 of all severity were actually intubated (9). A study in Italy by Grasselli et al. on 1591 patients showed that 88% of patients were intubated, while the mortality rate among those who completed intensive care was 64% (10). A study by Srinivasaiah et al. showed that mortality among those intubated within 24 hours of admission was higher compared to those on NIV (11). Ultimately, intubation with invasive ventilation must always be considered as one component of the overall treatment plan. On the one hand, it is often the only way to ensure that the patient receives sufficient oxygen. However, in older individuals with comorbidities and other organ dysfunctions, especially in the case of prolonged ventilation as is the case with COVID-19, complications must be anticipated.

This study presents the results of the effectiveness of non-invasive ventilation in patients with COVID-19 pneumonia and chronic diseases, and the final treatment outcomes are presented. This study included 17 patients, of whom 10 were male (59%) and 7 were female (41%), while in the study conducted by Krivačić, 85 (69.11%) men and 38 (30.89%) women participated (12). The age of the patients in the study ranged from 51 to 99 years, and the average age was 72 years, and in the study conducted by Krivačić in the Karlovac General Hospital it was 65.95 years (12). In the study conducted by Srinivasaiah et al., the age of the patients ranged from 34 to 72 years (11).

This study confirmed that more than half of the patients (53%) received HFNC therapy, while the study by Krivačić conducted in the Karlovac General Hospital showed that for the same

application, 54.27% of patients were treated with NIV, 4 (24%), of whom 3 were male and only 1 female, while in the Jarić study, out of 174 subjects, 102 were documented to have received NIV therapy (12, 13). Krivačić's study confirms the fact, as in this study, that younger age was a key parameter for the success of the therapy (12). Krivačić's study states that in the group in which only HFNC therapy was used, the proportion of male patients is higher, which can also be confirmed by this study (12). In this study, a third of male patients were treated with NIV (30%), while female patients were mainly treated with 02. I state that the average number of days of hospitalization is 24 regardless of the data (age, gender, use of ventilation, etc.), while in the study by Krivačić, patients who received HFNC therapy had an average number of days (6.82) longer than the group of patients (2.70) who received invasive mechanical ventilation due to disease progression (12). The results of the study by Bonnet et al. show that the average number of days was 11 in patients on HFNC (14). Mortality in the study conducted by Krivačić was 79.78% of 123 subjects, in patients who received non-invasive ventilation and/or invasive mechanical ventilation, which leads to the conclusion that invasive mechanical ventilation is associated with a high mortality rate (12). The study by Schönhofer et al. and Warren et al. state that two key factors for successful treatment with non-invasive ventilation are the rotation of the mask type and the selection of the appropriate interface. Their tests proved that changing different types of masks improves the effectiveness of treatment in the treatment of acute respiratory failure (15, 16). Through a comprehensive review of the current state of knowledge and practice, this paper provides a foundation for further research and improvement of the application of non-invasive ventilation in the treatment of Covid-19 patients. The results indicate that proper use of noninvasive ventilation can reduce the need for invasive ventilation and improve clinical outcomes.

Despite all the challenges in treating patients with COVID-19 pneumonia, non-invasive ventilation remains an important choice in the treatment of such patients, which certainly confirms its role in modern and intensive care medicine. Further research is needed to optimize its application.

CONCLUSION

The use of NIV in the treatment of patients with Covid-19 pneumonia has been shown to be effective. This study showed that patients with comorbidities (hematological disease) very rarely or never ended in death.

REFERENCES

1. World Health Organization / Health topics / Coronavirus disease (COVID-19).Dostupno na: https://www.who.int/health-topics/coronavirus#tab=tab_1,
2. Pauker K. Sestrinska skrb u bolesnika na neinvazivnoj mehaničkoj ventilaciji, diplomski rad. Sveučilište u Zagrebu, Medicinski fakultet; 2019. Dostupno na: https://repozitorij.mef.unizg.hr/islandora/object/mef%3A5430/datastream/PDF/view
3. Neinvazivna ventilacija i vrste neinvazivne ventilacije, Dräger Medical Croatia d.o.o., Dostupno na:

https://www.draeger.com/hr_hr/Hospital/Mechanical-Ventilation/Prevent/Non-Invasive-Ventilation

4. Frat JP, Thille AW, Mercat A, Girault C, Ragot S, Perbet S, et al. High flow oxygen through nasal cannula in acute hypoxemic respiratory failure. N Engl J Med. 2015;372(23):2185 2196.
5. Delorme M, Bouchard PA, Simon M, Simard S, Lellouche F. Effects of High Flow Nasal Cannula on the Work of Breathing in Patients Recovering From Acute Respiratory Failure. Crit Care Med. 2017;
6. Frat JP, Ragot S, Girault C, et al. Effect of non invasive oxygenation strategies in immunocompromised patients with severe acute respiratory failure: a post hoc analysis of a randomised trial. Lancet Respir Med. 2016;
7. Hamilton medical, High flow nasal cannula therapy. Dostupno na: https://www.hamilton-medical.com/en/Products/Technologies/High-flow-nasalcannula-therapy.html
8. Wang Y, Lu X, Li Y, Chen H, Chen T, Su N, et al Clinical course and outcomes of 344 intensive care patients with COVID-19. J Am J Respir Crit Care Med. 2020;201;:1430–1434.
9. Meng L, Qiu H, Wan L, et al. Intubation and ventilation amid the COVID-19 outbreak Wuhan's experience. Anesthesiology. 2020;132:1317–1332.
10. Grasselli G, Zangrillo A, Zanella A, et al. COVID-19 lombardy ICU network Baseline characteristics and outcomes of 1591 patients infected with SARS-CoV-2 admitted to ICUs of the Lombardy region, Italy. JAMA. 2020;323:1574–1581.
11. Srinivasaiah M, Gowda Varma MMK 2, Nandini M G , Chaitra V , Gulur H, Harshitha V. A Retrospective Analysis of Ventilatory Strategy Comparing Non-invasive Ventilation (NIV) With Invasive Ventilation in Patients Admitted With Severe COVID-19 Pneumonia. 20. Cureus. 2023 Jan 26;15(1):e34249.
12. Krivačić L. Ishod liječenja terapijom visokim protocima kisika kod Covid19 pozitivnih pacijenata u OB Karlovac, završni rad. Sveučilište u Rijeci, Fakultet zdravstvenih studija u Rijeci; 2022;
Dostupno na: https://repository.fzsri.uniri.hr/islandora/object/fzsri:1994
13. Jarić F, Korištenje jednostavnih neinvazivnih oblik ventilacije na Covid odjelima Kliničkog bolničkog centra Rijeka u svrhu smanjenja potrebe za invazivnijim oblicima mehaničke ventilacije u respiracijskom centru, diplomski rad. Sveučilište u Rijeci, Repozitorij Medicinskog fakulteta u Rijeci; 2022;
Dostupno na: https://zir.nsk.hr/islandora/object/medri:6586
14. Bonnet N, Martin O, Boubaya M, Levy V, Ebstein N, Karoubi P, et al. High flow
nasal oxygen therapy to avoid invasive mechanical ventilation in SARS-CoV-2pneumonia: (retrospective study). Ann Intensive Care. 2021 Feb 27;11(1):37.
15. Schönhofer B, Kuhlen R, Neumann P, Westhoff M, Berndt C, Sitter H. Clinical practice guideline: non-invasive mechanical ventilation as treatment of acute respiratory failure. Dtsch Arztebl Int. 2008 Jun; 105(24):424-33.

16. Warren DK, Zack JE, Cox MJ, Cohen MM, Fraser VJ. An educational intervention to prevent catheter-associated bloodstream infections in a nonteaching, community medical center. Crit Care Med. 2003 Jul;31(7):1959- 63.

NEINVAZIVNA VENTILACIJA PACIJENATA SA COVID-19 PNEUMONIJOM

Laura Kozina, Vesna Bratić, Slobodan Mihaljević
Klinika za anesteziologiju, reanimatologiju, intenzivnu medicinu i terapiju boli,
KBC Zagreb, Kišpatićeva 12, 10000 Zagreb, Hrvatska

SAŽETAK

Uvod: U teškim kliničkim scenarijima, neinvazivna ventilacija postala je sveprisutna terapijska mogućnost, pružajući vitalnu podršku pri disanju bez potrebe za invazivnom endotrahealnom intubacijom. Potrebno je istaknuti važnost istraživanja primjene neinvazivne ventilacije u kontekstu koronavirusne bolesti 2019 (COVID-19) pneumonije, analizirajući njezinu ulogu, učinkovitost i kliničke ishode. Metoda neinvazivne ventilacije sa korištenjem je krenula u jedinicama intenzivne medicine, a svoj vrhunac primjene doživjela je na odjelima u periodu COVID-19 pandemije.

Cilj: Prezentirati rezultate uspješnosti primjene neinvazivne ventilacije kod pacijenata kod kojih je primjena takve vrste ventilacije bila potrebna u odnosu na primjene kisika i visokog protoka kisika.

Materijali i metode: Provedena je retrospektivna studija u vremenskom razdoblju između siječnja 2021. do siječnja 2023. godine. Uključeno je 17 pacijenata liječenih na COVID odjelu KBC-a Zagreb. Prikupljeni podatci su za potrebe istraživanja anonimni, što znači da su svi podatci zaštićeni i obrađeni u BIS (bolnički informacijski sustav) sustavu.

Rezultati: Vrsta ventilacije je utjecala na ishod liječenja što je prikazano u slijedećim rezultatima: pacijenti kod kojih je korišten kisik završilo je svoje liječenje uspješno (75%), dok je jedan pacijent preminuo. Pacijenti kod kojih je korištena terapija visokim protokom kisika, od njih sveukupno 9 samo 4 (44%) je preživjelo, a pacijenti kod kojih je korišten neinvazivna ventilacija (NIV), od njih 4, jedan je preminuo.

Zaključak: Korištenje NIV-a pri liječenju pacijenata s COVID -19 pneumonijom pokazalo se učinkovito. Ovim istraživanjem se pokazalo da pacijenti s komorbiditetima (hematološka bolest) su vrlo rijetko ili uopće nisu završili smrtnim ishodom.

Ključne riječi: neinvazivna ventilacija, COVID-19 pneumonija

Osoba za korespodenciju: dr. sc. Vesna Bratić, magistra sestrinstva; vesna.bratic@kbc-zagreb.hr