# Improvement of biochemical parameters due to non-invasive ventilation in patients with chronic obstructive pulmonary disease and acute respiratory failure

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## Abstract

**Aim:** Our objective was to compare selected biochemical parameters including the pH level and the bicarbonate ($HCO_3$) level in patients with chronic obstructive pulmonary disease (COPD) and acute respiratory failure with and without administration of non-invasive ventilation (NIV).
**Methods:** Our study included 250 patients diagnosed with COPD and acute respiratory failure who were hospitalized at the University Hospital of Lung Diseases "Shefqet Ndroqi" in Tirana during 2011-2014. Patients were divided into two groups: 125 patients were administered NIV, whereas 125 patients underwent the standard (conventional) treatment procedure. Mann-Whitney U-test was used to compare the mean values of pH and $HCO_3$ between the two groups of patients both upon hospital admission and hospital discharge.
**Results:** Upon hospital admission, there were no statistically significant differences in the biochemical parameters between the two groups of the patients. Upon hospital discharge, patients who were administered NIV had a pH less acid compared with their counterparts who underwent the standard/conventional therapy (mean pH level: 7.39±0.03 vs. 7.31±0.02, respectively; $P<0.001$). Similarly, the blood level of bicarbonates ($HCO_3$) – which has a crucial role in the physiological pH buffering system – was significantly lower in patients undergoing NIV (25.6±1.7 compared with 33.9±2.1 in patients with conventional therapy, $P<0.001$).
**Conclusion:** Our study indicates that NIV improves important biochemical parameters in patients with COPD and acute respiratory failure. Hence, it is important to identify in the clinical practice patients who need to undergo NIV in order to benefit as much as possible from this treatment strategy.

***Keywords:*** bicarbonates ($HCO_3$), chronic obstructive pulmonary disease (COPD), lung diseases, non-invasive ventilation, pH.

## Introduction

The benefit of non-invasive ventilation (NIV) for the treatment of acute respiratory failure in chronic obstructive pulmonary disease (COPD) patients has been well-documented in many studies including also meta-analyses (1,2). Hence, several randomized controlled trials have indicated that NIV improves arterial blood gas tensions and dyspnea and may prevent the need for intubation in patients admitted to hospital with an exacerbation of COPD associated with decompensated respiratory acidosis (3-7). In two large trials, there was also reported a significant reduction of in-hospital mortality (6,7). Therefore, it has been convincingly argued that it is important to identify in the clinical practice patients who need to undergo NIV in order to benefit as much as possible from this treatment strategy (3). Identification of suitable patients would enable an effective management in a higher dependency area or an intensive care unit with ready access to mechanical ventilation (3). Otherwise, the absence of mechanical ventilation may lead an increase in mortality, as already reported in several studies (3,8).

Albania emerged in 1991 from the most rigid communist regime which was characterized by a Semashko-type health system. In the past few decades, the transition towards a market-oriented system has been characterized by a significant shift in the disease burden from infectious diseases to non-communicable diseases, in particular cardiovascular diseases, cancer and COPD (9,10). However, the information about the prevalence of COPD and management of this condition in Albanian patients with the presence of acute respiratory failure is scant.

In this framework, our objective was to compare selected biochemical parameters including the pH level and the bicarbonate ($HCO_3$) level in patients with COPD and acute respiratory failure with and without administration of NIV.

## Methods

A case-series study was conducted including 250 patients diagnosed with COPD and acute respiratory failure who were hospitalized at the University Hospital of Lung Diseases "Shefqet Ndroqi" in Tirana during the period 2011-2014.

Patients were divided into two groups: 125 patients were administered NIV, whereas 125 patients underwent the standard (conventional) treatment procedure.

Furthermore, information about demographic and socioeconomic characteristics [age, sex, place of residence (urban areas vs. rural areas), marital status (dichotomized in the analysis into: married vs. widowed/divorced/single), employment status (categorized into: employed, unemployed and retired), educational level, social status and income level (all trichotomized into: low, middle and high)] and lifestyle/behavioral factors [current smoking (no vs. yes), alcohol consumption (categorized into: never, occasionally and regularly) and physical activity (trichotomized into: low, moderate and high)] of study participants was collected through the medical charts and a structured interview.

The study was approved by the Faculty of Medicine in Tirana. All patients who agreed to participate in this study gave their informed consent.

Mann-Whitney U-test was used to compare the mean values of pH and $HCO_3$ between the two groups of patients (individuals with NIV vs. those without NIV) both upon hospital admission and upon hospital discharge. In all cases, a p-value of $\leq 0.05$ was considered as statistically significant. Statistical Package for Social Sciences (SPSS, version 17.0) was used for the data analysis.

## Results

Mean age of the patients with NIV was very similar to those without NIV (64.4±6.8 vs. 64.6±5.0, respectively). Likewise, the sex distribution was quite similar in both groups (34% women in patients with NIV compared to 33% in patients without NIV). Furthermore, there were no statistically significant differences regarding the other socio-demographic characteristics (place of residence, marital status, educational attainment, employment

status, income level and social status) between patients with NIV and their counterparts without NIV (data not shown in the tables).

The distribution of selected biochemical parameters in patients with NIV and those without NIV upon hospital admission is presented in Table 1. Mean value of pH was 7.27±0.04 in the NIV group compared with 7.29±0.03 in the group without NIV (P=0.11). On the other hand, the mean values of $HCO_3$ were 34.3±2.3 and 34.8±2.3, respectively (P=0.38). Therefore, given these findings, there were no statistically significant differences neither for the pH level nor for the $HCO_3$ level at the baseline of the study (i.e., before allocation of the patients into different treatment regimens).

**Table 1. Selected biochemical parameters in patients with and without NIV upon hospital admission**

| PARAMETER | Without non-invasive ventilation (NIV) [N=125] | | With non-invasive ventilation (NIV) [N=125] | | P |
|---|---|---|---|---|---|
| | Mean±SD | 95%CI of the mean | Mean±SD | 95%CI of the mean | |
| **pH** | 7.29±0.03 | 7.28-7.30 | 7.27±0.04 | 7.26-7.28 | 0.113 |
| **$HCO_3$** | 34.8±2.3 | 34.4-35.2 | 34.3±2.3 | 33.9-34.7 | 0.379 |

Upon hospital discharge (Table 2), patients who were administered NIV had a pH less acid compared with their counterparts who underwent the standard/conventional therapy (mean pH level: 7.39±0.03 vs. 7.31±0.02, respectively; P<0.001).

**Table 2. Selected biochemical parameters in patients with and without NIV upon hospital discharge**

| PARAMETER | Without non-invasive ventilation (NIV) [N=125] | | With non-invasive ventilation (NIV) [N=125] | | P |
|---|---|---|---|---|---|
| | Mean±SD | 95%CI of the mean | Mean±SD | 95%CI of the mean | |
| **pH** | 7.31±0.02 | 7.30-7.32 | 7.39±0.03 | 7.38-7.40 | <0.001 |
| **$HCO_3$** | 33.9±2.1 | 33.5-34.3 | 25.6±1.7 | 25.3-25.9 | <0.001 |

Similarly, the blood level of bicarbonates ($HCO_3$) – which has a crucial role in the physiological pH buffering system – was significantly lower in patients undergoing NIV (25.6±1.7 compared with 33.9±2.1 in patients with conventional therapy, P<0.001) (Table 2).

## Discussion

Main findings of this study comprising a sample of Albanian patients with COPD and acute respiratory failure include a significant improvement of two important biochemical parameters such as the pH level and the $HCO_3$ due to administration of NIV. Hence, upon hospital discharge, compared with patients treated with conventional therapy, those who underwent NIV had a pH less acid and a significantly lower level of $HCO_3$ in the blood. These findings bear important clinical implications which should be taken into consideration in the routine medical practice.

Our findings are in line with many previous reports from the international literature (1-7). Hence, our finding regarding sustained clinical stability due to NIV is compatible with several previous studies where a reduction in the number of hospital admissions after three months of therapy was observed (2,11). Furthermore, it has been shown that domiciliary administration of NIV in COPD patients

with recurrent admissions for acute-on-chronic respiratory failure requiring NIV reduces hospital admissions (12). Nevertheless, the particular strength of our estimates may be partly explained by our selection of patients with a high probability of recurrent respiratory failure. Future studies should be conducted in Albania to confirm and expand our findings.

This study may have some limitations including the sample representativeness and the validity of the information obtained. The sample included in this study included only patients hospitalized at the University Hospital of Lung Diseases "Shefqet Ndroqi" in Tirana. As such, this study sample may not represent the overall patients with COPD and acute respiratory failure in Albania. Therefore, findings from this study should be generalized only to patients who are admitted at the University Hospital in Tirana. The instruments used for data collection consisted of standardized and valid tools which tend to argue in favor of absence of information bias. However, there might have been some sorts of differential reporting between patients pertinent to different demographic and socio-economic backgrounds (based on age, sex, educational attainment, employment status, economic level and social status). As such, findings of this study should be interpreted with caution.

In conclusion, regardless of its potential limitations, this study indicates that NIV improves important biochemical parameters in patients with COPD and acute respiratory failure. Thus, it is important to identify in the clinical practice patients who need to undergo NIV in order to benefit as much as possible from this treatment strategy. Health professionals and policymakers in Albania should be aware of the clinical importance and benefits of NIV in patients with COPD and acute respiratory failure.

**Conflicts of interest**: None declared.

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