Effect of Oxygen-driven Nebulization at Different Oxygen Flows in Acute Exacerbation of Chronic Obstructive Pulmonary Disease Patients

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Abstract: *Objectives:* The aim of this study was to study the effect of oxygen-driven nebulization (ODN) at different oxygen flows on heart rate, respiratory rate, SpO_2, SaO_2, PaO_2, $PaCO_2$ and pH of acute exacerbation of chronic obstructive pulmonary disease (AECOPD) patients. *Methods:* According to random number table, 9 AECOPD patients were randomly divided into 3 groups, numbered A, B and C and treated with ODN. Oxygen flow of groups A, B and C was 4–5, 6–7 and 8–9 L/min, respectively. Heart rate, respiratory rate, SpO_2, SaO_2, PaO_2, $PaCO_2$ and pH were recorded before ODN and 30 minutes after ODN. Statistical differences of data before or after ODN were analyzed by analysis of variance and F-test, whereas data before and after ODN were tested by paired *t* test. *Results:* There was no significant difference of heart rate, respiratory rate, SpO_2, PaO_2, $PaCO_2$, SaO_2 and pH among 3 groups before ODN or after ODN. The heart rate was increased in all groups after ODN. But significant increase was only present in groups A and C but not in group B. SaO_2 was significantly increased in group C after ODN but no statistical difference was observed between before and after ODN in groups A and B. There was no significant change in respiratory rate, SpO_2, PaO_2, $PaCO_2$, SaO_2 and pH between before and after ODN in all groups. *Conclusions:* Optimal oxygen flow in ODN-treating AECOPD patients may be 6–7 L/min.

Key Indexing Terms: Oxygen flow; Oxygen-driven nebulization; Chronic obstructive pulmonary disease; Blood gas analysis. **[Am J Med Sci 2014;347(5):343–346.]**

Chronic obstructive pulmonary disease (COPD) is a respiratory disease characterized by an incompletely reversible limitation in airflow.[1] The airflow limitation is usually progressive and associated with an abnormal inflammatory response of the lungs to noxious particles or gases,[2] particularly those found in cigarette smoke.[3] Clinically, patients with COPD experience shortness of breath (dyspnea) and cough, productive of an excess of mucus. There may also be wheeze, fever, chest stufly and changes in the color and/or viscosity of sputum.[4] It is estimated that approximately 210 million people have moderate-to-severe COPD worldwide and 3 million people die of this condition in 2005, with an estimated 5% of all deaths.[5]

Strategies in the management of COPD usually include drug treatment[6,7] and nondrug treatment (pulmonary rehabilitation,[8,9] vaccination,[10] dietary input[11] and education[12]). Nebulization is an effective mode of drug delivery for select patients with COPD.[13] Oxygen-driven nebulization (ODN) is a therapy integrating physiotherapy and chemotherapy to achieve apophlegmatic and anticholinergic medications effect. By means of the negative pressure forming when high-speed airflow goes through a capillary tube, medicine solution is extracted and bumped into tiny droplets by high-flow oxygen. The medicine particles with appropriate diameter could be inhaled directly into the lower respiratory tract to improve tracheospasm, edema or inflammation, without increasing respiratory resistance.[14,15]

However, there are no standard procedures about oxygen flow rates when ODN is used in acute exacerbation of COPD (AECOPD) patients. The oxygen flows are usually adjusted randomly, which affects treatment outcome. The recommended oxygen flow rates are no more than 6,[16] 6–8 [17] or 9 L/min[18] in previous studies. Here, we aimed to compare the impact of ODN at different oxygen flows on blood-gas analysis of patients with COPD, so as to obtain the optimal oxygen flow. Based on these results, oxygen flow in ODN would be more scientific and normative, which could benefit to AECOPD patients in therapy and recovery and to nursing service.

METHODS

Nine patients (6 men and 3 women) with AECOPD admitted to Changzheng Hospital from January to May 2012 were recruited. Their mean age was 61.29 ± 18.71 years old. AECOPD was diagnosed according to current international guidelines.[19] The patients with serious heart diseases and other diseases of respiratory system were excluded. The study was approved by hospital medical ethics committees, and all participants gave written informed consent.

According to random number table, 9 AECOPD patients were randomly divided into 3 groups to undergo nebulization driven by different oxygen flows (group A, 4–5 L/min; group B, 6–7 L/min and group C, 8–9 L/min). Normal saline (0.9%, 5 mL), gentamicin (8×10^4 IU), chymotrypsin (0.4×10^4 U) and ipratropium bromide (500 μg) were nebulized for 15 minutes[20] by means of a breath-enhanced nebulizer (PARILCD, Bonn, Germany) driven by oxygen. All patients were seated while inhaling aerosol by a mouthpiece. Patients should gargle and expectoration each time after nebulization to avoid adverse reaction.[21–23] ODN was performed 2–3 times a day. Arterial blood gases, pH, PaO_2 and $PaCO_2$ were measured with a Blood Gas Analyzer (ABL 5; Copenhagen, Denmark) before ODN and 30 minutes after ODN.

All data were presented by mean ± standard deviations, and statistical software SPSS18.0 was applied. Statistical differences of data among 3 groups before or after ODN were analyzed by analysis of variance and *F* test, whereas statistical differences of data between before and after ODN were tested by paired *t* test. $P < 0.05$ was considered statistically significant.

RESULTS

There was no significant difference in heart rate, respiratory rate, SpO_2, PaO_2, $PaCO_2$, SaO_2 and pH among different

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groups before ODN or after ODN ($P > 0.05$, as shown in Table 1). Compared with baseline value, the heart rate was increased in all groups. However, only significant increase was present in groups A and C after ODN ($P < 0.05$, t test), but there was no statistical difference between before and after ODN in group B ($P > 0.05$, t test). Compared with baseline value, the SaO_2 was also significantly increased in group C ($P < 0.05$, t test), but there was no statistical difference was observed between before and after ODN in groups A and B ($P > 0.05$, t test). There was no significant change in respiratory rate, SpO_2, PaO_2, $PaCO_2$, SaO_2 and pH between before and after ODN in all groups ($P > 0.05$, t test).

DISCUSSION

AECOPD is a common clinical complication of COPD. The main cause is bacteria or virus infection in tracheal bronchus, leading to increased secretions of tracheal mucous, hyperemia and edema in mucosa, and sputum retention. Worse still, secondary infection could be loss of control with the result of pulmonary ventilation dysfunction. Therefore, drugs for dilating bronchi are needed. Nebulized ipratropium bromide is commonly administered for treatment of AECOPD patients, which can result in clinically meaningful changes in dyspnea.[24,25] In this study, we also used ipratropium bromide as aerosolized medication.

ODN makes use of high-flow oxygen to bump medicine solution into tiny droplets, which is inhaled into respiratory tract and then works.[26] However, most of the patients with COPD are elder (61.29 ± 18.71 years old in our study) who have poor response capability of their respiratory tract. High dose of nebulized medicine liquid may occupy their respiratory tract, which not only have an impact on intaking oxygen but also on ridding of carbon dioxide, and eventually lead to or

TABLE 1. Statistical analysis of heart rate, respiratory rate, SpO_2, PaO_2, $PaCO_2$, SaO_2 and pH obtained before and after ODN

	A	B	C	*F*	*P*
Heart rate					
Before ODN	87.50 ± 10.5	88.00 ± 11.3	94.50 ± 11.10	0.47	0.64
After ODN	91.50 ± 10.2	91.00 ± 4.24	99.50 ± 10.90	0.82	0.48
t	−4.90	−0.600	−5.000		
P	0.02	0.656	0.02		
Respiratory rate					
Before ODN	20.75 ± 4.24	23.00 ± 4.24	22.75 ± 2.87	0.38	0.70
After ODN	21.75 ± 3.10	22.50 ± 2.12	21.00 ± 1.41	0.28	0.76
t	−1.414	0.333	1.09		
P	0.252	0.795	0.35		
SpO_2, %					
Before ODN	98.50 ± 0.58	95.50 ± 3.54	94.50 ± 4.65	1.50	0.29
After ODN	99.25 ± 1.15	96.00 ± 2.82	98.00 ± 0.82	3.88	0.07
t	−1.19	−1.00	−1.67		
P	0.32	0.50	0.19		
PaO_2, mm Hg					
Before ODN	98.25 ± 22.90	83.50 ± 20.51	74.50 ± 13.38	1.58	0.27
After ODN	97.75 ± 15.06	87.50 ± 24.75	102.00 ± 26.37	0.51	0.62
t	1.42	−1.33	−2.36		
P	0.25	0.41	0.10		
$PaCO_2$, mm Hg					
Before ODN	45.00 ± 10.42	42.00 ± 4.24	48.75 ± 7.14	0.47	0.65
After ODN	45.94 ± 10.30	40.50 ± 4.95	43.00 ± 10.33	0.22	0.81
t	−1.22	3.00	1.21		
P	0.31	0.21	0.31		
SaO_2, %					
Before ODN	97.25 ± 2.21	96.00 ± 2.83	94.25 ± 2.75	1.39	0.31
After ODN	97.50 ± 1.91	96.50 ± 3.54	97.50 ± 1.91	0.16	0.85
t	−0.52	−1.00	−3.43		
P	0.64	0.50	0.04		
PH					
Before ODN	7.49 ± 0.04	7.44 ± 0.00	7.45 ± 0.04	1.59	0.27
After ODN	7.49 ± 0.04	7.48 ± 0.06	7.44 ± 0.07	0.75	0.51
t	−0.33	−1.00	0.27		
P	0.76	0.50	0.80		

Statistical differences of data among 3 groups before or after ODN were analyzed by F test, whereas between before and after ODN were tested by t test. $P < 0.05$ was considered statistically significant. There was no significant difference of all indexes among different groups before ODN or after ODN. Compared with baseline value, the heart rate was significantly increased in groups A and C after ODN but not in group B. Compared with baseline value, the SaO_2 was also significantly increased in group C ($P < 0.05$, t test) but not in groups A and B. Group A, 4—5 L/min oxygen flows; group B, 6–7 L/min oxygen flows and group C, 8–9 L/min oxygen flows.