Diffusion oxygen mask is better in asthma attacks but not in COPD attacks.

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Abstract

Background: Asthma and COPD (Chronic Obstructive Pulmonary Disease) attacks are frequently seen in emergency departments. While giving oxygen to these patient groups we generally use standard masks. We compared the standard mask with diffuser mask which was an open-style oxygen mask in reducing carbon dioxide levels and increasing the PEF (peak expiratory flow) values.

Methods: In our study, 52 patients used diffuser mask and 51 used standard masks. Salbutamol +ipratropium bromide treatment was applied with either diffuser or standard mask. Reducing the $EtCO_2$ and increasing the PEF values were the target point for effectiveness of the treatment.

Results: 67 (65.0%) of the patients were COPD; 36 (35.0%) were asthma. The initial pCO_2 values were correlated strongly with $EtCO_2$ values (p<0.001, r=0.875). There was a moderate negative correlation between initial arterial gas pCO_2 value and PEF values (p=0.002, r=-0.300). At admission, the initial pCO_2, $EtCO_2$ and PEF values were similar between the diffuser mask and standard mask group. If we think about COPD and asthma patients together, at the second and four hours, $EtCO_2$ values were significantly lower in diffuser mask group (p=0.013 and p=0.004 respectively). In COPD group; at the second and fourth hours, $EtCO_2$ values of both masks were similar. In asthma group; $EtCO_2$ values in the second and fourth hours was lower in diffuser mask group. PEF values were higher in the second and fourth hours for both of the masks for all patients.

Conclusion: We argued that especially in asthma attacks, diffuser mask is better in reducing carbon dioxide; additionally it provides good PEF values for COPD and asthma attacks.

Introduction

Asthma and COPD (Chronic Obstructive Pulmonary Disease) attacks are frequent reasons of emergency department visits. Bronchospasm and prolongation of the expiration are the typical symptoms of the attacks. The main target of the treatment is to resolve the bronchospasm. The most frequently used agents are salbutamol as short-acting β2-adrenergic receptor agonist and ipratropium as anticholinergic for this purpose. Salbutamol and ipratropium are given the patient via various types of oxygen masks.

The diffuser mask is an open-style oxygen mask that was originally developed in 2005 which concentrates and directs oxygen toward the nose and mouth via a small diffuser [1,2]. Classical masks are closed systems that can trap expiratory CO_2 in regions of flow re-circulations like lower areas of the mask; however, the diffuser mask is an open system that avoids CO_2 accumulations inside the mask [1]. Futrell et al. reported that OxyArm™ which is a type of diffuser mask provides large concentrations of supplemental oxygen therapy to patients without the complications of older devices and with great patient compliance and comfort [3].

In this study we compared the effectiveness of the diffusion versus standard oxygen mask in asthma and COPD attacks.

Material and Methods

This prospective study was conducted in Emergency Department of Ordu University Hospital after ethics committee approval between 1st January 2014 and 31th March 2014. The patients admitted to emergency department with dyspnea and had a past history of asthma or COPD was included the study. Informed consent was signed by patients. 103 patients was included the study.

One type of envelopes are prepared that are containing either diffuser mask or oxygen mask. Envelopes are mixed and were put into a box. An envelope was taken from the box for every study patient; salbutamol+ipratropium bromide treatment was applied by the mask type that was written in the envelope. Diffuser mask was used for 52 of the patients and standard oxygen mask was used for 51 patients.

At the beginning of the treatment the pCO_2 (partial carbondioxide) in arterial blood gas; $EtCO_2$ (end tidal carbon dioxide) level that was measured by caphnograph and PEF

(peak expiratory flow) value with peak expiratory flow meter was recorded. Then, 2 µgr salbutamol nebule was given for four times at 0-20-40-60th minutes; 200 µgr ipratropium bromides were given for two times in 0-20th minutes. At the 2nd and 4th hour, $EtCO_2$ and PEF values were measured again. $EtCO_2$ and PEF values before and after the treatment were compared for both mask types. PEF value was measured with peak flow meter for three times in every measurement and the highest value was recorded. $EtCO_2$ was measured by mainstream technology.

SPSS 17.0 for windows package program was used for statistical analyses. Continuous variables were expressed by mean ± standard deviation, ordinal variables as median and minimum-maximum and frequent variables as rates. The normal distributions of continuous variables were checked by histogram and One-Sample Kolmogorov Smirnov Test. To calculate the difference between normally distributed data, independent sample t-test was used; and Mann-Whitney U Test for data that are not normally distributed. Spearman Correlation Coefficient used for correlation of continuous variables. Difference between categorical data was checked by Pearson Chi-Square Test and Fisher's Exact Test. All hypotheses were constructed two-tailed and $p \leq 0.05$ was considered as significant.

Results

Among 103 patients, 68 (66.0%) of the patients were male; mean age was 71.2 (range 46-90). Diffuser mask was used for 52 (50.5%) of the patients; 67 (65.0%) of the patients were COPD; 36 (35.0%) were asthma.

Initial arterial blood gas pCO_2 values are compared with PEF and $EtCO_2$. The initial pCO_2 values were correlated strongly with $EtCO_2$ values (p<0.001, r=0.875). There was a moderate negative correlation between initial arterial gas pCO_2 value and PEF values (p=0.002, r=-0.300). Also there was a mild negative correlation between initial $EtCO_2$ and PEF values (p=0.022, r=-0.225); a moderate negative correlation between the second hour values (p=0.001, r=-0.327); a moderate negative correlation between the fourth hour values (p=0.001, r=-0.378). With these results we can claim that we can use $EtCO_2$ or PEF values instead of arterial blood gas pCO_2 values for 2nd and 4th hours follow up and check the effectiveness of the treatment because they are non-invasive methods.

At admission, the initial pCO_2, $EtCO_2$ and PEF values were similar between the diffuser mask and standard mask group (p values are given in Table 1). So we can say that the patients were similar in two groups initially.

Table 1. *Comparison of diffuser and standard mask.*

	Diffuser mask (n=52)	Standard mask (n=51)	p
Arterial blood gas pCO_2	42,0 ± 12,3	39,4 ± 7,4	0.482
$EtCO_2$ value at admission	34,7 ± 9,7	36,3 ± 5,9	0.117
$EtCO_2$ value 2nd hour	33,1 ± 8,3	35,5 ± 5,4	0.013
$EtCO_2$ value 4th hour	32,2 ± 8,3	35,3 ± 5,3	0.004
PEF value at admission	137,9 ± 53,9	143,1 ± 65,6	0.855

If we think about COPD and asthma patients together, at the second and four hours, $EtCO_2$ values were significantly lower in diffuser mask group (p=0.013 and p=0.004 respectively).

We divided the patients as asthma and COPD group. There were 36 patients in asthma group and 67 in COPD group. In COPD group; at the second and fourth hours, $EtCO_2$ values of both masks were similar (Table 2). Also PEF values of both masks were similar in second and fourth hours. In asthma group; $EtCO_2$ values in the second and fourth hours was lower in diffuser mask group. PEF values were higher in the second and fourth hours but it wasn't statistically significant.

Discussion

In our study we initially evaluated the oxygen and carbondioxide status of the patients with arterial blood gases, $EtCO_2$ and PEF. Because taking repeated arterial blood case specimens from a patient is very traumatic, we used non-invasive methods to follow up the patients. PEF monitoring can provide an objective data theoretically [4]. In our study we only measured the changes in a very short period. We didn't compare its effectiveness between patients.

Capnography is a non-invasive measurement method of the partial pressure of carbondioxide. Changes in the capnogram are diagnostic of disease conditions so it can be used to assess disease severity and response to treatment [5]. Previous studies have reported that $EtCO_2$ values will not accurately reflect blood gas pCO_2 [6-9]. However, $EtCO_2$ monitoring could be used in following the trend in ventilation status [9-11]. So we used $EtCO_2$ levels in determining the response to the treatment.

When we measure the initial values of pCO_2, PEF and $EtCO_2$; baseline values of pCO_2 was positively correlated with $EtCO_2$ and negatively correlated with PEF values. So we used the

EtCO$_2$ and PEF values for further evaluation of treatment effectiveness.

Table 2. *Comparison of diffuser and ventolin mask in patients with COPD and asthma.*

	COPD				Asthma			
	Diffuser mask (n=31)	Standard mask (n=36)		p	Diffuser mask (n=21)	Standard mask (n=15)		p
Arterial blood gas pCO$_2$	44.6 ± 11.8	39.8 ± 8.1		.053	38.3 ± 12.5	38.5 ± 5.8		0.970
EtCO$_2$ value at admission	36.5 ± 10.4	36.7 ± 6.4		.918	32.3 ± 8.2	35.5 ± 4.6		0.185
EtCO$_2$ value 2nd hour	35.1 ± 9.8	35.8 ± 5.9		.727	30.2 ± 6.6	35.1 ± 4.5		0.020
EtCO$_2$ value 4th hour	34.1 ± 9.2	35.6 ± 5.9		.395	29.6 ± 6.2	34.7 ± 4.3		0.010
PEF value at admission	126.8 ± 48.1	146.7 ± 70.0		.188	154.4 ± 58.9	134.7 ± 55.4		0.316
PEF value 2nd hour	157.7 ± 56.4	170.1 ± 67.2		.421	191.1 ± 56.2	172.7 ± 59.5		0.352
PEF value 4th hour	182.7 ± 60.5	188.3 ± 71.1		.729	214.5 ± 59.1	178.3 ± 46.3		0.056

In COPD patient group; at the second and fourth hours both of the masks similarly reduced the EtCO$_2$ and PEF values. But in asthma patient group; EtCO$_2$ values were lower in diffuser mask using patients. Although, the evaluation of the clinical outcome with peak flow meter wasn't statistically significant p value was close to significance; the diffuser mask increased the PEF values better as shown on Table 2. The diffuser mask provides a higher inspired pO$_2$ at a lower flow rate, without evidence of carbondioxide retention [2]. Probably this feature provided a lower EtCO2 values in asthma patients. In COPD patients; EtCO$_2$ values were lower both in diffuser and standard masks; additionally PEF values were higher in both of the mask groups. This means diffuser mask is effective both COPD and asthma attacks and better than standard mask in asthma patients particularly.

In conclusion, the diffuser mask provides more effective oxygen to the COPD and asthma attacks. Especially in asthma attacks, diffuser mask is better in reducing carbondioxide in asthma attacks and provides better PEF values for patients.

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