Risk and impact of using mask on COPD patients with acute exacerbation during the COVID-19 outbreak: a retrospective study

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Abstract

Background: Chronic Obstructive Pulmonary Disease（COPD) is an inflammatory airway disease characterized by the presence of expiratory flow limitation. Exacerbations of COPD are common acute events. During epidemic of COVID-19, concerns have been raised with regard to mask- using because of increasing respiratory resistance. In this study, we aimed to evaluate the relationship between the vital signs , inflammation index, hypercapnia, hypoxia and mask-using in AECOPD patients.

Methods: This retrospective study was performed at a tertiary hospital, and enrolled 23 patients with AECOPD who were hospitalized three or more times in the respiratory department. Patients in Group C were hospitalized and used masks during the epidemic period of COVID-19. Patient's data of the previous two hospitalizations from the medical record system divided into group A and group B according to the time sequence. Vital signs, inflammation index, artery blood gas from medical record system and questionnaires of three hospitalizations in the same patient were collected to perform paired test.

Results: Surgical mask using increased the levels of $PaCO_2$ (8.98mm Hg; p = 0.004), HCO_3^-act (4.1mmol/L; p =0.006), BE (3.01mmol/L; p =0.019) and systolic blood pressure (11.39mm Hg; p = 0.01) in patients with AECOPD compared to last hospitalization. Surgical mask using for 30 to 120 minutes is associated with hypercapnia. There were no significant differences observed between group B and group A without using mask in vital signs, inflammation index, and artery blood gas.

Conclusions: In this study, we found that systolic blood pressures and $PaCO_2$, HCO_3^-act, BE were significantly elevated in AECOPD patients using masks compared to the other groups without masks. In addition，the changes in $PaCO_2$,HCO_3^-act,BE is closely related to serum chloride concentration. Therefore, it is need to increase awareness and understanding of the use of masks in patients with chronic cardiopulmonary diseases.

Background

Chronic Obstructive Pulmonary Disease (COPD) is an inflammatory airway disease characterized by persistent respiratory symptoms and airflow limitation in patients with chronic bronchitis and/or emphysema. As the leading cause of death, the morbidity and mortality of COPD have been increasing worldwide that markedly increases healthcare costs. Special attention should be paid to the acute exacerbations of COPD (AECOPD), of which the typical clinical Manifestations include respiratory rate increasing, tachycardia, and symptomatic dyspnea and exercise capacity reducing. As a common respiratory disease, acute exacerbations are common in the natural history of patients with COPD and related to poor prognosis [1]. Moreover, patients are frequently hospitalized for acute exacerbations, and some severe cases need non-invasive ventilator (NIV) to prevent aggravation of respiratory failure caused by hypercapnia or hypoxemia. Respiratory tract infection is one of the most common causes of AECOPD in hospitalized patients. It has reported that viral infection in the upper respiratory tract could induce acute exacerbations[2–4],thereby inducing micro biome alteration and bacterial load elevation[5].And

bacterial secondary to viral infection leads to higher rate of hospital admission increases the severity of the disease and results in placing economic burden on family and society. Therefore, respiratory tract infection as a common cause and associated diseases of AECOPD is particularly important to prevent. Mask as one of the prevention measure of infectious diseases is always used in health care facilities for protecting health care workers from respiratory infections[6].

People wear various types of facial coverings to cover the nose and mouth for a number of purposes worldwide. Facial coverings include respirators, medical/surgical masks; cloth masks veils, balaclavas and bandanas. Of which, surgical masks have become among the most commonly used to protective equipment in the initial stages of pandemics, while drugs and vaccines are not available, especially epidemic of respiratory disease, such as SARS, influenza, and novel corona virus disease-19(COVID-19). COVID-19 outbreak becomes biggest global health threat and challenge to public health. Concerns have been raised about the use of respiratory protective devices for the need for epidemic prevention [7, 8]. Government suggests wearing mask in public in order to prevent infection, although most people would tolerate masks-using as a regularly respiratory protective device,medical staff's uncomfortable of using masks was significantly increased. The problem with the personal protective equipment(PPE) was attributed to general discomfort including headache, overheated, decreased visual ,auditory acuity, dyspnea, and anxiety[9–12].longer duration of face-mask wear may raise the frequency and severity of uncomfortable[13].Healthcare workers may develop headaches following the use of the personal protective equipment in COVID-19[11],which may also lead to the occurrence of symptoms in general population and especially in patients with chronic cardiopulmonary disease ? The mask is the most popular individual protective device to prevent disease which may impose variable external resistive loads to the wearer, considering on the number of filter layers, packing density, filter material thickness that have been shown to negatively impact pulmonary function and cardiovascular responses□even with good filtering ventilation. Little scientific data is available on the short or long-term effects of using masks; however, concerns have been raised with regard to its use because it can increase respiratory resistance which may cause an increase in tidal volume, and reduce in breathing frequency and minute ventilation, with a concomitant decrease in alveolar ventilation[14]associated with cardiovascular and pulmonary responses. Limited data are available on the association between mask wearing in AECOPD patients with concomitant changes in arterial partial pressure of carbon dioxide ($PaCO_2$) and oxygen (O_2) saturation levels. Thus, the aim of this study was to assess the safety of using mask in patients with AECOPD□and benefit for us to timely detect abnormal vital signs from blood gas analysis.

Methods

Study Design and Subjects

We performed retrospective control study between23 January 2020 and 01 May 2020 in the First Affiliated Hospital of Shantou University Medical College in China. In total, 23 patients cumulative hospitalization of three or more times were enrolled in the respiratory department. The inclusion criteria were patients diagnosed with COPD and treated in the pulmonary department admitted with AECOPD as

admission diagnosis and the patients wore masks on the way to the hospital. Diagnosis of COPD and acute exacerbation of COPD, pulmonary function grading were defined according to the global guidelines for chronic obstructive pulmonary disease (GOLD)[4]. The exclusion criteria were severe respiratory failure with long-term oxygen therapy, comorbid pneumothorax, history of invasive mechanical ventilation or long term tracheotomy, receiving NIV in the emergency department, pulmonary embolism, severe hepatic or renal failure, history of acute cardiovascular or cerebrovascular event within the previous three months, upper gastrointestinal bleeding, hemodynamic instability, diffuse intravascular coagulation, malignant arrhythmia and decompensate acid-base imbalance.

Ethics

All enrolled patients were informed about the research and signed written informed consent. And the study was assessed and approved by the institutional review board Ethics Committee of the First Affiliated Hospital of Shantou University Medical College. The study followed to the principles of the Declaration of Helsinki.

Data Collecting

Group C was the patients who were hospitalized during the epidemic period of COVID-19, Patients data of the previous two hospitalizations from the medical record system divided into group A and group B according to the time sequence. Baseline data including reports of pulmonary function in previous hospitalization and laboratory measurements were recorded in clinical data. Heart rate, systolic blood pressure, diastolic blood pressure, breathing frequency was measured by using electrocardiogram monitoring during the study when they arrived in hospital or respiratory department. Blood gas analysis was performed after admission to the hospital and before the use of non-invasive ventilation or AIRVO, serum ion concentration(Na^+,Cl^-、K^+、Ca^{2+}), blood routine, and C-reactive protein(CRP) were monitored during subsequent examinations. The duration and discomfort of mask-wearing were obtained by questionnaire. Symptoms associated with mask-use were evaluated by using a symptom questionnaire that included the presence of dyspnea, headache, facial pressure and fever feeling, dizziness, anxiety, or as bad as symptom of AECOPD.

Statistical Analyses:

We calculate and statistical analyze by using IBM SPSS Statistics for Windows, Version 25 (IBM, Armonk, New York). Normally distributed data are expressed using Mean and standard deviation, and data that were not normally distributed are expressed as median by quartering method. To compare parameters between two hospitalizations, normally distributed variables were contrasted by using paired sample t test and Wilcoxon signed rank test was used for the variables that were not normally distributed. Pearson correlation test was used to analyze the correlation of different parameters in group C. Two-tailed $P < 0.05$ indicated statistically significant.

Results

Subject Characteristics

The mean age of patients was 71.26 ± 8.83 years (range from 54 to 87 years). 22 are males and 1 is female. There were 9 patients suffering from hypertension and 10 with asthma. All of them had no diabetes mellitus. The most common air-flow obstruction grade was severe and very severe, while 7 patients were unable to cooperate with pulmonary function test because of disease severity.21 of the 23 patients (91.30%) had past smoking history (Table 1).The time for patients using mask before arrived in hospital ranges from 30 to 120 minutes.

Table 1
Baseline Demographics and Clinical Characteristics

Characteristic	Value(N = 23)
Age, years	71.26 ± 8.83
Male, n (%)	22(95.65)
Past smoker (%)	21(91.30)
Severity of COPD, n (%)	
Mild	1(4.34)
Moderate	1(4.34)
Severe	7(30.43)
Very severe	7(30.43)
uncooperate	7(30.43)
Comorbidity	
Hypertension,n(%)	9(39.13)
Dibetes mellitus(%)	0(0)
Asthma, n(%)	10(43.48)

The impacts of Wearing Mask

The clinical parameters values of the patients without wearing masks (group A and group B), including ion concentration of serum, vital signs, inflammation markers and artery blood gas, were showed in Table 2.There were no significantly changes in$PaCO_2$, HCO_3^-act, BE and other parameters between these two hospitalizations.

Table 2
Comparison of parameters between group B and group A

Parameter	B group(n = 23)	A group(n = 23)	P value
Vital signs			
Temperature(℃)	36.5(36.2–36.5)	36.5(36.3–36.8)	0.577*
Heart(bent/min)	93.35 ± 18.49	92.04 ± 17.36	0.732
RR(Breaths/min)	22.48 ± 2.94	22.22 ± 2	0.615
SBP(mmHg)	127.48 ± 16.64	131.26 ± 21.25	0.434
DBP(mmHg)	80.87 ± 10.57	79.09 ± 11.72	0.451
Serum			
K^+(mmol/L)	4.12 ± 0.38	3.98 ± 0.46	0.085
Na^+(mmol/L)	135.98 ± 5.45	135.76 ± 5.53	0.826
Cl^-(mmol/L)	99.85 ± 7.12	99.86 ± 6.89	0.991
Ca^{2+}(mmol/L)	2.22 ± 0.07	2.22 ± 0.1	0.924
CO_2CP	28.5(25.28–31.22)	26.3(24.6-29.01)	0.082*
Glucose(mmol/L)	6.67(5.40–7.33)	6.11(5.06–7.10)	0.291*
Serum creatinine(mmol/L)	90.00(74–104)	90.00(72.00-102.00)	0.948*
WBC(10^9/L)	10.38 ± 4.07	10.67 ± 4.22	0.774
NE%(%)	76.92 ± 13.84	76.47 ± 12.44	0.861
HGB(g/L)	132.74 ± 14.67	131.13 ± 17.12	0.547
PLT(10^9/L)	232.91 ± 75.84	219.96 ± 67.14	0.172
CRP(mg/L)	47.2 ± 69.01	47.6 ± 60.25	0.979
pH	7.42 ± 0.04	7.42 ± 0.04	0.823
$PaCO_2$(mmHg)	40.77 ± 9.58	42.55 ± 10.36	0.436
PaO_2(mmHg)	87.55 ± 28.4	89.93 ± 20.26	0.768
SO_2(%)	96.00(94.00–98.00)	96.4(95.2–97.5)	0.664*
Lactic acid(mmol/L)	1.45 ± 0.46	1.54 ± 0.72	0.544
HCO^{3-}act(mmol/L)	26.32 ± 5.01	26.98 ± 4.6	0.590

Parameter	B group(n = 23)	A group(n = 23)	P value
HCO^{3-}std (mmol/L)	26.1 ± 3.74	26.63 ± 3.05	0.542
BE(mmol/L)	1.59 ± 4.22	2.25 ± 3.53	0.489
Oxygenation index(mmHg)	322.36 ± 88.53	316.82 ± 75.02	0.804
Inpatient days(days	8.00(7.00–11.00)	8.00(6.00–11.00)	0.25*
Wilcoxon Signed Rank test* and Paired Sample t test			
Data are presented as Mean ± SD* and Median (Min-Max) values			

In Table 3, investigation results indicated that wearing mask patients in group C before hospitalization resulted in significantly elevated the levelsof$PaCO_2$, serum bicarbonate, and BE, compared to the group B (group C VS group B, 49.75VS40.77 mmHg, P = 0.004) The change in acid-base between-groups is obvious although accompanying change in blood pH were no difference (group C VS group B, 7.41VS7.42, P = 0.277).PO2 was statistically insignificant. The patients in group C have used masks during the outbreak of COVID-19 from home to hospital because of acute exacerbation. However, the patients failed to explain the symptoms related to mask-using. Compared with group B, Group C showed an increase in systolic blood pressure(group C VS group B,138.87 mmHg VS127.48 mmHg, P = 0.01), while diastolic blood pressure has no statistical significance(85.17 VS 80.87 mmHg, P = 0.221).The average patients' length of hospital stay was 10.22 ± 5.37days. All three groups of patients in this study showed hyponatremia. Serum calcium concentration has descended and meets the criteria for the diagnosis of hypocalcaemia group C, while other group is above normal physiological value. The change in the acid-base is closely related to serum chloride concentration (Table 4).Inflammation markers including WBC, NE% and CRP has no correlation with $PaCO_2$,

Table 3
Comparison of parameters between group C and group B

Parameter	C group(n = 23)	B group(n = 23)	P value
Vital signs			
Temperature(℃)	36.5(36.5–36.8)	36.5(36.2–36.5)	0.067*
Heart(bent/min)	95 ± 16.24	93.35 ± 18.49	0.668
RR(Breaths/min)	22(20–26)	22(20–23)	0.396*
SBP(mmHg)	138.87 ± 13.18	127.48 ± 16.64	0.010
DBP(mmHg)	85.17 ± 10.05	80.87 ± 10.57	0.221
Serum			
K^+(mmol/L)	4.08 ± 0.48	4.12 ± 0.38	0.689
Na^+(mmol/L)	135.6 ± 4.32	135.98 ± 5.45	0.680
Cl^-(mmol/L)	102(98–104)	101.09(97.17-105.07)	0.254*
Ca^{2+}(mmol/L)	2.16 ± 0.13	2.22 ± 0.07	0.078
CO_2CP	28.73 ± 5.81	29.09 ± 6.06	0.639
Glucose(mmol/L)	6.34 ± 1.37	6.62 ± 1.56	0.527
Serum creatinine(mmol/L)	79(69–99)	90(74–104)	0.223*
Albumin(g/L)	34.88 ± 4.05	35.64 ± 3.77	0.289
WBC(10^9/L)	10.27 ± 3.59	10.38 ± 4.07	0.897
NE%(%)	75.53 ± 12.09	76.92 ± 13.84	0.664
HGB(g/L)	130.96 ± 14.66	132.74 ± 14.67	0.431
PLT(10^9/L)	228.43 ± 71.67	232.91 ± 75.84	0.736
MPV(fl)	9.38 ± 1.46	9.02 ± 1.38	0.196
CRP(mg/L)	30.85 ± 45.55	47.2 ± 69.01	0.356
pH	7.41 ± 0.05	7.42 ± 0.04	0.277
$PaCO_2$(mmHg)	49.75 ± 15.06	40.77 ± 9.58	0.004
PaO_2(mmHg)	95.09 ± 27.82	87.55 ± 28.4	0.325
SO_2(%)	98(96–98)	96(94–98)	0.085*

Parameter	C group(n = 23)	B group(n = 23)	P value
Lactic acid(mmol/L)	1.37 ± 0.47	1.45 ± 0.46	0.519
HCO_3^-act(mmol/L)	30.42 ± 6.39	26.32 ± 5.01	0.006
HCO_3^-std (mmol/L)	28 ± 3.42	26.1 ± 3.74	0.036
BE(mmol/L)	4.6 ± 5.18	1.59 ± 4.22	0.019
Oxygenation index(mmHg)	326.61 ± 90.38	322.36 ± 88.53	0.868
Inpatient days(days)	10.22 ± 5.37	9.52 ± 3.98	0.539
Wilcoxon Signed Rank test* and Paired Sample t test			
Data are presented as Mean ± SD* and Median (Min-Max) values			

Table 4
Correlation between ion concentration and blood gas parameters in group C

Parameter	pH	$PaCO_2$	PaO_2	SO_2	HCO_3^--act	HCO_3^--std	BE	Oxygenation index
K^+								
r	-0.374	.429*	-0.313	− .552**	0.321	0.007	0.312	-0.280
P value	0.079	0.041	0.146	0.006	0.135	0.976	0.148	0.196
Na^+								
r	-0.086	-0.298	.457*	.462*	-0.282	-0.097	-0.291	.440*
P value	0.697	0.168	0.028	0.027	0.193	0.661	0.178	0.036
Cl^-								
r	0.246	− .727**	.562**	.758**	− .701**	-0.384	− .701**	.553**
P value	0.258	0.000	0.005	0.000	0.000	0.071	0.000	0.006
Ca^{2+}								
r	0.057	-0.052	-0.033	-0.051	-0.077	-0.167	-0.102	0.094
P value	0.796	0.814	0.881	0.817	0.728	0.447	0.644	0.670
*Correlation is significant at the 0.01 level (2-tailed), Pearson correlation analysis.(2-tailed)								
**Correlation is significant at the 0.05 level								

Table 5. Correlation Between Inflammatory Biomarkers, Inpatient Days and Blood Gas Parameters in Group C

Parameter	pH	$PaCO_2$	PaO_2	SO_2	HCO_3^--act	HCO_3^--std	BE	Oxygenation index
WBC								
r	0.247	-0.023	-0.042	0.060	0.188	0.353	0.249	-0.080
P value	0.256	0.919	0.849	0.786	0.390	0.099	0.252	0.717
NE%								
r	0.118	0.162	-0.343	-0.321	0.270	0.302	0.354	− .540**
P value	0.591	0.460	0.110	0.135	0.213	0.162	0.097	0.008
CRP								

Parameter	pH	$PaCO_2$	PaO_2	SO_2	HCO_3^--act	HCO_3^--std	BE	Oxygenation index
r	0.230	-0.224	-0.213	-0.097	-0.208	-0.157	-0.154	-0.328
P value	0.291	0.305	0.328	0.660	0.340	0.473	0.483	0.126
Inpatient days								
r	-0.064	0.287	-0.221	− .487*	0.307	0.092	0.385	-0.276
P value	0.770	0.185	0.311	0.019	0.154	0.676	0.070	0.202
*Correlation is significant at the 0.01 level (2-tailed), Pearson correlation analysis.(2-tailed).								
**Correlation is significant at the 0.05 level								

Discussion

During outbreak of COVID-19, people use mask in public for infection prevention and patients with AECOPD are no exception. Even if there was no previous respiratory failure or hypercapnia, the results of this study indicated that the patients with AECOPD should be careful to use mask, due to the increased risk for inducing hypercapnia from 40 mmHg to 49 mmHg, and increased SBP with 11.39 mmHg.This was the first self-paired study on the safety of using mask in patients with AECOPD, which could lead to respiratory failure, aggravate exacerbation of COPD and elevate systolic pressure. Hypercapnia was defined by $PaCO_2$ > 45 mmHg in arterial blood gas (ABG) analysis[4], and the development of hypercapnia may drive COPD progression. Patients in group C who have used masks before arriving in hospital with mean$PaCO_2$ of 49 mmHg could be diagnosed with hypercapnia. High concentrations of carbon dioxide pressure in bloodstream stimulates breathing, increases heart rate and leads to expansion of blood vessel[15]which lead to discomfort,, anxiety and headache, shortness of breath. Much more as a predicting maker of COPD severity, hypercapnia increased airway contraction and resistance in severe COPD patients were taken a turn for better after correction of hypercapnia. Previous study provides evidence that CO_2 acts as a signaling molecule in mouse and human airway smooth muscle cells, high CO_2 activated calcium-calpain signaling and consequently leas to smooth muscle cell contraction in mouse airway smooth muscle cells[16]. Hypercapnia could change autonomic nerve function which increase heart rate and blood pressure, especially at higher workloads[17, 18]. The sympathetic nervous system will be activated and affect the body although hypercapnia and hypoxemia are corrected immediately, especially cardiovascular autonomic nervous reflex.

COPD patients suffer weakness and muscle fatigue including respiratory muscle fatigue aggravates respiratory dysfunction [19, 20]. Therefore, using mask as airtight as possible increase work of breathing due to high respiratory resistance, heat pressure, In particular, N95 masks filter particles with a diameter of less than 0.1um,increaseexpiratory resistance impacted ventilation and can be associated with decreased peak flows and minute ventilation[21, 22].In addition, the increased flow resistance of mask

with a concomitant decrease in alveolar ventilation can bring out an increase in tidal volume, a decrease in minute ventilation[14].Therefore ,dyspnea may gradually worsen with the progression of respiratory muscle fatigue in patient with AECOPD. The respirator affected with moisture is particular clear. It can be seen that body fluids are on the surface of the respirator, which increase breathing resistance because of water vapor carried on the exhaled breath and the droplets expelled when speaking. A study reported average peak inspiratory pressures of decreasing in 12.4 mm H_2O and average peak expiratory pressures of increasing in 11.9 mm H_2O at 50% maximal oxygen consumption[23]. Patients are unable to exhale more carbon dioxide and increased more oxygen consumption when exercise and resistance load. On the other hand, masks may cause carbon dioxide re-respiration. Previous investigation has shown that tidal volume decrease and CO_2 retention increased along with the increasing in inspiratory resistance. An increase in inspiratory resistance from 3 mm H_2O to 18 mmH_2O pressure results in a relative 3 percent increase in end-tidal CO_2 level, and increasing the inspiratory resistance to 28 mmH_2O pressure results in a 10 percent relative increase in end-tidal CO_2 level[24].In particular, study reported that N95 use produces an average increment of 126% and 122% in inspiratory and expiratory flow resistance[25], which indicated that using mask may causes or exacerbates hypercapnia in COPD patients even if tolerated. Cases have been reported that mask can cause carbon dioxide re-breathing due to its sealing [26, 27]. It is particularly important for COPD patients that mask with visible body fluids on the surface and excessive mask dampness result in high respiratory resistance which increases with ongoing use and frequency. Furthermore,retention of bacteria, viruses, particles within the filter of masks and respirators also increase respiratory resistance by plugging up the stomata. Thus, even bacterial or virus infection induces acute exacerbation of COPD; using mask may also exacerbate the severity of disease.

Our data showed that all the patients did not use masks before the COVID-19 outbreak, and no one showed discomfort obviously such as dizziness after using masks mentioned in this study. However, wearing masks on people is affected by disease, environmental factors, breathing, exercise load and surgical mask filter and fit performance [6, 28]. General population feels discomfort because of wearing mask could lead to anxiety, breathing rate and depth accelerated. In patients with AECOPD who cough, expectorate and feel dyspnea, the condition may be further aggravated and may lead to respiratory failure. Most of the patients wearing masks did not feel discomfort or exacerbation of their original symptoms significantly, however, our study showed that $PaCO_2$elevation in the blood gas analysis could be detected in the patients before the onset of symptoms, and the body was in a compensatory state. Observed abnormal physiology may be influenced by the patient's chronic deviation from normal values resulting in oversight of possible aggravating risk factor. The impact of using masks on AECOPD patients may be covered up by the primary symptoms of the disease, which makes us ignore. Patients usually spent more than 30 minutes from home to hospital. Monitoring vital signs in patients may potentially allow clinicians to intervene medical diagnosis and treatment quickly. Improper use of masks and long transport process of patient with acute exacerbation may lead to hypercapnia. The study suggests that longer ambulance journeys may lead to a greater risk of hypercapnia if unduly high concentration of oxygen are given during AECOPD [29], so that use inhalants to improve discomfort or the body compensates for hypercapnia when using mask repeatedly, it will bring out repeated episodes of

hypercapnia which result in aggravation if clinician cannot identify the cause. Considering COPD patients often comorbid with bronchial asthma, bronchiectasis and tuberculosis, we should pay attention to the safety of using mask because of respiratory resistance related to carbon dioxide emissions. The use of masks causes significant increase in $PaCO_2$, bicarbonate and residual base in patients while some patients develop hypercapnia, which may aggravate disease if they are used for a long time. The balance between the risks and benefits of using mask in AECOPD patients is unclear. People with underlying diseases infected with COVID-19 are more likely to become more severe and complicated[30, 31],nevertheless mask as a prevent measure, the safety of which should be concerned. Therefore, when the elderly with respiratory disease, heart disease, or stroke wear mask to prevent infectious diseases, they should consult their physician regardless of the type of mask. At the same time, patients with nasopharyngeal carcinoma, thoracic deformity or myasthenia gravis need attention. Identification of such high-risk patients could provide an opportunity for appropriate and timely treatment.

COPD is performed by malnutrition, low immunity, and susceptibility to infection [4],what should patients with COPD do during pandemic when masks have to be worn to prevent infection, especially in hospital? How can we make masks filter out bacteria and viruses while reduce breathing resistance is a potentially important problem.N95 with exhalation valve may be the option to reduce respiratory resistance if respiratory protection is not affected. On the other hand, no matter whether the patient has acid-base imbalance, lung function assessment and blood gas analysis should be carried out .It is necessary to use masks carefully to avoid aggravating respiratory failure in case of acute exacerbation while the $PaCO_2$of patients increased potentially. Furthermore, AECOPD patient would use NIV if necessary. In addition, people could go out less to avoid infection during the stable stage of COPD. It is easy to be hospitalized repeatedly due to acute exacerbation, which is combined with nosocomial infection because of malnutrition and low immunity.

Patient is hypocalcemia in group C, which may related to the usage of gluococorticoid and diuretics and deficiency of intake. Studies show that patients with AECOPD comorbid with hypocalcaemia are susceptible to co-infection. The change in the acid-base is closely related to hydroelectrolyte imbalance which conforms to the effect of chloride ions on the imbalance of acid-base as other previous study [32]. The increased PCO_2 caused by using masks and hydro electrolyte imbalance should be reviewed and maintain during the stable period of COPD. In the following research, we will further study the influence of electrolyte abnormality on long-term acid-base imbalance and prognosis of patients.

Conclusion

Although the surgical masks have been generally utilized during the COVID-19 outbreak, patients with COPD and low baseline pulmonary function may have a greater physiologic impact with mask. The results showed that the mean values of $PaCO_2$, HCO_3^-, and BE were increased and systolic blood pressure was elevated in patients with AECOPD. Our data indicate that using mask result in hypercapnia

even if the patient is in compensatory state of respiratory failure. Considering the increase of disease aggravation risk, patients with COPD should use masks with caution.

Limitation

This study is a retrospective study. Only 23 patients is included in this study, which could not cover in all patients with different disease, besides, patient with malignant tumors, cardiovascular and cerebrovascular accidents, acute renal failure are more likely to have respiratory failure, which should be paid more attention.

All the patients used disposable medical masks according to our questionnaire. There was no uniform brand of masks, although all of which were disposable medical masks. In addition,the parameters of masks could not be unified. At the same time, no comparison was made with other masks such as N95.Furthermore, were not sure that whether all patients wear masks correctly and did not evaluated the tightness of masks, and leakage of masks.

According to the history of respiratory symptoms, original symptoms of AECOPD could not be excluded. 7 patients could not be evaluated for lung function due to disease severity, so the patients could not be statistic by lung function grading in the study,as a result the association between lung function grades and hypercapnia related to mask-using was not analyzed.

All the patients in the study were in the acute exacerbation period, and we did not monitor the blood gas analysis value and other biochemical indicators of the patients in the stable period for comparison.

List Of Abbreviations

Titles	Abbreviations
Coronavirus Disease 2019	COVID-19
Chronic Obstructive Pulmonary Disease	COPD
Acute exacerbations of chronic obstructive pulmonary disease	AECOPD
Non-invasive ventilator	NIV
Partial pressure carbon dioxide	$PaCO_2$
Partial pressure oxygen	PO_2
Base excess	BE
Bicarbonate	HCO_3^-
Oxygen saturation	SO_2
White blood cell	WBC
Neutrophil percentage	NE%
C-reactive protein	CRP
Hemoglobin	HGB
Blood platelet	PLT
Systolic blood pressure	SBP
Diastolic blood pressure	DBP
Heart rate	HR

Declarations

Ethics approval and consent to participate: The study was approved by the Human Research Ethics Committee Faculty Research of the First Affiliated Hospital of Shantou University Medical College. Written informed consent was obtained from all patients.

Consent for publication: Not applicable.

Availability of data and materials: The datasets analysed during the current study are available from the corresponding author on reasonable request.

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