

# Asthma control, self-management and healthcare access during the COVID-19 pandemic in Beijing

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## Abstract

Background Social distancing and restriction measures during the COVID-19 pandemic may have impacts on asthma control and management in terms of medication availability and healthcare access. We aimed to understand the status of asthma control, exacerbations, self-management and healthcare utilization during the COVID-19 pandemic in Beijing, China. Methods Patients with asthma, selected randomly from our hospital database, were interviewed by phone call. During the interview, sociodemographic information and clinical data, including status of asthma control, asthma exacerbation, self-management and medication before and during the COVID-19 pandemic (From January 25, 2020 to April 25, 2020), were collected. Results We contacted 286 patients, of whom 178 (62.2%) responded with valid results. Before the COVID-19 pandemic, 4.5% (8/178) and 6.7% (12/178) of the patients, respectively, had been hospitalized and visited emergency departments due to asthma exacerbations. 66.7% (118/177) had received maintenance medication. During the COVID-19 pandemic, the majority (92.1%, 164/178) of the patients felt that their symptoms were similar or improved compared with usual times. The mean ACT score of the patients was  $22.76 \pm 3.06$ . 24.7% (44/178) of patients sought medical care for asthma. 25.6% (45/176) of the patients ever experienced aggravation of asthma symptoms, but mostly managed by themselves. 13.5% (24/178) of the patients had worried about potential shortage of medications and some reduced dosing. Conclusion It is important for patients to continue taking their prescribed asthma medications as usual and maintain good asthma control during the ongoing pandemic.

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## Abstract

**Background** Social distancing and restriction measures during the Coronavirus Disease-19 (COVID-19) pandemic may have impacts on asthma control and management in terms of medication availability and healthcare access. We aimed to understand the status of asthma control, exacerbations, self-management and healthcare utilization during the COVID-19 pandemic in Beijing, China.

**Methods** Patients with asthma, selected randomly from our hospital database, were interviewed by phone call. During the interview, sociodemographic information and clinical data, including status of asthma control, asthma exacerbation, self-management and medication before and during the COVID-19 pandemic (From January 25, 2020 to April 25, 2020), were collected.

**Results** We contacted 286 patients, of whom 178 (62.2%) responded with valid results. Before the COVID-19 pandemic, 4.5% (8/178) and 6.7% (12/178) of the patients, respectively, had been hospitalized and visited emergency departments due to asthma exacerbations. 20.3% (36/177) of the patients had regularly visited the hospital for follow-up and prescription, and 66.7% (118/177) had received maintenance medication. During the COVID-19 pandemic, the majority (92.1%, 164/178) of the patients felt that their symptoms were similar or improved compared with usual times. The mean asthma control test (ACT) score of the patients was  $22.76 \pm 3.06$  (ranging from 8 to 25). 24.7% (44/178) of patients sought medical care for asthma. 25.6% (45/176) of the patients ever experienced aggravation of asthma symptoms, but mostly managed by themselves. It was also notable that 13.5% (24/178) of the patients had worried about potential shortage of medications and some reduced dosing.

**Conclusion** During the COVID-19 pandemic, most of the patients interviewed reported controlled asthma and compliance with usual care. Although a quarter of the patients experienced asthma exacerbations, only a few needed emergency visit or hospitalization. It is important for patients to continue taking their prescribed asthma medications as usual and maintain good asthma control during the ongoing pandemic.

**Keywords:** COVID-19 pandemic; asthma control; asthma medication, self-management, healthcare access

## Introduction

The pandemic of COVID-19, caused by the pathogen respiratory syndrome coronavirus (SARS-CoV-2), has now spread around the globe with over 4.0 million individuals affected and over 270,000 deaths internationally. As of May 10, 2020, 84431 cases have been diagnosed and 4643 died in China<sup>1, 2</sup>. Chronic health conditions such as diabetes, hypertension and heart diseases are major risk factors for developing more severe symptoms of COVID-19<sup>3</sup>.

Asthma is a common chronic airway disease worldwide, affecting 1–18% of the populations of different countries<sup>1</sup>. A large comprehensive asthma survey in a nationally representative sample of Chinese adults indicated that asthma is a major public health challenge in China that affects 45.7 million adults aged 20 years or older<sup>4</sup>. Published data from China noted that asthma was not a strong risk factor for severe COVID-19 disease<sup>5–8</sup>. However, recently, a report from the CDC in the US indicated that adults hospitalized with COVID-19 had a higher rate of a history of asthma (12.9%) than the general population (10%)<sup>9</sup>.

International societies responded quickly by releasing guidelines/guidance on the management of asthma during the COVID-19 pandemic<sup>1, 10, 11</sup>, and the recommendation that patients with asthma should remain on their current asthma medications is supported by multiple international organizations, including the Centers for Disease Control and Prevention<sup>11</sup>, the Global Initiative for Asthma<sup>1</sup>, and the North American consensus guideline on allergy care during the COVID-19 pandemic<sup>12</sup>. However, these temporary guidelines were based largely on previous asthma guidelines and expert consensus, because evidence from related studies was lacking.

During the COVID-19 pandemic, governments have implemented restrictions, even city lockdown, to contain transmission of the disease. In Beijing, from late January 2020, the government advised citizens to stay home

and keep social distancing. These measures could compound asthma medication or healthcare access, and even negatively impact asthma control and management. However, there has been no study on the real impact of COVID-19 on asthma. Therefore, we conducted a survey of asthma control, medication, self-management and health resource use during the COVID-19 pandemic in Beijing.

## Methods

### Study design

This was a single-center, retrospective, cross-sectional survey by telephone call performed in Peking University Third Hospital. Patients were selected for interview by the following inclusion criteria: (1) 18 years of age or older; (2) a history of at least 3 months of diagnosed asthma according to GINA guidelines [GINA, 2016]. During the phone interview, sociodemographic information and clinical data, including the status of asthma control, exacerbation, medication, self-management plan, and the patients' perceptions of overall asthma control before and during the COVID-19 pandemic (From January 25, 2020 to April 25, 2020) were collected.

The study protocol was approved by the Independent Ethics Committee of the Peking University Third Hospital. (IRB00006761-M2020189)

### Telephone interview and data collection

The study was performed via a telephone interview that was communicated in plain language and designed to assess the status of asthma control, exacerbation, self-management, hospital visits, medication availability and the patients' perceptions of asthma control before and during the COVID-19 pandemic. The interviewing physician would explain the aim and significance of this investigation, the amount of time required, and the confidentiality and user-permissions for the collection of data. Upon getting approval from the patients, the interviewer carried on asking the questions from a questionnaire, which covered the following items.

#### Demographics

Demographic variables assessed included time of the survey (month/day/year), sex (male vs. female), age, ethnicity, permanent residence, employment (currently working, retired, unemployed vs. other), professions, education, medical insurances, and smoking status.

#### Asthma control, self-management and medication before the COVID-19 pandemic

Questions concerning asthma control, self-management and medication before the COVID-19 pandemic were asked, including, (1) history of asthma, status of asthma control, hospitalization or emergency department (ED) visits due to asthma exacerbation in the previous year before the COVID-19 pandemic; (2) asthma management: written asthma action plans, peak flow monitoring, attendance to asthma education program, online consultation, regular follow-up; (3) asthma medications: medications used and compliance.

#### Asthma control, self-management, medication and healthcare utilization during the COVID-19 pandemic

For evaluation of asthma control, self-management, compliance and health resource utilization in the previous 3 months during the COVID-19 pandemic, we asked the following questions: (1) Asthma Control Test (ACT) scores, by which the control level of asthma was classified into well-controlled (20-25), not well-controlled (16-19) and very poorly controlled (5-15) (1). (2) Asthma exacerbations, hospital or ED visits due to asthma exacerbation; (3) Self-management, disease monitoring, rescue drug use; (4) Asthma medications: compliance in maintenance therapy, maintenance medication, prescription refill, follow-up visits to doctors.

### Quality control

Prior to the investigation, the physicians involved were required to attend a centralized training session. Any identifier to an individual patient, such as identification number and full name, was not collected. All data

were inputted into a programmed database by two people independently for statistical analysis.

## Statistical analysis

Statistical analyses were performed using SPSS Statistics 24(The IBM, Chicago, USA). The mean (SD) was used for continuous variables, and frequency distribution, constituent ratios and percentages were used for categorical variable/binary data. Our analyses used all participants for whom the variables of interest were available. We did not impute missing data.

## Results

### Demographic and clinical characteristics of study participants

We made telephone calls to 286 patients, of whom 178 (62.2%) accepted the interview and responded with valid results, while 108 (37.8%) refused. The mean age of the 178 patients was  $49.74 \pm 17.06$  (ranging from 20 to 92) years, with a median duration of disease of 4.00 (ranging from 0.5 to 62) years. There were 100 women (56.2%) and 78 men (43.8%). The majority of them (90.8%) lived in urban Beijing. 11.0% (19/172) of the patients were current smokers and 7.6% (13/172) were former smokers, with an amount of smoking of  $21.03 \pm 16.76$  (ranging from 4 to 57) pack-years. 54.0% (88/163) were employed, and 88.8% (150/169) had medical insurance coverage, including Free Medical Service, Urban Resident Basic Medical Insurance (URBMI)/Urban Employee Basic Medical Insurance (UEBMI), Medical Insurance in Different Places and New Rural Cooperative Medical System (NCMS). The demographic and socioeconomic data are summarized in Table 1.

Table 1. Demographic and socioeconomic data.

	<i>N</i>	<i>n</i> (%)	95%CI
Age( <i>M</i> ± <i>SD</i> )*	178	49.74 ± 17.06	
Sex	178		
Women		100(56.2)	48.8-63.5
Men		78(43.8)	36.5-51.2
Smoking status	172		
Never-smoker		140(81.4)	75.5-87.3
Current smoker		19(11.0)	6.3-15.8
Former smoker		13(7.6)	3.6-11.5
Education	153		
Primary school		17(11.1)	6.1-16.1
Middle school		19(12.4)	7.1-17.7
High school		34(22.2)	15.6-28.9
College		55(35.9)	28.3-43.6
Postgraduate and above		28(18.3)	12.1-24.5
Employment status	163		
Current employment		88(54.0)	46.3-61.7
Retired		54(33.1)	25.8-40.4
Unemployed		5(3.1)	0.4-5.7
Other		16(9.8)	5.2-14.4
Medical insurance	169		
No insurance		19(11.2)	6.4-16.1
URBMI/ UEBMI		92(54.4)	46.9-62.0
Free Medical Service		44(26.0)	19.4-32.7
Medical Insurance in Different Places		5(3.0)	0.4-5.5
NCMS		9(5.3)	1.9-8.7

\*Data are  $n$  (%), unless otherwise indicated.  $N$ , total number of qualified subjects for evaluation;  $M \pm SD$ , average  $\pm$  standard deviation;  $n$  (%), frequency (percentage of frequency); 95% CI, 95% confidence interval. Total number of qualified subjects for evaluation of the quantity of cigarettes smoked per year, including former and current smokers.

### Asthma control, management and medication before the COVID-19 pandemic

Over the preceding 12 months before the COVID-19 pandemic, 4.5% (8/178), and 6.7% (12/178) of patients were admitted to hospitals or visited ED, respectively, due to asthma exacerbations. 28.2% (48/170) of the patients had a written personalized asthma action plan from their specialists, but only 1.2% (2/172) performed peak respiratory flow every day. Of the patients investigated, 11.0% (19/173) had attended the asthma education program organized by the hospitals, and as many as 10.7% (19/178) of patients expressed that they would seek medical online consultation services. Only 20.3% (36/177) of the patients had regularly visited outpatient clinics for asthma reassessment and prescription refill, while the remaining 79.7% visited outpatient clinics irregularly. Of note, 33.3% (59/177) of the patients had not used any asthma medication regularly before the COVID-19 pandemic, while 66.7% (118/177) had regularly used, as advised by their physicians, long-term maintenance medications which consisted of inhaled corticosteroids (ICS) plus a long-acting  $\beta_2$  agonist (LABA) (85.6%, 101/118), and/or oral leukotriene modifiers (38/118, 32.2%). Inhaled short-acting  $\beta_2$  receptor agonists, used as required for relieving symptoms for exacerbation, were used daily by 19.5% (23/118) of patients. Daily oral theophylline was used by 6.8% (8/118) of the patients. (Table 2)

Table 2. Summary of asthma medications before the COVID-19 pandemic

Parameters	$N$	$n$ (%)	95%CI (%)
Daily use of the following medications	118		
ICS plus LABA		101(85.6%)	79.2-92.0
ICS		6(5.1%)	1.1-9.1
Oral theophylline		8(6.8%)	2.2-11.4
Inhaled Short-acting $\beta$ -agonist (SABA)		23(19.5%)	12.2-26.7
Oral leukotriene modifiers		38(32.2%)	23.6-40.8
Inhaled anticholinergics		3(2.5%)	0.0-5.4
Oral antihistamines		9(7.6%)	2.8-12.5
Without medication	59		

$N$ , total number of qualified subjects for evaluation;  $n$ (%), frequency (percentage of frequency); 95% CI, 95% confidence interval.

### Asthma control, self-management and medical visits during the COVID-19 pandemic

During the COVID-19 pandemic (January 25, 2020 to April 25, 2020), the majority (74.2%, 132/178) of the patients felt that their symptoms had not changed as compared with usual times, while 18.0% (32/178) felt better, and 7.9% (14/178) felt worse. The mean ACT score of the 178 patients was  $22.76 \pm 3.06$  (ranging from 8 to 25) in the last 4 weeks before the survey. According to the criteria of ACT scoring from GINA, asthma was well-controlled in 89.3% of the patients, not well-controlled in 6.2%, and very poorly controlled in 4.5%.

During these period, only 24.7% (44/178) of patients had ever visited a hospital or clinic for asthma, of whom 11 patients had 2 visits, and 6 had [?]3 visits, totaling 74 visits. 14.9% (11/74) of all medical visits were due to exacerbation of asthma, i.e., aggravation of wheezing, chest tightness, and/or coughing, while the remaining visits (63/74, 85.1%) were for regular prescription of asthma medications. Only 6 patients (3.4%) had consultation online.

Notably, 25.6% (45/176) of the patients experienced aggravation of asthma symptoms during the COVID-19 pandemic, but 75.6% (34/45) of them did not see a doctor, because 67.6% (23/34) of the patients thought that they did not need to go to the hospital and took more medications by themselves, and the remaining 32.4% (11/34) worried about cross-infection of COVID-19 in the hospital. No patient said that they did not see a doctor because they could not arrange an appointment. 11 patients went to the hospital due to aggravation, 81.8% (9/11) of them to the outpatient department, while only 18.2% (2/11) to the ED. (Table 3)

Table 3. Asthma control and management during the COVID-19 pandemic

Parameters	<i>N</i>	<i>n</i> (%)	95%CI (%)
Perception of overall control of asthma	178		
No change (asthma control as usual)		132(74.2%)	67.7-80.7
Improve (better asthma control and less exacerbation)		32(18.0%)	12.3-23.7
Aggravation (worse asthma control and more exacerbation)		14(7.9)	3.9-11.9
ACT score	178		
20-25		159(89.3%)	84.7-93.9
16-19		11(6.2%)	2.6-9.8
5-15		8(4.5%)	1.4-7.6
Number of medical visits due to asthma	178		
0		134(75.3%)	68.9-81.7
1		27(15.2%)	9.8-20.5
2		11(6.2%)	2.6-9.8
[?]3		6(3.4%)	0.7-6.0

Scores of 20–25 are classified as well-controlled asthma; 16–19 as not well-controlled; and 5–15 as very poorly controlled asthma. *N*, total number of qualified subjects for evaluation; *n* (%), frequency (percentage of frequency); 95% CI, 95% confidence interval.

### Maintenance therapy, medication availability and prescription during the COVID-19 pandemic

Of note, during the COVID-19 pandemic, 13.5% (24/178) of the patients had worried about insufficient maintenance medications, among whom 45.8% (11/24) had reduced medication dosing for this reason. After reducing medication dosing, 27.3% (3/11) of them experience asthma aggravation.

Among patients who had their prescriptions refilled during the COVID-19 pandemic, 60.6% (40/66) chose to go to hospitals (including community clinics, secondary and tertiary hospitals), 36.4% (24/66) chose a nearby pharmacy, and 3.0% (2/66) chose to buy online. For those who could tell the amount of medication they got in a visit (*n*=55), 52.7% (29/55), 21.8% (12/55), and 21.8% (12/55) had prescriptions enough for 1 month, 2 month and 3 month(or more) treatment, respectively.

For patients on maintenance therapy (*n*=105), 93.3% (98/105) used two or even three drugs, as illustrated in Table 4. ICS plus LABA was the most commonly used therapy, followed by ICS/LABA plus oral leukotriene modifiers (LTRA) (Table 4).

Table 4. Current maintenance therapy

Parameters	<i>N</i>	<i>n</i> (%)	95%CI (%)
Maintenance medications	105		
ICS/LABA		96(91.4%)	86.0-96.9
ICS		3(2.9%)	0.0-6.1
Oral theophylline		4(3.8%)	0.1-7.5
Inhaled Short-acting $\beta$ -agonist (SABA)		7(6.7%)	1.8-11.5
Oral leukotriene modifiers		25(23.6%)	15.5-32.1
Inhaled anticholinergics		2(1.5%)	0.0-4.6
Oral antihistamines		4(3.8%)	0.1-7.5

*N* , total number of qualified subjects for evaluation; *n*(%), frequency (percentage of frequency); 95% CI, 95% confidence interval. *M*  $\pm$ SD, average  $\pm$  standard deviation.

## Discussion

To our knowledge, there have been no studies on the status of asthma control, exacerbation and treatment during the COVID-19 pandemic. Although the current COVID-19 pandemic may fade away and hopefully a vaccine may be eventually available, it is unavoidable that new respiratory viruses will appear and that similar pandemics will happen in the future<sup>13</sup>. Guidance on how to manage patients with asthma during the pandemic is strongly needed. Our survey was conducted to comprehensively evaluate the status of asthma control, medication and compliance, and healthcare resource use in Beijing during the COVID-19 pandemic.

Our survey found that, during the COVID-19 pandemic, in 89.3% of the patients, asthma remained controlled as defined by GINA, which is higher than the results of general population before the pandemic. A multi-center, retrospective, cross-sectional study in China<sup>14</sup> indicated that less than one-third (28.7%) of the patients had controlled asthma, and the control rate in Beijing was 31.4%. We speculate that this might be due to social distancing and mandatory closure of places where aggregation may occur, stepped-up public hygiene measures and the wearing of masks during the COVID-19 pandemic, thereby reducing contact with allergens and viruses. Interestingly, a database survey in the US, in which data were collected from a digital platform that tracked inhaler use through electronic medication monitors and sent alerts to patients for missed doses, found that adherence to asthma controller inhaler use had improved during COVID-19 pandemic<sup>15</sup>.

During the COVID-19 pandemic, 25.6% of our patients experienced an acute attack of asthma, which is more than the general population before the COVID-19 pandemic. A cross-section study in China showed that the proportion of people with asthma experiencing an exacerbation (including an ED visit) in the previous year before the study was 15.5%<sup>4</sup>. A questionnaire-based survey<sup>14</sup> showed that the rate of ED visit and hospitalization in Beijing in one year was 25.8% and 12.2%, respectively. In our survey, during the year before the COVID-19 pandemic, 6.7% of the patients visited ED and 4.5% of the patients were hospitalized due to exacerbations of asthma. But during the COVID-19 pandemic, only 1.1% of the patients visited ED, and no one was hospitalized. Indeed, during the outbreak of SARS in Singapore, the incidence of acute respiratory infections and acute asthma attacks (triggered by respiratory viruses) declined dramatically<sup>16</sup>. The patients enrolled in our study had a higher rate of asthma exacerbation but lower rates of ED visit and hospitalization. It is not surprising to see that 32.4% of them worried about the risk of exposure to SARS-CoV-2 in the hospital, although most patients (67.6%) regarded their symptoms as not severe and could be relieved by self-management with asthma medication.

In our survey, the majority of the patients (85.6% before and 91.4% during the COVID-19 pandemic, respectively) used ICS plus LABA as maintenance therapy, which is consistent with guideline recommendations<sup>10, 12, 17</sup>. Indeed, there is no evidence regarding whether currently available asthma and allergy treatments, including antihistamines, corticosteroids and bronchodilators increase the susceptibility

to or severity of COVID-19<sup>1</sup>. On the contrary, it may be more likely that a patient with asthma would have an exacerbation from other causes, including seasonal pollen exposure or a virus other than SARS-CoV-2 if they stopped regular use of indicated controller therapy. An exacerbation may drive asthmatic patients to seek medical treatment, which would put them at increased risk of being exposed to SARS-CoV-2 during the current pandemic<sup>12</sup>. Continuing the original treatment plan is supported by multiple international organizations<sup>1, 12, 18</sup>. Because the use of nebulized therapy is more likely to aerosolize SARS-CoV-2 and increase the risk of contagion, asthma therapy delivered by metered dose inhaler or dry powder inhaler, for example, ICS plus LABA, would be most appropriate both in the health care setting and at home<sup>19-21</sup>.

Also of note is that, during the COVID-19 pandemic, 13.5% of our patients had worried about insufficient maintenance medications, among whom 45.8% (11/24) had reduced medication dosing for this reason, and 27.3% (3/11) of them experienced asthma aggravation. At the very beginning of the spreading of COVID-19 in Beijing, the medical insurance sector had informed healthcare providers that, for patients with chronic diseases, such as asthma and COPD, medications for maintenance therapy per prescription could be increased from 2 weeks to up to 3 months, hoping that this contingency measure could reduce medical visits and potential cross-infection in the hospital.

Experts recommend the use of telehealth in asthma treatment within a risk-stratified context of the SARS-CoV-2 pandemic<sup>12</sup>. However, in our interview, only a few patients used online consultation during the COVID-19 pandemic. Telehealth can limit exposure to SARS-CoV-2 and provide access to rapid evaluation for potential COVID-19 infection and status of asthma control. Patients with mild-to-moderate or well-controlled asthma were encouraged to use digital medicine services including phone, video, and email consults<sup>22-24</sup>. Outpatient service should be prioritized for patients who have poorly controlled asthma, have worsening asthma symptoms, or who have required dose escalations of their asthma medications in the past several months' time<sup>12</sup>.

Since our survey was cross-sectional, no definite conclusion can be drawn about the causal relationship between risk factors and uncontrolled asthma. The enrollment of study participants was largely dependent on patients' willingness to be surveyed. These participants may be more compliant to therapy and have well-controlled asthma, which might result in selection bias, and therefore the proportion of patients with poorly controlled disease may be underestimated. However, since the participants were enrolled from a tertiary hospital, it is likely that the symptoms of these patients were more severe. Moreover, the study was carried out in spring (from January 25 to April 25) when seasonal aeroallergens, and other respiratory viruses were also prevalent<sup>25</sup>, which may be associated with higher asthma exacerbation.

In conclusion, our survey revealed the status of asthma control, exacerbations, self-management and health-care utilization during the COVID-19 pandemic in Beijing, which supports the recommendation that patients continue taking their prescribed asthma medications as usual and maintain good asthma control during the ongoing pandemic. While social distancing is being encouraged, measures should be taken to mitigate the negative impact on asthma.

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## Conflict of interest

The authors declare that they have no relevant conflicts of interest.

## Author Contributions

Chang Chun: Conceptualization, Methodology, Writing - Original Draft, Supervision, Project administration, Funding acquisition.

Zhang Linlin: Formal analysis, Investigation, Data Curation, Writing - Original Draft.

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Sun Yongchang: Conceptualization, Writing- Reviewing and Editing.

## References

1. Global Initiative for Asthma. Global Strategy for Asthma Management and Prevention, 2020. Available from:<https://ginasthma.org/>. Accessed May 9, 2020.
2. World Health Organization. Coronavirus disease 2019 (COVID-19) situation report. Available from:<https://www.who.int/emergencies/diseases/novel-coronavirus-2019>. Accessed May 10, 2020.
3. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *Lancet* . 2020;395(10229):1054-1062. doi:10.1016/S0140-6736(20)30566-3
4. Huang K, Yang T, Xu J, Yang L, Zhao J, Zhang X, et al. Prevalence, risk factors, and management of asthma in China: a national cross-sectional study. *Lancet* . 2019;394(10196):407-418. doi:10.1016/S0140-6736(19)31147-X
5. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet* . 2020;395(10223):507-513. doi:10.1016/S0140-6736(20)30211-7
6. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet* . 2020;395(10223):497-506. doi:10.1016/S0140-6736(20)30183-5
7. Zhang JJ, Dong X, Cao YY, Yuan YD, Yang YB, Yan YQ, et al. Clinical characteristics of 140 patients infected with SARS-CoV-2 in Wuhan, China. *Allergy* . 2020;10.1111/all.14238. doi:10.1111/all.14238
8. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China. *JAMA* . 2020;323(11):1061-1069. doi:10.1001/jama.2020.1585
9. Garg S, Kim L, Whitaker M, O'Halloran A, Cummings C, Holstein R, et al. Hospitalization Rates and Characteristics of Patients Hospitalized with Laboratory-Confirmed Coronavirus Disease 2019 - COVID-NET, 14 States, March 1-30, 2020. *MMWR Morb Mortal Wkly Rep* . 2020;69(15):458-464. Published 2020 Apr 17. doi:10.15585/mmwr.mm6915e3
10. National Institute for Health and Care Excellence. COVID-19 rapid guideline: severe asthma. Available from:<https://www.nice.org.uk/guidance/ng166>. Accessed May 9, 2020.
11. National Health Service. Clinical guide for the management of respiratory patients during the coronavirus pandemic. Available from:<https://www.england.nhs.uk/coronavirus/publication/specialty-guides/>. Accessed May 9, 2020.
12. Shaker MS, Oppenheimer J, Grayson M, Stukus D, Hartog N, Hsieh E, et al. COVID-19: Pandemic Contingency Planning for the Allergy and Immunology Clinic. *J Allergy Clin Immunol Pract* . 2020;8(5):1477-1488.e5. doi:10.1016/j.jaip.2020.03.012
13. Brough HA, Kalayci O, Sediva A, Untersmayr E, Munblit D, Rodriguez Del Rio P, et al. Managing childhood allergies and immunodeficiencies during respiratory virus epidemics - the 2020 COVID-19 pandemic. *Pediatr Allergy Immunol* . 2020;10.1111/pai.13262. doi:10.1111/pai.13262
14. Su N, Lin J, Chen P, Li J, Wu C, Yin K, et al. Evaluation of asthma control and patient's perception of asthma: findings and analysis of a nationwide questionnaire-based survey in China. *J Asthma* .

- 2013;50(8):861-870. doi:10.3109/02770903.2013.808346
15. Kaye L, Theye B, Smeenk I, Gondalia R, Barrett MA, Stempel DA. Changes in medication adherence among patients with asthma and COPD during the COVID-19 pandemic. *J Allergy Clin Immunol Pract* . 2020;S2213-2198(20)30412-8. doi:10.1016/j.jaip.2020.04.053
16. Van Bever HP, Chng SY, Goh DY. Childhood severe acute respiratory syndrome, coronavirus infections and asthma. *Pediatr Allergy Immunol* . 2004;15(3):206-209. doi:10.1111/j.1399-3038.2004.00137.x
17. Global Initiative for Asthma. Recommendations for Inhaled Asthma Controller Medications. Available from: <https://ginasthma.org/recommendations-for-inhaled-asthma-controller-medications/>. Accessed May 9, 2020.
18. Centers for Disease Control and Prevention. Severe acute respiratory distress syndrome. Available from: <https://www.cdc.gov/sars/>. Accessed May 9, 2020.
19. Amirav I, Newhouse MT. Re Transmission of coronavirus by nebulizer—a serious underappreciated risk! Available from: <https://www.cmaj.ca/content/re-transmission-corona-virus-nebulizer-serious-underappreciated-risk>. Accessed May 9, 2020.
20. van Dormalen N, Bushmaker T, Morris D, Holbrook M, Gamble A, Williamson B, et al. Aerosol and surface stability of HCoV-19 (SARS-CoV-2) compared to SARS-CoV-1. Available from: <https://doi.org/10.1101/2020.03.09.20033217>. Accessed May 9, 2020.
21. Desai M, Oppenheimer J, Lang DM. Immunomodulators and Biologics: Beyond Stepped-Care Therapy. *Clin Chest Med* . 2019;40(1):179-192. doi:10.1016/j.ccm.2018.10.011
22. Malipiero G, Paoletti G, Puggioni F, Racca F, Ferri S, Marsala A, et al. An academic allergy unit during COVID-19 pandemic in Italy. *J Allergy Clin Immunol* . 2020;S0091-6749(20)30489-9. doi:10.1016/j.jaci.2020.04.003
23. Centers for Disease Control and Prevention (U.S.). Coronavirus Disease 2019 (COVID-19)/People Who Need Extra Precautions/People Who Are At Higher Risk/People with Moderate to Severe Asthma. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/index.html>. Accessed May 9, 2020.
24. Abrams EM, Szefer SJ. Managing Asthma during Coronavirus Disease-2019: An Example for Other Chronic Conditions in Children and Adolescents. *J Pediatr* . 2020;S0022-3476(20)30528-X. doi:10.1016/j.jpeds.2020.04.049
25. Teach SJ, Gergen PJ, Szefer SJ, Mitchell HE, Calatroni A, Wildfire J, et al. Seasonal risk factors for asthma exacerbations among inner-city children. *J Allergy Clin Immunol* . 2015;135(6):1465-73.e5. doi:10.1016/j.jaci.2014.12.1942