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# RESPIRATORY SUPPORT FOR CHRONIC HYPERCAPNIC RESPIRATORY FAILURE IN THE OUTPATIENT SETTINGS. LITERATURE REVIEW.

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**Abstract**

Chronic respiratory failure (CRF) represents a common outcome of chronic bronchopulmonary diseases and significantly influences hospitalization rates, quality of life, and mortality. Improvement in patient prognosis depends not only on the management of the underlying disease but also on the targeted correction of CRF through various modalities of respiratory support, both during exacerbations and in remission phases. The principal strategies for respiratory support include oxygen therapy and non-invasive ventilation (NIV). The primary indication for long-term non-invasive ventilatory support is chronic hypercapnic respiratory failure. Prolonged use of NIV has been shown to improve pulmonary function, enhance gas exchange, increase exercise tolerance, reduce dyspnea, improve quality of life, decrease the risk of rehospitalization, and ultimately enhance survival. Currently, there is insufficient evidence regarding the initiation of non-invasive respiratory support in the outpatient setting for patients with chronic bronchopulmonary pathology. Only a limited number of studies with small cohorts have investigated home initiation of NIV in patients with hypercapnic CRF due to chronic obstructive pulmonary disease (COPD). These studies have demonstrated comparable efficacy in terms of arterial carbon dioxide levels when compared to in-hospital initiation. There is a clear need to expand research in this area by increasing sample sizes, which would allow for the development of evidence-based guidelines for outpatient NIV initiation. At present, there are no standardized recommendations regarding the timing of NIV initiation, patient selection criteria, or parameters for monitoring the effectiveness of non-invasive respiratory support in the ambulatory setting. Moreover, there is no consensus on evaluating the effectiveness of outpatient management of chronic hypercapnic respiratory failure. Thus, the development of clinical algorithms and evidence-based recommendations for the initiation, monitoring, and long-term management of patients receiving non-invasive ventilatory support in the outpatient setting remains a pressing issue.

***Keywords:*** *chronic respiratory failure, hypercapnia, non-invasive ventilation*

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**Резюме**

# РЕСПИРАТОРНАЯ ПОДДЕРЖКА ПРИ ХРОНИЧЕСКОЙ ГИПЕРКАПНИЧЕСКОЙ ДЫХАТЕЛЬНОЙ НЕДОСТАТОЧНОСТИ В АМБУЛАТОРНЫХ УСЛОВИЯХ. ОБЗОР ЛИТЕРАТУРЫ.

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Хроническая дыхательная недостаточность (ХДН) является исходом хронических бронхолегочных заболеваний и определяет частоту госпитализаций, качество жизни и летальность. Улучшение прогноза пациентов обусловлено не только лечением основного заболевания, но и коррекцией непосредственно ХДН различными вариантами респираторной поддержки, как при обострении, так и в период ремиссии. Основные направления респираторной поддержки включают в себя применение кислородотерапии и неинвазивной вентиляции легких (НИВЛ). Показаниями

для назначения длительной неинвазивной респираторной поддержки является хроническая гиперкапническая дыхательная недостаточность. Долгосрочная НИВЛ может улучшить функцию легких, газообмен, повысить толерантность к физическим нагрузкам, уменьшить одышку, улучшить качество жизни, снизить риск повторной госпитализации и повысить выживаемость. На сегодня, данных об инициации неинвазивной респираторной поддержки амбулаторно у пациентов с бронхолегочными заболеваниями недостаточно. Существуют единичные исследования с небольшим количеством пациентов с гиперкапнической ХДН на фоне ХОБЛ по началу неинвазивной респираторной поддержки в домашних условиях. Эти исследования продемонстрировали равнозначную эффективность с началом терапии в стационаре по уровню углекислого газа в артериальной крови. Необходимо расширение подобных исследований, увеличения группы наблюдения, что позволит создать рекомендации для инициации НИВЛ в амбулаторных условиях. На данный момент нет четких рекомендаций по срокам инициации НИВЛ, критериям отбора пациентов и контроля эффективности амбулаторной неинвазивной респираторной поддержки. Нет единой рекомендации по оценке эффективности хронической гиперкапнической дыхательной недостаточности на амбулаторном этапе. Актуальным является разработка алгоритмов и рекомендаций по инициации, контролю и ведению таких пациентов на амбулаторном этапе.

***Ключевые слова:*** *хроническая дыхательная недостаточность, гиперкапния, неинвазивная вентиляция легких.*

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**Түйіндеме**

# АМБУЛАТОРИЯЛЫҚ ЖАҒДАЙДА СОЗЫЛМАЛЫ ГИПЕРКАПНИЯЛЫҚ ТЫНЫС ЖЕТІСПЕУШІЛІГІ КЕЗІНДЕ ТЫНЫС АЛУДЫ ҚОЛДАУ. ӘДЕБИЕТТІК ШОЛУ.

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Созылмалы тыныс жеткіліксіздігі (СТЖ) созылмалы бронхөкпелік аурулардың ақырғы кезеңі болып табылады және ол ауруханаға жатқызу жиілігін, өмір сапасын және өлім-жітім көрсеткішін айқындайды. Науқас болжамын жақсарту тек негізгі ауруды емдеумен ғана емес, сонымен қатар СТЖ-нің өзін әртүрлі тыныс қолдау әдістері арқылы түзетумен байланысты, бұл шаралар аурудың асқыну кезеңінде де, ремиссия кезеңінде де қолданылады. Тыныстық қолдаудың негізгі бағыттарына оттегі терапиясы мен инвазивті емес өкпенің жасанды желдетілуі (ИЕӨЖ) жатады. Ұзақ мерзімді инвазивті емес тыныс қолдауын тағайындауға көрсеткіш — созылмалы гиперкапниялық тыныс жеткіліксіздігі. Ұзақ уақыт бойы ИЕӨЖ қолдану өкпе қызметін, газ алмасуын жақсартып, физикалық жүктемеге төзімділікті арттыруы, ентігуді азайтуы, өмір сапасын жоғарылатуы, қайта ауруханаға жатқызу қаупін төмендетуі және өміршеңдікті арттыруы мүмкін. Қазіргі уақытта бронхөкпелік аурулары бар науқастарға амбулаториялық жағдайда инвазивті емес тыныс қолдауын бастау туралы мәліметтер жеткіліксіз. Созылмалы обструктивті өкпе ауруы (СӨА) аясында гиперкапниялық СТЖ бар науқастарға үй жағдайында тыныстық қолдауды бастауды зерттеген аздаған шағын зерттеулер бар. Бұл зерттеулер артериялық қандағы көмірқышқыл газы деңгейі бойынша емдеуді стационарда бастаумен салыстырғанда ұқсас тиімділікті көрсетті. Мұндай зерттеулердің ауқымын кеңейту және бақылау топтарын ұлғайту қажет, бұл өз кезегінде амбулаториялық жағдайда ИЕӨЖ бастаудың клиникалық ұсынымдарын әзірлеуге мүмкіндік береді. Қазіргі уақытта ИЕӨЖ-ді бастау мерзімі, науқастарды іріктеу критерийлері және амбулаториялық тыныс қолдаудың тиімділігін бақылау бойынша нақты ұсынымдар жоқ. Созылмалы гиперкапниялық тыныс жеткіліксіздігін амбулаториялық кезеңде бағалауға арналған бірыңғай тәсіл қалыптаспаған. Сондықтан амбулаториялық кезеңде ИЕӨЖ-ді бастау, бақылау және жүргізу бойынша клиникалық алгоритмдер мен ұсынымдарды әзірлеу – өзекті мәселе болып отыр.

***Түйінді сөздер:*** *созылмалы тыныс жетіспеушілігі, гиперкапния, инвазивті емес желдету.*

***Дәйексөз үшін:***

*Серикова А.С., Мукатова И.Ю., Байдурин С.А., Уразалина Ж.М.* Амбулаториялық жағдайда созылмалы гиперкапниялық тыныс жетіспеушілігі кезінде тыныс алуды қолдау. Әдебиеттік шолу // Ғылым және Денсаулық сақтау. 2025. Vol.27 (4), Б. 183-191. *doi 10.34689/SH.2025.27.4.023*

**Introduction**

In recent years, the number of patients with chronic respiratory failure (CRF) requiring respiratory support has increased. This is due to improved diagnostics, approaches to the treatment of chronic bronchopulmonary diseases with a corresponding increase in life expectancy and the emergence of a pool of patients in need of additional non-drug interventions [53, 20]. Due to the need to correct CRF, select individual patient management schemes, which is usually carried out in specialized departments, the workload on hospitals has increased, leading to an increase in financial costs. There is a need to update the diagnostics and correction of CRF at the outpatient stage to optimize patient management and reduce the socio-economic burden of this condition.

**Search strategy**

The following full-text and bibliographic databases were used: PubMed, Embase, Web of Science, Scopus, The Cochrane Library, eLIBRARY. Ru, while writing the literature review. The search for primary information sources was carried out at a depth of 5 years (2020-2025) using the following keywords: chronic respiratory failure, chronic obstructive pulmonary disease, congenital bronchopulmonary anomalies, cystic fibrosis, bronchiectasis, idiopathic pulmonary fibrosis, acid-base balance, hypercapnia, respiratory support, oxygen therapy, non-invasive ventilation. In total, 70 publications were included in the review.

**Search results**

Chronic respiratory failure is the outcome of most chronic bronchopulmonary diseases and determines the frequency of hospitalizations, quality of life and mortality in this category of patients [46, 18]. Improved prognosis and reduced patient mortality are due not only to the treatment of the underlying disease, but also to timely correction of CRF directly with various options for respiratory support, both during exacerbation and during remission. The main directions of respiratory support include the use of oxygen therapy and non-invasive ventilation (NIV) [9].

CRF is divided into two main types: hypoxemic, hypercapnic [46, 31]. The issue of diagnosis and treatment of hypoxemic CRF has been studied quite well [17, 52, 40]. There are recommendations for long-term oxygen therapy in hypoxemic CRF and most specialists are well informed on this issue. Hypercapnic CRF is more difficult to diagnose and correct. Hypercapnic respiratory failure (RF) is associated with more frequent and prolonged hospitalizations, decreased quality of life and increased mortality [64, 5, 6].

A prospective study examined whether hypercapnia could predict hospital and annual mortality in patients with dyspnea or lung diseases [63]. The study included 2710 patients, of whom 588 had hypercapnia on admission. The observation was carried out for 12 months from the moment of hospitalization. The results of the study showed a significant increase in mortality in patients with acute hypercapnia compared to patients with chronic hypercapnia and normocapnia. The mortality rate of hospitalized patients with acute hypercapnia during the next year after discharge reached 32%, significantly exceeding similar data in patients with chronic hypercapnia, in whom the mortality rate was 20. 2%, and in patients with normocapnia, with a mortality rate of 14. 5% [63].

A study from the University of Vermont, USA, studied the risks of rehospitalizations and mortality in patients with hypercapnic RF [37]. The study included 202 patients who met the inclusion criteria: 46% of them were diagnosed with COPD, 10% with bronchial asthma, 24% with obstructive sleep apnea syndrome, and 6% with obesity-hypoventilation syndrome. During hospitalization, 15 patients died, which accounted for 7%. Forty-one patients (23%) were readmitted within 30 days after discharge. Analysis of comorbid conditions showed that peripheral vascular disease (OR 4. 78, CI 1. 45–15. 74) and tachycardia (OR 2. 97, CI 1. 22–7. 26) were associated with an increased risk of readmission. During the next 12 months after discharge, 66 patients (36%) died. When analyzing the deceased, it was found that the risk of death was higher in elderly patients (OR 1. 32, CI 1. 13–1. 54 per 5 years), in patients with peripheral vascular disease (OR 12. 56, CI 2. 35–67. 21), in patients with a higher Charlson comorbidity index (OR 1. 39, CI 1. 09–1. 76). Also, the use of long-term home oxygen therapy (OR 4. 03, CI 1. 89–8. 57) and repeated hospitalizations (OR 3. 07, CI 1. 46–6. 43) were identified as important risk factors for death [37]. This study demonstrates the significant impact of hypercapnic RF against the background of chronic bronchopulmonary diseases, in particular COPD, and an increased risk of mortality in the presence of comorbidity, with the use of long-term oxygen therapy, as well as with repeated hospitalizations during the next few months after discharge.

Hypercapnic respiratory failure is a complex diagnosis in routine clinical practice. It is not always possible to diagnose this type of respiratory failure in a timely manner. This is due to diagnostic difficulties, in particular the need for an invasive study - acid-base balance (ABB), which is not a generally available method in routine practice [68, 2, 48]. The study requires arterial blood sampling, which is usually available only in intensive care units and resuscitation departments. Accordingly, hypercapnic CRF is diagnosed late, usually with a significant increase in the level of partial pressure of carbon dioxide (PaCO2), which leads to the need for hospitalization of the patient in the intensive care unit, often the need for artificial ventilation of the lungs (ALV). Since the advent of NIV more than 30 years ago, the approach to respiratory support in patients with CRF has changed. Initially, NIV was used at the stage of weaning the patient from artificial ventilation and transition to spontaneous breathing. Today, NIV with positive pressure has become more widespread and has been actively used at all levels of medical care [39, 30, 70]. This method of respiratory support is used not only in intensive care units, but also in routine departments and outpatient practice. The most significant historical study is one of the first available for analysis, published back in 1996, which compared NIV and artificial ventilation with endotracheal intubation (EI) in patients with COPD and acute RF. This study showed that early use of NIV prevented EI and was associated with better survival compared to patients who received mechanical ventilation [61].

The beginning of NIV use was usually accompanied by its use in hospital settings against the background of exacerbation of chronic bronchopulmonary diseases. Much later, NIV began to be recommended for longer outpatient use. Long-term NIV is a recognized method of treating patients with terminal COPD suffering from hypercapnic CRF. This is reflected in national and international guidelines [34, 41, 27]. The goal of NIV is both to normalize PaCO2 during direct ventilation and to maintain this effect in the periods between the use of NIV and the patient's comfortable perception of the treatment itself [25, 22, 3].

There is less evidence for the effectiveness of long-term NIV in hypercapnic CRF compared to the improved outcomes of NIV in acute life-threatening hypercapnic HF due to COPD exacerbations [54, 36]. The implementation of NIV in an acute situation in hospitalized patients is fundamentally different from daily NIV at home. In everyday practice, patients with CRF should understand that they will probably need respiratory support for the rest of their lives and should be fully motivated to use NIV every night for at least 5 hours to significantly reduce PaCO2 levels [49, 66]. Therefore, full patient commitment and motivation are necessary to achieve control, especially during the recovery period after acute RF and discharge from hospital [69].

The available publications on the correction of CRF mainly concern patients with COPD. This is due to the fact that there are quite a large number of these patients and there is an opportunity to conduct studies. Accordingly, CRF due to COPD has been the most well studied [42]. In stable patients with COPD and chronic hypercapnia (FEV1/FVC < 0. 70; PaCO2 at rest > 45 mmHg; in stable condition), long-term NIV can improve lung function, gas exchange, increase exercise tolerance, reduce dyspnea, improve quality of life, reduce the risk of rehospitalization and increase survival [34].

Recent large studies have also shown positive results of long-term use of NIV in patients with stable COPD [43, 19, 23]. A meta-analysis including studies from 1995 to 2019, covering a total of 51, 085 patients with COPD and hypercapnia, demonstrated that the use of BiLevel positive airway pressure at home, compared with no respiratory support, was associated with a lower risk of mortality (OR, 0. 66), fewer hospitalizations (OR, 0. 22) and a lower need for intubation (OR, 0. 34) [67].

The most common causes of COPD exacerbations are respiratory infections and progression of CRF. In both situations, acute hypercapnic RF may occur against the background of existing CRF [65, 32]. And then, for the first time, the question of initiating non-invasive respiratory support is raised when a hospitalized patient with a severe exacerbation, progression of RF develops severe hypercapnia. Often these patients undergo a stage of artificial ventilation in the intensive care unit, which increases the risk of hospital infection, prolongs the duration of hospitalization, and increases mortality [56, 1, 33].

One of the general goals in the treatment of patients with COPD is to minimize the number of hospitalizations for severe exacerbations of the disease and to prolong the period until the next exacerbation, especially in patients with a high risk of developing acute hypercapnic RF [16, 26].

With diagnosed hypercapnic CRF, initiation and titration of long-term NIV aimed at reducing PaCO2 is usually carried out in a hospital setting, which in some cases is the main reason for hospitalization, which naturally increases the financial costs associated with hospitalization in general, the risk of hospital complications and is the cause of a worsening prognosis [57].

The study demonstrated that initiation of long-term NIV in patients with COPD in a stable condition can reduce the number of future hospitalizations [29]. In a study involving 195 patients with stable COPD GOLD IV and PaCO2 51. 9 mm Hg. and above and pH more than 7. 35, NIV was started in the main group with the goal of reducing PaCO2 by at least 20% or to achieve PaCO2 less than 48. 1 mm Hg. The observation was carried out for a year. The results of the study demonstrated a decrease in the number of emergency hospitalizations in the group receiving NIV, compared with the control group (2. 2 and 3. 1 exacerbations per patient per year, respectively). Mortality within 12 months was 12% (12 of 102 patients) in the intervention group and 33% (31 of 93 patients) in the control group; hazard ratio 0. 24 (95% CI 0. 11–0. 49; p=0. 0004) [29]. This study demonstrated the feasibility and effectiveness of NIV in patients with stable hypercapnic CRF in terms of reducing future hospitalizations for exacerbation of COPD.

Despite the existing international guidelines for the use of NIV in patients with hypercapnic CRF, numerous studies confirming the effectiveness of NIV in reducing future exacerbations, mortality and improving quality of life in general, the issue of the frequency of prescription and use of NIV at home remains relevant. In one such study, the prevalence of hypercapnic CRF and the use of home NIV was examined among a high-risk group - individuals with a history of at least one hospitalization for COPD [15]. A retrospective analysis of the medical records of patients at the Veterans Affairs Medical Center, Iowa, who had at least one hospitalization for COPD between 2011 and 2017 was conducted. In 186 patients, the overall prevalence of hypercapnic CRF, defined as PaCO2> 45 mmHg at pH = 7. 35–7. 45, was 52. 7%, and the overall prevalence of home NIV was 4. 3%. In patients with one hospitalization for COPD, the prevalence of hypercapnic CRF was 43. 6%, and home NIV was 1. 8%. Among patients with ≥4 hospitalizations for COPD, the prevalence of hypercapnic CRF was 77. 8% (14 of 18), and home NIV was 11. 1% (2 of 18). Thus, approximately half of patients who have had at least one hospitalization for COPD have hypercapnic CRF, but only 8. 2% of them use home NIV [15]. Large multicenter studies are needed to examine the prevalence of CRF and the extent of NIV underuse in this category of patients.

The conducted literature review showed that there is no data on the correction of hypercapnic CRF in the outcome of other chronic bronchopulmonary diseases, among which bronchopulmonary anomalies of various origins, conditions after pulmonary tuberculosis with an outcome in pneumofibrosis, and interstitial lung diseases are quite common. One of the recent studies, which retrospectively analyzed 1281 case histories of patients with CRF of various etiologies who received NIV in the period from 2004 to 2014, was conducted [14]. According to the diseases, patients were divided into nine categories: obstructive airway diseases (COPD, bronchial asthma, bronchiectasis)

(16%); interstitial lung diseases (3%); obesity-hypoventilation syndrome (11%); neuromuscular diseases (10%); chest diseases (4%); obstructive sleep apnea syndrome (26%); malignant neoplasms (2%); others (3%) and acute respiratory failure (8%), which refers to patients who did not meet the criteria for CRF. After the start of NIV, the median overall survival was 4. 5 years (95% CI from 3. 6 to 5. 4) and varied depending on the disease. There are also isolated descriptions of clinical cases on the effectiveness of long-term respiratory support in a patient after pulmonectomy in the outcome of pulmonary tuberculosis with the development of hypercapnic CRF. In the described cases, the effectiveness and safety of outpatient NIV in this category of patients was demonstrated [4, 38].

Since the number of patients with CRF who will be indicated for non-invasive respiratory support increases every year, the issue of increasing the frequency of hospitalizations, respectively, increasing the risks of nosocomial infection, and generally increasing the burden on the healthcare system arises. This fact requires changing approaches to the initiation of non-invasive respiratory support. There are already data on outpatient initiation of NIV, in particular in patients with neuromuscular and restrictive diseases of the chest. In one of such studies, in patients with amyotrophic lateral sclerosis, initiation of NIV at home was equally effective and cost-effective compared to initiating this type of therapy in a hospital setting [62, 50]. A Dutch study showed the same improvement in gas exchange and quality of life, as well as the cost-effectiveness of initiating NIV at home in patients with neuromuscular diseases and chest deformities, compared to initiating NIV in a hospital setting [59]. These data indicate the possibility of starting non-invasive respiratory support at home, without additional hospitalization for the initiation of NIV and require further expansion to develop clearer criteria for the selection of patients who need this type of therapy.

The use of outpatient initiation of NIV in patients with a pulmonary profile can minimize the need for hospitalization, which will reduce the risks of hospital infections and the cost of managing these patients in general [28, 21]. But to date, there is insufficient data on the initiation of NIV on an outpatient basis specifically in patients with bronchopulmonary diseases.

There are isolated studies with a small number of patients with hypercapnic CRF against the background of COPD on the initiation of NIV at home, where equivalent effectiveness of starting therapy both in hospital and outpatient in terms of PaCO2 levels was demonstrated [11]. A study of 67 patients with stable hypercapnic COPD who were initiated with NIV in hospital and at home using telemedicine showed that NIV initiation in the outpatient setting was essentially equivalent to inpatient. Mean PaCO2 in outpatient vs. Inpatient was 0. 04 kPa (95% CI -0. 31 to 0. 38 kPa), with both groups demonstrating a decrease in PaCO2 at 6 months compared to baseline (home: from 7. 3 ± 0. 9 to 6. 4 ± 0. 8 kPa ($p < 0. 001$) and inpatient: from 7. 4 ± 1. 0 to 6. 4 ± 0. 6 kPa ($p < 0. 001$)). Quality of life improved in both groups with no significant difference between groups. In addition, the study results demonstrated that initiation of NIV in the outpatient setting was significantly cheaper (outpatient: median €3, 768 versus hospitalization: median €8, 537; $p<0. 001$). This is the first study to demonstrate that outpatient initiation of long-term NIV in patients with stable hypercapnia and COPD using telemedicine is non-inferior to inpatient initiation, is safe, and reduces costs by more than 50% [11].

Jolly and colleagues from Rouen University, France conducted a cohort study including 250 patients with obesity hypoventilation syndrome (n = 95; 38%), neuromuscular disease (n = 70; 28%), COPD (n = 66; 26%), and chest wall disease (n = 19; 8%) [25]. These patients were treated with NIV at home for 2 years. Quality of life was assessed at baseline and follow-up using the Severe Respiratory Insufficiency (SRI) Questionnaire and five targets had to be met: daily use for more than 4 h/day, improvement in gas exchange, health-related quality of life (HRQL), and sleep quality without adverse effects. Adequate treatment initiation was defined as achieving at least three of the five targets, and successful initiation was defined as achieving all targets. At follow-up, all five targets were achieved in only 141 (56%) patients. NIV initiation was adequate in 96 (68%) patients and successful in 12 (9%) patients. Improvement in PaCO2 did not correlate with improvement in HRQL or sleep quality. Based on this observation, the investigators concluded that successful initiation of home NIV is rarely achieved in real life and that quality of life and tolerability of NIV should be assessed to improve patient-centered outcomes [25].

In addition to the specifics of initiating NIV in an outpatient setting, the question of direct management and observation of these patients always arises [10]. This monitoring can be carried out through the use of modern methods for monitoring the condition of these patients. In particular, one study surveyed patients and caregivers. All patients with hypercapnic CRF received NIV. A survey of NIV users showed that approximately half of them and 60% of their caregivers welcomed telemonitoring for monitoring the patient's condition and adjusting therapy. Telemonitoring provides information through a cloud-based system that allows the transmission of patient data and data on therapy, time of use, and adherence to NIV. Based on the information received, doctors have the opportunity to adjust the settings of the NIV device. Telemedicine is used both at the stage of initiating NIV and for monitoring and titrating treatment [10, 58].

Although initiation of NIV in COPD requires careful titration and monitoring, initiation does not necessarily have to be done in a hospital setting [7, 51]. Therapy can be administered under the supervision of a physician, who can also delegate this task to a respiratory therapist, a specialist nurse or other specially trained health care professional. The presence of a physician is not necessary, provided that appropriate communication channels (telephone, telemonitoring) are available [55, 60, 8]. This approach is feasible, acceptable and can improve clinical symptoms, help physicians in monitoring patients, identifying those who are suitable for home NIV. Telemonitoring can also help with adaptation, titration and adherence to NIV [12].

A multicenter prospective RCT examined the benefits of management using different types of internet communication with patients receiving home NIV compared with traditional management with a personal visit by a

health care professional [24]. The study enrolled 148 patients (age: 72. 7 ± 6. 8 years; male: 85. 8%; FEV1: 0. 7 ± 0. 3 L; PaCO2: 66. 4 ± 12. 0 mmHg) recruited from 11 Chinese hospitals between 2019 and 2021. Patients were randomly assigned to the intervention group (n = 73) and control group (n = 75). After 12 months of follow-up, the mean Severe Respiratory Insufficiency (SRI) Questionnaire score was 56. 5 in the intervention group and 50. 0 in the control group (95% CI, 3. 71–8. 80; P < 0. 001). The risk of rehospitalization within 12 months was 34. 3% in the intervention group compared with 56. 0% in the control group, adjusted hazard ratio 0. 56 (95% CI 0. 34–0. 92; P = 0. 023). The study demonstrated that in stable patients with hypercapnic CRF due to COPD, NIV monitoring using different internet communication options improves health-related quality of life and increases the time to rehospitalization.

A study comparing transcutaneous capnometry-guided and polysomnography-guided NIV initiation included patients with COPD and obstructive sleep apnea syndrome [44]. The results demonstrated that nurse-led nocturnal titration of NIV using transcutaneous capnometry was more effective than polysomnography-guided NIV initiation. The study showed that this telemedicine-based monitoring method is feasible at home.

Another study also confirmed the effectiveness of using telemedicine to assess the effectiveness of NIV and long-term oxygen therapy at home. In patients with chronic hypercapnia COPD on respiratory support, telemonitoring can reduce the frequency of exacerbations and hospitalizations [45, 47].

Thus, the conducted analysis of available literature sources demonstrates the possibilities of conducting positive pressure respiratory support in patients with CRF of various genesis at the outpatient stage. However, all currently available studies are insufficient in terms of the number of patients covered; it is necessary to expand such studies and increase the observation group. At the moment, there are no clear recommendations on the timing of NIV initiation, patient selection criteria and monitoring of the effectiveness of outpatient NIV.

There is also no single recommendation for assessing the effectiveness of hypercapnic CRF at the outpatient stage. The existing criterion for the effectiveness of respiratory support is a decrease in PaCO2, is difficult to implement at the outpatient stage, since this method is not used in routine outpatient practice, but is available only in inpatient settings.

It should also be noted that various healthcare systems require the development of algorithms for the initiation of non-invasive respiratory support, taking into account local characteristics. In particular, regarding Kazakhstan, there are currently no data on the initiation of NIV on an outpatient basis in available sources. It is relevant to create recommendations for the initiation and specific features of NIV in outpatients.

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