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ORIGINAL ARTICLE / ÖZGÜN ARAŞTIRMA MAKALESİ

The Effect of Carbondioxide Clearance on Clinical Prognosis in Patient with Hypercapnic Respiratory Failure

Hiperkapnik Solunum Yetmezliği Olan Hastalarda Karbondioksit Klirensinin Klinik Prognoza Etkisi

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ABSTRACT

Aim: Hypercapnic respiratory failure is defined as a carbon dioxide (CO_2) level >45 mmHg. High $PaCO_2$ levels are related with increased mortality in acute exacerbation of COPD. In our study, we aimed to determine CO_2 clearance value for predicting patients' prognosis.

Material and Methods: 68 patients were included in the study. The patients were divided into two as, good and poor prognosis groups according to the outcome. The patients' demographic information, comorbidities, vital parameters, blood gas results on admission (first measurement) and in the first sixth hour (second measurement), treatment, and outcomes were recorded in data forms. The relation between CO_2 change and outcome was evaluated.

Results: There was no statistically significant difference in CO_2 clearance and delta pCO_2 levels between the good and poor prognosis groups (11.7±12 vs. 6.2 ± 23, p=0.205 and -11.77±12.92 mmHg vs. -7.66±24.76 mmHg, p=0.281 respectively). $NaHCO_3$ levels in the second measurement were higher than the first measurement in both good (23.89 ±5.28, 25.78±4.39, p<0.0001) and poor prognosis (23,26±6.05, 23.53 ± 5.05, p<0.0001) groups. And also, pCO_2 levels in the second measurement was lower than the first measurement in the good (60.68 ± 11.89, 48.92 ± 14.02, p=0.007) and poor (68.04 ± 20.15, 61.76 ± 22.87, p=0.007) prognosis groups. There was also a significant decrease in lactate levels in the poor prognosis group between the first and the second measurements (p<0.001).

Conclusion: Our study revealed that the CO_2 clearance calculated in the first six hours in hypercarbic patients who came to the emergency department with shortness of breath was not useful in predicting the short-term prognosis of the patients. However, delta lactate and delta $NaHCO_3$ levels significantly changed in the poor prognosis group.

Keywords: Carbondioxide clearance, hypercapnia, respiratory failure, emergency medicine

ÖZ

Amaç: Hiperkapnik solunum yetmezliği, karbondioksit (CO_2) seviyesinin >45 mmHg olması olarak tanımlanır. Yüksek $PaCO_2$ seviyeleri, KOAH'ın akut alevlenmesinde artan mortalite ile ilişkilidir. Çalışmamızda hastaların prognozunu öngörmek için CO_2 klirens değerini belirlemeyi amaçladık.

Gereç ve Yöntemler: 68 hasta çalışmaya dahil edildi. Hastalar sonuca göre iyi ve kötü prognoz grubu olarak iki gruba ayrıldı. Hastaların demografik bilgileri, komorbiditeleri, vital parametreleri, başvuru (ilk ölçüm) ve altıncı saat (ikinci ölçüm) kan gazı sonuçları, verilen tedavi ve sonuçları veri formuna kaydedildi. CO_2 değişimi ve sonuç arasındaki ilişki değerlendirildi.

Bulgular: İyi ve kötü prognoz grupları arasında CO_2 klirensi ve delta CO_2 seviyelerinde istatistiksel olarak anlamlı bir fark yoktu (sırasıyla 11.7±12 vs 6.2 ± 23, p=0.205 ve -11.77±12.92 mmHg vs -7.66±24.76 mmHg, p=0.281). $NaHCO_3$ seviyeleri ikinci ölçümde birinci ölçüme göre iyi (23.89 ±5.28, 25.78±4.39, p<0.0001) ve kötü (23,26±6.05, 23.53 ± 5.05, p<0.0001) prognoz gruplarında yüksek saptanmıştır. Bununla beraber pCO_2 seviyeleri, ikinci ölçümlerde iyi (60.68 ± 11.89, 48.92 ± 14.02, p=0.007) ve kötü (68.04 ± 20.15, 61.76 ± 22.87, p=0.007) prognoz gruplarında ilk ölçümlere göre düşük çıkmıştır. Ayrıca kötü prognozlu grupta birinci ve ikinci ölçümler arasında laktat düzeylerinde anlamlı bir azalma oldu (p<0.001).

Sonuç: Çalışmamız sonucunda acil servise nefes darlığı şikayeti ile gelen hiperkarbik hastalarda ilk altı saatte hesaplanan CO_2 klirensinin hastaların kısa dönem prognozunu öngörmede yararlı olmadığı görüldü. Ancak delta laktat ve delta $NaHCO_3$ düzeyleri kötü prognozlu grupta anlamlı olarak değişmektedir.

Anahtar Kelimeler: Karbondioksit klirensi, kiperkapni, solunum yetmezliği, acil tıp

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Introduction

Hypercapnic respiratory failure is defined as carbon dioxide (CO_2) level >45 mmHg. Common etiologic causes are chronic obstructive pulmonary disease (COPD), asthma, chest wall abnormalities (1). In addition, hypercapnia can be seen in congestive heart failure patients (2).

Based on the balance between carbon dioxide and carbonic acid, in hypercapnia serum pH level decreases and respiratory acidosis occurs (3). Early symptoms of hypercapnia are skin rash, tachypnea, shortness of breath, extrasystoles, muscle tics, tremors, decreased neuronal activity, and sometimes increased blood pressure. Besides mild hypercapnia can cause headache, confusion, and lethargy. Hypercapnia elevates blood pressure by increasing cardiac output and it can cause arrythmia (4,5).

High partial CO_2 ($PaCO_2$) levels are related with increased mortality in acute exacerbation of COPD. Patients with significantly high carbon dioxide levels have poor long-term outcome after discharge from hospital. Similar situation applies for patients with high carbon dioxide levels, recovering from acute exacerbation (6).

There are many other conditions that can cause hypercapnic respiratory failure. These are drug overdose, myasthenia gravis, polyneuropathy, poliomyelitis, primary muscle disorders, head and spinal cord injuries, obesity – hypoventilation syndrome, pulmonary edema, acute respiratory distress syndrome (ARDS), myxedema and tetanus (7).

Blood gas analysis supply important clinical information for patients with respiratory disorders, compromised circulation, or abnormal metabolism. The amount of oxygen and carbon dioxide in the blood can be measured and reported as the partial pressure of the gas. Blood gas analysis also typically includes a direct measurement of the serum pH and estimates of serum bicarbonate derived from the measured partial pressure of carbon dioxide (pCO_2) and pH (8).

When respiratory failure is suspected, blood gas analysis should be performed to confirm diagnosis and to decide if it is acute or chronic. This helps to evaluate severity of respiratory failure and guides treatment. Furthermore, complete blood count (CBC – evaluates anemia), biochemical markers (for differential diagnosis), serum creatinine kinase and troponin I levels (to exclude myocardial ischemia) and thyroid stimulating hormone (TSH–to exclude hypothyroidism) test should be performed (9).

In our study, we adapted lactate clearance formula for sepsis patients to CO_2 clearance. "The CO_2 clearance formula" is a parameter that has not been defined in the literature before. CO_2 clearance is calculated by subtracting last carbon dioxide level from the initial carbon dioxide level and dividing by the initial value. In our study, we aimed to determine CO_2 clearance value for predicting patients' prognosis. We also evaluated the relation between treatment methods and CO_2 clearance.

Materials and Methods

Study Type

This observational, prospective, descriptive study was conducted at the Dokuz Eylül University Emergency Department (ED) after the approval of the Ethics Committee of Dokuz Eylül University (12.03.2015 dated and/2004-GOA numbered). All the procedures were done according to Helsinki Declaration and the written informed consent forms were obtained from all the participants.

Study Population

Adult patients (>18 years old) admitted to emergency room with complaint of dyspnea and hypercarbia (PCO_2> 45 mmHg) were included in the study after obtaining consent form.

Patients, who refused to participate in the study, whose blood gas was unavailable, who had hypercarbia without respiratory failure (central nervous system pathologies, drug intoxications), and who had cardiac arrest in the first two hours of the emergency room admission (since clearance calculation could not be made) were excluded.

Dataset

Patients' demographic information, comorbidities, vital parameters, blood gas results on admission (first measurement) and in first sixth hour (second measurement), treatment, and outcomes were recorded to dataset. Outcome measures were determined as discharge, inpatient admission to the ward or intensive care unit, and death.

Clinical Evaluation

Transition to the next step of therapy in patients who did not respond to the treatment, deterioration of consciousness in the conscious patient, continuation of the patient's vital instability (tachypnea, tachycardia, low saturation) at the end of the 2nd hour, need for intensive care admission, need for hospitalization without relief of symptoms, and death were accepted as indicators of poor prognosis. Recovery of the patient with confusion, improvement of vital signs at the end of the second hour, application of a lower treatment protocol (such as reduction of inhaler drug doses, reduction of the drug), more than half relief from shortness of breath and discharge from the emergency service was accepted as good prognostic results.

Measurement of Arterial Blood Gas Analysis and CO_2 Clearance

Arterial blood gas analyses were done by "Radiometer ABL800 FLEX blood gas analyzer" (Radiometer Company, Denmark). CO_2 clearance was calculated by using blood gases taken before treatment (first measurement) and second blood gas in the first 6 hours (second measurement).

$$CO_2 \text{ Clearence} = \frac{(\text{first measured } CO_2 - \text{last measured } CO_2)\times 100}{\text{First measured } CO_2}$$

Statistical analysis

The data gathered were listed in the "Study Data Form" previously prepared for the study and a standard program named "Statistical Package for Social Sciences for Windows 19.0" (IBM Corporation, Armonk, New York, United States). The compliance of the data to normal distribution was evaluated with the Kolmogorov-Smirnov test. Differences between categorical variables were tested by Chi-Square Analysis. Mann Whitney U test was used for the analysis of independent variables that did not conform to normal distribution. Paired samples t test was used for the analysis of dependent variables compatible with normal distribution. $p<0.05$ was considered significant.

Results

There were 76 patients admitted to the emergency service with complaint of dyspnea between 01.06.2015 – 31.08-2015 Eight of these patients were excluded from the study because they met the exclusion criteria. Sixty-eight patients were enrolled to study. The average age of the participants was 73.9 ± 11.5 and 43 (63%) were male.

When the first and the second measurement control blood gas parameter levels of all patients were compared, pH and $NaHCO_3$ levels were significantly higher in the second measurements and pCO_2 and lactate levels were significantly lower (respectively p=0.026, p<0.0001, p<0.0001, p<0.0001). There was a significant decrease in pCO_2 levels in the good and the poor prognosis groups (p=0.007 and p=0.007 respectively) between the first and the second measurements. There was a significant increase in $NaHCO_3$ levels in the good and the poor prognosis groups (p<0.0001 and p<0.0001 respectively) between the first and the second measurements. There was also a significant decrease in lactate levels in poor prognosis group between the first and the second measurements (p<0.001) (Table 1).

When we compare blood gas parameters of the good and the poor prognosis groups, there were no significant difference between the first blood gas values (p>0.05 for all comparisons). In the second blood gas results, pH was significantly higher and pCO_2 was significantly lower in the good prognosis group than the poor prognosis group (p<0.0001 and p=0.01 respectively) (Table 2).

When we compare delta values (difference between the first and the second blood gas parameters), lactate levels decreased more in good prognosis group than poor prognosis group (p=0.042). $\Delta NaHCO_3$ level was found positive in good prognosis group. In contrast, $\Delta NaHCO_3$ level was found negative in poor prognosis group. There was a significant difference between good and poor prognosis group in $\Delta NaHCO_3$ levels (p=0.04). And, there was no statistically significant difference in CO_2 clearance between the good and the poor prognosis groups (p=0.205) (Table-2).

It was observed that the patients mostly received NIMV (n = 45 and 66.1%) treatment in the emergency department. There was no statistically significant difference between the patients in the good and the poor prognostic groups in terms of gender, smoking history, receiving NIMV treatment in the emergency department, and diuretic and nitroglycerine therapy (p>0.05 for all comparisons). Patients in the good prognosis group received more nebulized bronchodilator treatment than the poor prognosis group (p=0.01).

		First Measurement	Second Measurement	*p*
All the Participants (n=68)	pH	7.24 ± 0.09	7.29 ± 0.09	0.026
	pO_2 (mmHg)	79.4 ± 37.19	97.3 ± 53.89	0.216
	pCO_2 (mmHg)	65.18 ±17.69	56.77 ± 20.77	0.0001
	Lactate (mmol/L)	2.09 ± 2.11	1.68 ± 1.55	0.0001
	$NaHCO_3$ (mmol/L)	23.51 ± 5.73	24.41 ± 4.89	0.0001
Good Prognosis Group (n=26)	pH	7.27 ± 0.08	7.35 ± 0.04	0.84
	pO_2 (mmHg)	89.64 ± 45.82	87.72 ± 42.53	0.50
	pCO_2 (mmHg)	60.68 ± 11.89	48.92 ± 14.02	0.007
	Lactate (mmol/L)	2.2 ± 1.98	1.35 ± 0.98	0.482
	$NaHCO_3$ (mmol/L)	23.89 ± 5.28	25.78 ± 4.39	0.0001
Poor Prognosis Group (n=42)	pH	7.23 ± 0.11	7.27 ± 0.09	0.11
	pO_2 (mmHg)	73.13 ± 29.71	103.07 ± 59.53	0.11
	pCO_2 (mmHg)	68.04 ± 20.15	61.76 ± 22.87	0.007
	Lactate (mmol/L)	2.03 ± 2.2	1.89 ± 1.81	0.0001
	$NaHCO_3$ (mmol/L)	23.26 ± 6.05	23.53 ± 5.05	0.0001

p values are derived from paired-samples t-test and refer to a comparison between the first and second measurements.

Table 1: First and second blood gas analysis of patients

		All the Participants (n=68)	Good Prognosis Group (n=26)	Poor Prognosis Group (n=42)	*P* Value
First Measurement	pH	7.24 ± 0.09	7.27 ± 0.08	7.23 ± 0.11	0.163
	pO_2 (mmHg)	79.4 ± 37.19	89.64 ± 45.82	73.13 ± 29.71	0.211
	pCO_2 (mmHg)	65.18 ±17.69	60.68 ± 11.89	68.04 ± 20.15	0.141
	Lactate (mmol/L)	2.09 ± 2.11	2.2 ± 1.98	2.03 ± 2.2	0.286
	$NaHCO_3$ (mmol/L)	23.51 ± 5.73	23.89 ± 5.28	23.26 ± 6.05	0.908
Second Measurement	pH	7.29 ± 0.09	7.35 ± 0.04	7.27 ± 0.09	**0.0001**
	pO_2 (mmHg)	97.3 ± 53.89	87.72 ± 42.53	103.07 ±59.53	0.148
	pCO_2 (mmHg)	56.77 ± 20.77	48.92 ± 14.02	61.76 ± 22.87	**0.01**
	Lactate (mmol/L)	1.68 ± 1.55	1.35 ± 0.98	1.89 ± 1.81	0.189
	$NaHCO_3$ (mmol/L)	24.41 ± 4.89	25.78 ± 4.39	23.53 ± 5.05	0.097
Δ Values	ΔpH	0.05 ± 0.11	0.08 ± 0.09	-0.14 ± 1.15	0.097
	ΔpO_2 (mmHg)	19.6 ± 60.7	0.83 ± 58.56	27.29 ± 61.31	0.091
	ΔpCO_2 (mmHg)	-8.3 ± 20	-11.77 ± 12.92	-7.66 ± 24.76	0.281
	ΔLactate (mmol/L)	-0.42 ± 1.83	-0.85 ± 2.08	-0.16 ± 1.6	**0.042**
	$\Delta NaHCO_3$ (mmol/L)	0.2 ± 6.91	0.67 ± 6.86	-0.85 ± 8.5	**0.04**
CO_2 Clearance (%± SD)			11.7 ± 12	6.2 ± 23	0.205

p values are derived from the Mann-Whitney U test and refer to a comparison between good and poor prognosis groups.

Table 2 - Blood gas analysis changes of the participants

When we evaluated the patients' outcomes, it was found that most of the patients in the good prognostic group were discharged and in the poor prognostic group most of them were transferred to intensive care ($p<0.0001$) (Table 3). When the demographic characteristics of the participants and the effect of their comorbidities on CO_2 clearance were evaluated, CO_2 clearance of patients diagnosed with congestive heart failure (CHF) were found to be significantly lower than those without CHF ($p=0.04$). In contrast, CO_2 clearance was higher in patients who had coronary artery disease (CAD) compared to who did not have. When the CO_2 clearance was compared according to the treatments, a significant difference was seen only in the intubated patients ($p=0.01$). There was no significant difference in CO_2 clearance in other treatment methods ($p>0.05$ for all comparisons) (Table 4).

Discussion

The data obtained in our study showed that the CO_2 clearance calculated in the first six hours in hypercarbic patients who came to the emergency department with dyspnea was insufficient to predict the short-term prognosis of the patients.

In our study, we predicted that the prognosis of hypercarbic patients would improve as CO_2 levels decreased. We couldn't find a study in the literature that investigated the effect of CO_2 clearance on prognosis in hypercarbic patients presenting with shortness of breath. Contou et al. investigated the effects of carbon dioxide on outcome in patients with cardiogenic edema. At the end of the study, no difference was observed between normo and hypercarbic patients in terms of NIMV duration, time of intensive care unit stay, poor prognosis and intubation. The high carbon dioxide level at the time of admission did not affect prognosis. Although it does not affect the intubation rate and the length of stay in the intensive care unit, the short-term outcome of severe hypercapnic patients (PCO_2> 60 mmHg) was poor (10).

Quintana et al. did not find any significant difference on short–term and one-month mortality of hypercarbic COPD patients admitted to emergency service with exacerbation (11). In the study conducted by Gattinoni et al on ARDS patients, survival rate was found to be 49% in patients whose high CO_2 level was corrected by the extracorporeal method. (12). Pesenti et al also stated that extracorporeal CO_2 clearance would be beneficial in intensive care patients. (13). When the first and the control blood gas values of all patients were compared, a significant increase in pH and $NaHCO_3$ and a significant decrease in lactate and pCO_2 levels were found. These results suggest that all patients received effective treatment regardless of prognosis. When we group patients as good and poor prognosis, carbon dioxide levels decreased significantly in the second measures in both groups, but there was no significant difference on delta CO_2, CO_2 clearance, and mortality between two groups.

		Good Prognosis Group n (%)	Poor Prognosis Group n (%)	P Value
Gender	*Male*	17 (65.4)	26 (61.9)	0.49
	Female	9 (34.6)	16 (38.1)	
Smoking	*Yes*	9 (34.6)	13 (30.9)	0.48
	No	17 (65.4)	29 (68.1)	
NIMV	*Yes*	15 (57.7)	30 (71.4)	0.18
	No	11 (42.3)	12 (28.6)	
Nebulised bronchodilator	*Yes*	16 (61.5)	13 (30.9)	0.01
	No	10 (38.5)	29 (68.1)	
Diuretic	*Yes*	10 (38.5)	10 (23.8)	0.15
	No	16 (61.5)	32 (76.2)	
Iv. nitroglycerine	*Yes*	9 (34.6)	7 (13.4)	0.08
	No	17 (65.4)	35 (86.6)	
Intubation	*Yes*	0	14 (33.3)	0.0001
	No	26 (100)	28 (66.7)	
	Discharge	15 (57.6)	0	
	Hospitalized to service	11 (42.4)	1 (2,4)	
Outcome	*Hospitalized to ICU*	0	37 (88.1)	0.0001
	Death	0	4 (9.5)	
	COPD	19 (73.1)	25 (59.5)	0.42
	CHF	11 (42.3)	13 (30.1)	0.6
Comorbidities	*CAD*	1 (3.8)	2 (4.7)	1
	Lung Cancer	1 (3.8)	2 (4.7)	1
	Hypertension	6 (23.1)	15 (35.7)	0.28

p values are derived from the Chi-square test.

Table 3 – Gender, smoking, and treatment data of the groups.

Considering of CO_2 clearance of both groups are similar, we can assume that CO_2 clearance cannot be used as an indicator for predicting hypercarbic patients short–term prognosis.

In our study, in the second measures $NaHCO_3$ levels were significantly higher than the first measures in both groups. This result suggests that physiological response of acid-base balance is normal for both groups. Sensitive regulation is required as all enzyme systems in the body are affected by the H+ concentration (14). In our study, there was no significant difference between the good and the poor prognosis groups in terms of pH, pO_2, pCO_2, lactate and $NaHCO_3$ levels in the first measurement blood gases. In the second measurement blood gas values, it was observed that pH was significantly higher in the good prognosis group compared to the poor prognosis group. There was no significant difference between pO_2, pCO_2, lactate, and $NaHCO_3$ levels.

Although base levels were not different, improvement in pH levels in the good prognosis patients was expected. On the other hand, with the stabilization of the pH, some improvement was seen in the other buffer systems, pCO_2 and $NaHCO_3$, as expected. But improvement in pCO_2 and $NaHCO_3$ did not make a significant difference. Again, there was no significant difference between the groups in pO_2 and lactate levels, which shows tissue oxygenation. These results support that parameters pO_2, pCO_2, lactate and $NaHCO_3$ alone are not useful in predicting prognosis in hypercarbic patients.

We investigated that if delta values (which shows the difference between first and second measurements) could be meaningful and there was no significant difference in delta pH, delta pO_2, and delta pCO_2 levels in both groups. Conti et al. similarly did not find any significant difference between the good and the poor prognosis groups in delta pO_2, delta pH and delta pCO_2 levels of COPD patients who needed NIMV (15). Only delta lactate value of the good prognosis group was significantly higher than the poor prognosis group. Lactate level is an important indicator of tissue perfusion disorder, and its level may increase positively in many disease (16). High lactate level is an independent risk factor for mortality and normalization of lactate level in early period is a good prognostic indicator (17, 18). In accordance with the literature, in our results, there was a significant improvement in lactate level in the good prognosis group.

Treatment	*n (%)*	*Yes Mean±SD*	*No Mean±SD*	*p*
NIMV	45 (66.1)	12.69±28.1	7.48±27.88	0.471
Bronchodilator	26 (42.6)	12.16±25.89	9.95±29.84	0.749
Diuretic	20 (29.4)	17.78±24.83	9.21±29.37	0.452
Nitroglycerine	16 (23.5)	21.9±19.9	7.54±29.37	0.072
Intubation	14 (20.5)	-10.06±38.1	16.37±22.07	0.001
Comorbidities	***n(%)***	***Yes*** *Mean±SD*	***No*** *Mean±SD*	
COPD	44 (64.7)	7.49±29.48	17.24±24.33	0.55
CHF	24 (35.3)	2.53±26	15.51±28.24	0.04
CAD	3 (4.4)	43.15±14.54	9.44±27.61	0.05
Lung Cancer	3 (4.4)	37.56±28.21	9.7±27.57	0.16
Hypertension	21 (30.9)	8.57±21.48	11.98±30.6	0.50

p values are derived from independent sample t-test.

Table 4 Relations between CO_2 clearance and treatment strategies and comorbidities

No significant relationship was found between patients' gender, comorbidities (COPD, CHF, CAD, lung cancer and hypertension), smoking history, and home NIMV use and CO_2 clearance. But Quintana et al. investigated COPD patients admitted to emergency service in their study and discovered that NIMV usage in home and comorbidities influenced poor outcome. In the study, the effect of gender on prognosis was not evaluated since 97% of the participants were male (11). In our study, 63% of the patients were male and the mean age was 73.9 ± 11.5. Similarly, in other studies conducted in hypercapnic patients in the literature, it has been reported that hypercarbia was observed more frequently in the 70s and in the male gender (2,10). In both our study and similar studies, it was observed that gender did not influence prognosis in hypercarbic patients.

When we investigate the effect of smoking on prognosis, there were no significant difference between the good and the poor prognosis groups. 9 patients (34.6%) in the good prognosis group and 13 patients (30.9%) in the poor prognosis group were smoking. Konishi et al found smoking in the hypercapnic patient as 37.1% in their study (2). In the study of Contou et al., this figure was 43% for hypercapnic patients. In the same study, smoking ratio was 39% in short-term poor prognosis patients (10). The lack of a significant difference between the two groups can be explained by the similarity of smoking rates in both groups and these rates were similar to our country's data (19).

When patients were examined in terms of the treatments they received, 15 patients (57.6%) in the good prognosis group and 30 patients (71.4%) in the poor prognosis group received NIMV treatment. No significant relationship was found between NIMV treatment and prognosis. In the study of Konishi et al. 58.5% of hypercapnic patients received NIMV treatment (2). Despite the high rate of NIMV use in both groups, different prognostic results can be explained by the fact that the good prognostic group responded to NIMV treatment and then this need disappeared. Therewithal, in the poor prognosis group, the NIMV treatment was insufficient, and the patients needed longer NIMV treatment or transition to an upper-level treatment.

In our study, NIMV, bronchodilators, diuretics or nitroglycerin treatment had no significant effect on CO_2 clearance. Only endotracheal intubation had a significant effect on CO_2 clearance. In the study conducted by Contou et al. on patients with cardiogenic pulmonary edema, no significant difference was found between the NIMV taking time between hypercapnic and normocapnic patients. However, considering short-term outcome, duration of NIMV use was significantly lower in the good outcome group than the poor outcome group (10). In the study of Ucgun et al. on COPD patients with hypercapnic respiratory failure, there was a significant difference between the pCO_2 levels of intubated patients who survived and those who died (20).

Limitations

The most important limitations of our study were the small number of patients, heterogeneous diagnosis groups of patients with hypercarbic respiratory distress and the lack of investigation on the causes of death.

Conclusion

As a result of our study, it was seen that the CO_2 clearance calculated in the first six hours in hypercarbic patients who came to the emergency department with shortness of breath was not useful in predicting the short-term prognosis of the patients. After treatment blood gas values were not enough alone to predict prognosis. However, delta lactate and delta $NaHCO_3$ levels significantly changes in the poor prognosis group.

Conflict of Interest: The authors declare no conflict of interest regarding this study.

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Ethical Statement: Approval was obtained from Dokuz Eylül University School of Medicine Clinical Researches Ethical Committee Date: 16.03.2015, Decision No: 2015/08-18). All authors declared that they follow the rules of Research and Publication Ethics.

References

1. Kaynar AM. Respiratory Failure. Web Site. Available at: http://emedicine.medscape.com/article/167981-overview (Accessed January 23, 2021).
2. Konishi M, Akiyama E, Suzuki H, et al. Hypercapnia in patients with acute heart failure. ESC Heart Fail. 2015;2:12-9. doi: 10.1002/ehf2.12023.

3. Vestbo J, Hurd SS, Agustí AG, Jones PW, et al. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: GOLD executive summary. Am J Respir Crit Care Med. 2013;187:347-365. doi: 10.1164/rccm.201204-0596PP.
4. Stapczynski JS. Respiratory Distress. In: Tintinalli JE, Ma OJ, Yealy DM, Meckler GD, Stapczynski JS, Cline DM, Thomas SH editors. Tintinalli's Emergency Medicine : A Comprehensive Study Guide, 9th Ed. New York: McGraw-Hill Education Medical: 2020, p.425-432.
5. Morgan GE, Jr, Mikhail MS, Murray MJ. Breathing Systems. In:Morgan GE, Jr., Mikhail MS, Murray MJ: Clinical Anesthesiology, 5th Ed.. New York: McGraw-Hill Education Medical: 2013,p.29-42.
6. Conti G, Antonelli M, Navalesi P, et al. Noninvasive vs. conventional mechanical ventilation in patients with chronic obstructive pulmonary disease after failure of medical treatment in the ward: a randomized trial. Intensive Care Med. 2002;28:1701-7. doi: 10.1007/s00134-002-1478-0.
7. Xuan J, Duong PT, Russo PA, Lacey MJ, Wong B. The economic burden of congestive heart failure in a managed care population. Am J Manag Care. 2000;6:693-700. PMID: 10977478.
8. Glass CM. Blood Gases, Pulse Oximetry, and Capnography.In: Tintinalli JE, Ma OJ, Yealy DM, Meckler GD, Stapczynski JS, Cline DM, Thomas SH editors. Tintinalli's Emergency Medicine: A Comprehensive Study Guide, 9th Ed. New York: McGraw-Hill Education Medical; 2020:78-81.
9. Fayyaz J. Hypoventilation Syndromes Workup. Web Site. Availabe at: http://emedicine.medscape.com/article/304381-workup (Accessed January 23, 2021).
10. Contou D, Fragnoli C, Córdoba-Izquierdo A, Boissier F, Brun-Buisson C, Thille AW. Severe but not mild hypercapnia affects the outcome in patients with severe cardiogenic pulmonary edema treated by non-invasive ventilation. Ann Intensive Care. 2015;5:55. doi: 10.1186/s13613-015-0055-y.
11. Quintana JM, Esteban C, Unzurrunzaga A, et al, Predictive score for mortality in patients with COPD exacerbations attending hospital emergency departments. BMC Medicine. 2014;12:66.
12. Gattinoni L, Pesenti A, Mascheroni D, et al. Low-frequency positive-pressure ventilation with extracorporeal CO2 removal in severe acute respiratory failure. JAMA. 1986; 256:881-6.
13. Pesenti A, Patroniti N, Fumagalli R. Carbon dioxide dialysis will save the lung, Crit Care Med. 2010; 38:S549 –S554.
14. Acide-Bas Regulation. In: Hall JE. Editor. Guyton and Hall Textbook of Medical Physiology. 12 th Ed. Philadelphia: Saunders Elsevier; 2011:379-410.
15. Conti V, Terzano C, Mollica C, et al, Predictors of Outcome in COPD Patients with Hypercapnic Respiratory Failure Requiring NIV. Enliven: J Anesthesiol Crit Care Med. 2014;1: 004.
16. Andersen LW, Mackenhauer J, Roberts JC, Berg KM, Cocchi MN, Donnino MW. Etiology and therapeutic approach to elevated lactate levels. Mayo Clin Proc. 2013;88:1127-40. doi: 10.1016/j.mayocp.2013.06.012.
17. Husain FA, Martin MJ, Mullenix PS, Steele SR, Elliott DC. Serum lactate and base deficit as predictors of mortality and morbidity. Am J Surg. 2003;185:485-91. doi: 10.1016/s0002-9610(03)00044-8.
18. Dellinger PR, Surviving Sepsis Campaign: International Guidelines for Management of Severe Sepsis and Septic Shock; 2012:12.
19. Tobacco Control Studies in Turkey. Available at: http://www.saglik.gov.tr/TR/belge/1-15787/turkiyede-tutun-kontrolu-calismalari-31052012.html [Last Accessed Date: 23 January 2021].
20. Ucgun I, Metintas M, Moral H, Alatas F, Yildirim H, Erginel S. Predictors of hospital outcome and intubation in COPD patients admitted to the respiratory ICU for acute hypercapnic respiratory failure. Respir Med. 2006;100:66-74. doi: 10.1016/j.rmed.2005.04.005.