

# The use of non-invasive ventilation (NIV) in the treatment of patients with COVID-19

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Research

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**ABSTRACT**

Non-invasive ventilation (NIV) is a method of respiratory support, in which a mask is used as the main interface, which can be easily applied and also easily disconnected from the patient's respiratory tract. The study included patients admitted to the intensive care unit of the surgical clinic of the AMU from April 1 to May 1, 2020. NIV has significant advantages over traditional mechanical ventilation. But it must be remembered that even in experienced hands, NIV is successful only in 75–90% of all cases, which depends on many factors, such as the severity of acute respiratory failure, training and experience of medical personnel, and the place of respiratory support. As with many types of therapy, operations, and technologies, improvement in the results of this method can be expected as experience is gained.

**Key words:** COVID-19, non-invasive ventilation, mechanical ventilation.

## INTRODUCTION

Non-invasive ventilation (NIV) is a method of respiratory support, in which a mask is used as the main interface, which can be easily applied and also easily disconnected from the patient's respiratory tract.

The harmful effects of the treatment of respiratory distress syndrome (RDS) with invasive ventilation have led to a deeper study of non-invasive ventilation methods (NIV). The key to success with NIV is proper patient selection. It is important to emphasize that a strict selection of patients is required for NIV, the main criteria are the preservation of consciousness and patient consent, as well as stable hemodynamics. Based on extensive experience using NIV in 147 patients with ARDS, Antonelli and count. recommend avoiding NIV in patients with SAPS greater than 34 points. According to Rana and colleagues, metabolic acidosis and severe hypoxemia are predictors of a poor response to NIV patients with ARDS. The possibility of using NIV in well-selected patients with ARDS has been shown in several studies (4, 7, 8). The authors of all studies devoted to NIV are unanimous in that there are significantly fewer complications when used than NIV with traditional mechanical ventilation. Mask ventilation allows you to minimize the number of infectious and "mechanical" complications. Nosocomial pneumonia is a common complication of lung ventilation and is a critical factor in determining patient outcome. With NIV, there is no direct contact with the trachea (endotracheal tube, aspiration catheter), the patient can release sputum after removing the mask. In the largest study by Meduri et al., Which included 158 patients who received NIV, nosocomial pneumonia was detected in only one patient. Studies show that complications of NIV, as a rule, do not require cessation of respiratory support (12, 14, 17, 19). The most common of these are facial skin necrosis, conjunctivitis, nasal irritation, transient hypoxemia, general discomfort, aerophagia, leakage. Erosions and necrosis of the skin are formed most often in the place of the greatest pressure of the mask on the skin of the face (usually the nose bridge). According to various studies, they occur in 6–18% of cases. Erosions and necrosis of the skin are not a serious complication, because they usually heal very

quickly (after 2-7 days). The disadvantage of NIV is the need for patient motivation. According to a meta-analysis conducted by Muir, the NIV procedure was discontinued due to intolerance to patients with the presence of a mask in 37 of 747 cases (5%) of using NIV in ONE (5, 15, 20). This method is practically not used in patients with severe impaired consciousness (the number of points on the Glasgow scale is less than 9), because these patients need protection of the respiratory tract and require frequent sanitation of the tracheobronchial tree, which is difficult to do when using NIV. Unfortunately, in our clinical practice, NIV is not widely used, while the experience of many countries has demonstrated the benefits of a wider implementation of NIV. For example, in the USA, the use of NIV over one decade increased by 462%, which led to a decrease in cases of invasive ventilation by 42% and was generally associated with a decrease in hospital mortality (5). For a wider implementation of NIV, an adequate level of providing high-quality equipment is important (6). The use of high-quality respirators is more comfortable for patients, and the ease and simplicity of setting respiratory support parameters are important for a doctor (6). A wide range of types and sizes of masks is also important. In recent years, manufacturers of respiratory equipment have presented a wide selection of different masks and helmets that are comfortable for patients, which reduces the risk of mechanical complications.

**The aim of the study:** to determine the benefits of NIV in ODN patients with COVID-19.

**Study material:** The study included patients admitted to the intensive care unit of the surgical clinic of the AMU from April 1 to May 1, 2020.

**The results of the study:** Our experience with NIV has shown that most patients treated with NIV tolerate this procedure relatively well already at the initial stage. However, in a number of patients, during the first minutes or hours of NIV, no improvement (clinical indicators and gas exchange) is observed or the procedure is poorly tolerated, the proportion of such patients is usually about 15–35%. Usually, a

respiratory support session of 2–3 hours is sufficient to predict the success of the NIV or response to the NIV. In normal practice, the effectiveness of NIV therapy is obvious with a simple examination - there is a decrease in the frequency of respiratory movements and the work of auxiliary respiratory muscles. Objective markers of the effectiveness of mask ventilation are changes in arterial blood gas parameters: an increase in pH and a decrease in PaCO<sub>2</sub>. A short NIV session allows you to identify not only patients who can be effectively managed with NIV in the future, but also patients with a poor response who subsequently need urgent tracheal intubation and connection to a ventilator. Experience shows that longer attempts to use NIV without achieving a noticeable improvement only delay the time of the use of mechanical ventilation, which significantly increases the risk of increased respiratory failure, an adverse outcome, up to a lethal one. Using NIV, we came to the conclusion that, in most cases, NIV therapy failures are detected quite early - in the first hours from the initiation of respiratory support, however, in some patients, NIV therapy failure manifests itself later - 24–48–72 hours after the initial improvement. Lack of improvement in consciousness or respiratory acidosis 24 hours after onset is NIV another predictor of NIV failure. Indications for the implementation of NIV are as follows:

1. Symptoms and signs of ONE: a) severe shortness of breath at rest; b) BH > 25 / min, participation in the breathing of the auxiliary respiratory muscles, paradoxical breathing.
2. Signs of gas exchange disturbance: a) PaCO<sub>2</sub> > 45 mm Hg. Art., pH < 7.35; b) PaO<sub>2</sub> / FiO<sub>2</sub> < 200.

The criteria for the exclusion of NIV in acute respiratory failure are as follows:

- ◆ Stop breathing.
- ◆ Unstable hemodynamics (hypotension, uncontrolled arrhythmias or myocardial ischemia).
- ◆ Inability to protect the respiratory tract (cough and swallowing disorders).
- ◆ Excessive bronchial secretion.
- ◆ Signs of impaired consciousness (agitation or oppression), the patient's inability to cooperate with medical personnel.

- ◆ Facial trauma, burns, anatomical disorders that prevent masking.

The criteria for termination of NIV and the transition to traditional mechanical ventilation include the following:

- ◆ The patient's inability to carry the mask due to discomfort or pain.
- ◆ The inability of the NIV to improve gas exchange within 2 hours: an increase or preservation of hypoxemia, despite the high values of PEEP and FiO<sub>2</sub>.
- ◆ Inability to mask ventilation to ease dyspnea.
- ◆ The need for endotracheal intubation to remove secretions or protect the respiratory tract.
- ◆ Instability of hemodynamics and ECG, instability with the phenomena of ischemia or clinically significant ventricular arrhythmias.
- ◆ The increase in encephalopathy.

The physiological effects of NIV are as follows:

- ◆ preservation of spontaneous breathing and independent movements of the diaphragm;
- ◆ reduction of negative effects on hemodynamics;
- ◆ reduced work to ensure breathing.

NIV also has the following economic significance:

- ◆ reduction in the average length of stay in the intensive care unit compared with mechanical ventilation;
- ◆ reduction in the duration of hospitalization;
- ◆ 50% reduction in the need for mechanical ventilation;
- ◆ reduction in treatment costs;
- ◆ mortality reduction in professional use of NIV.

The study identified the following benefits of non-invasive ventilation:

- ◆ prevention of “mechanical” and infectious complications associated with intubation, reducing the risk of developing infectious complications and mechanical damage (trauma to the larynx and trachea, stenosis and bleeding from the upper respiratory tract);
- ◆ preservation of natural protective reflexes of the

upper respiratory tract;

- ◆ preservation of physiological cough, the patient's ability to talk, swallow, eat, cough up sputum;
- ◆ increase patient comfort;
- ◆ reduced need for muscle relaxants, opioids and tranquilizers;
- ◆ the possibility of discrete use and weaning from the apparatus.

In our clinic, NIV was performed using Salvia Elisa ventilator respirators in CPAP + PSV mode through a face mask. Used standard masks from Drager (Germany) or Respironics (USA). To determine the parameters of the gas and acid-base composition of the blood, an ABL500 gas analyzer with an OSM3 oximeter (Radiometer, Denmark) was used. Indicators of the function of external respiration were recorded from the display of the respirator. All data were recorded immediately before the start of ventilation. The level of PEEP and pressure support was set individually, based on the specific clinical situation. The ventilation parameters required by patients were as follows: PEEP - from 5 to 12 cm of water, PSV - from 0 to 14 cm of water. Art., FiO<sub>2</sub> - from 0.3 to 0.6. At the initial stage, auxiliary ventilation was carried out in a continuous mode. Further, a gradual decrease in respiratory support was carried out in accordance with the degree of clinical improvement, after which they switched to NIV sessions for several hours a day until it was completely canceled. The criterion for successful NIV was the improvement of the arterial blood gas composition and the ability to avoid endotracheal intubation.

### Clinical case

One Patient - a man aged 60 years, with complaints of alternating chronic cough, temperature 38.6 ° C, chills, headache, shortness of breath. During auscultation of the lungs, crepitus was observed, moist rales in the lower lobes of the lungs, oxygen saturation 90%, respiratory rate 28-30 per minute. Admission laboratory tests included: WBC - 14.47 x 10<sup>9</sup> / L, LYM - 0.81 x 10<sup>9</sup> / L, albumin - 3.19 g / dL, PI - 51.7%, PT - 13.8 sec., INR - 1.37, Fibrinogen - 138 mg / L, GRP 17.4 mg / L, D-Dimer > 7500 ng / mL, Ferritin - 1092 ng / mL, P / F > 150. Chest x-ray and

CT are shown in the following figures (1, 2, 3, 4, 5).

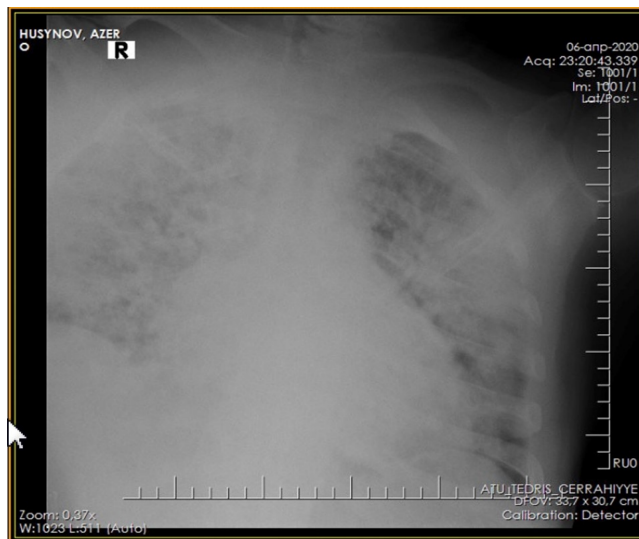


Figure 1. X-ray upon admission



Figure 2. CT scan of the lungs upon admission

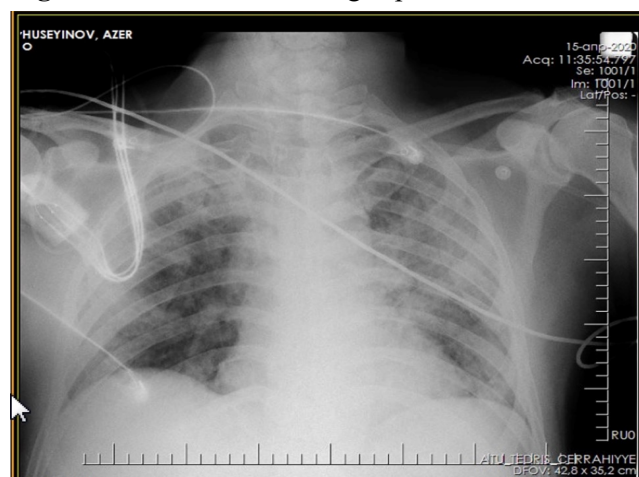


Figure 3. Radiograph after improvement of the patient

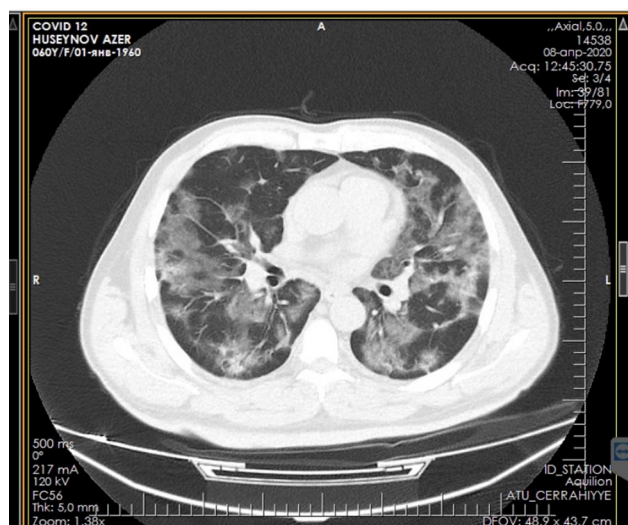


Figure 4. CT scan after patient improvement

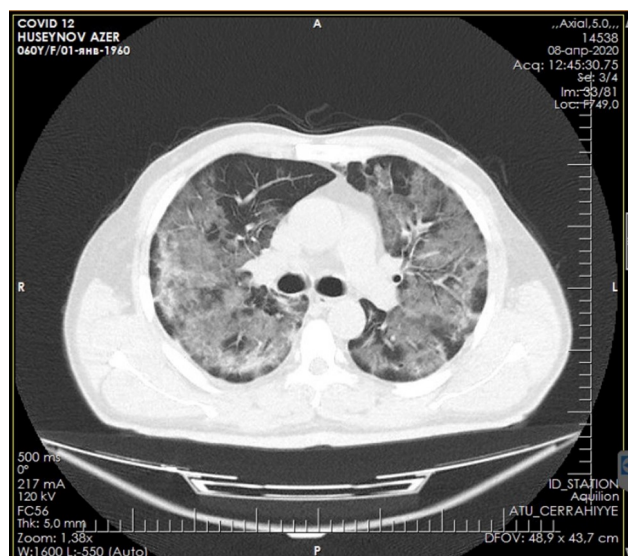


Figure 5. CT scan of the lungs after improvement

Non-invasive ventilation was carried out by an oral-nasal mask with a ventilator ELISA. Installation and adjustment of the parameters was carried out according to the general condition and according to the data of blood gases: respiratory rate <35, pH > 7.30, neurological dysfunction according to the Kelly scale > 3-5, a modified scale for determining the participation of auxiliary respiratory muscles <3 points. For hypercapnia, the following parameters were set: Ps - 12, PEEP - 5 cm water column, FiO<sub>2</sub> -30-40%, and with hypoxemia - Ps - 12, PEEP - 5 cm water column, FiO<sub>2</sub> -50-60 %. The median treatment period with NIV was 6 days. The average daily treatment time with NIV on the first day was 17.3 hours, on the sec-

ond day - 18.2 hours and on the third day 16.7 hours. The patient was discharged on the 12th day with improvement.

## CONCLUSIONS

1. NIV has significant advantages over traditional mechanical ventilation. But it must be remembered that even in experienced hands, NIV is successful only in 75–90% of all cases, which depends on many factors, such as the severity of acute respiratory failure, training and experience of medical personnel, and the place of respiratory support. As with many types of therapy, operations, and technologies, improvement in the results of this method can be expected as experience is gained.
2. The use of NIV in severe respiratory distress syndrome is uncertain. High minute lung ventilation (> 11 L / min) during NIV can predict non-invasive lung ventilation.

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