











Impact of COVID-19 on pediatric pulmonology healthcare practice

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Abstract

Introduction: Coronavirus 2019 (COVID-19) is typically spread by droplets and has had a remarkable effect on pediatric pulmonology healthcare practice. Here, we aimed to evaluate the effect of the COVID-19 pandemic on the clinical follow-up and hospital visits of patients followed up at a pediatric pulmonology unit at a tertiary care center.

Methods: This study was an observational descriptive study performed at a tertiary care center pediatric pulmonology unit between January 2019 and December 2020. We analyzed the outpatient visits, laboratory procedures which including pulmonary function tests (PFTs), diffusion capacity assessment, plethysmography, and lung clearance index (LCI), high-speed video microscopy, gastric aspirate sampling, and Flexible fiberoptic bronchoscopy (FFB) during clinical follow-up, and hospitalization numbers of patients with chronic lung diseases during the COVID-19 pandemic and compared them with the previous year before the pandemic started.

Results: In 2020, compared with 2019, outpatient visits decreased by 42.2%; from 8324 patients to 4804 patients and other laboratory procedures decreased after the pandemic started; PFTs including spirometry by 87.2%; from 2990 to 380 tests, diffusion capacity assessment from 172 to 55 tests, plethysmography from 172 to 53 and LCI from 70 to 9 tests, also high-speed video microscopy analyses by 64.3% from 300 to 107 patients, and gastric aspirate sampling by 75.5% from 42 to 9 patients. FFB procedures also decreased by 59.1%, from 142 to 58 patients, and only 15 were after the first reported case of COVID-19 in our country, and they were all for urgent indications. None of these patients was positive pretesting for COVID-19 who underwent the FFB. There was no significant decrease in patients' hospitalization due to pulmonary exacerbation in cystic fibrosis, interstitial lung disease, and primary ciliary dyskinesia.

KEYWORDS

children, COVID-19, flexible fiberoptic bronchoscopy, pulmonary function testing

This study was performed at Ihsan Dogramaci Children's Hospital, University of Hacettepe, Ankara, Turkey.

1 | INTRODUCTION

The global 2019 novel coronavirus disease (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a public health emergency of international concern.¹ The first case was reported on March 11th 2020 in our country by the Ministry of Health, after which the number of cases increased quickly and it is still an important public health problem, as it is worldwide.^{2,3} COVID-19 is predominantly transmitted via respiratory droplets and aerosol transmission.^{4–7} During the peak of the COVID-19 pandemic in our country, some decisions were made to reduce the spread of the virus and to maintain social distancing between people. For children, first, schools were locked down on March 16th. On April 3rd, a curfew was installed for people aged 1–20 years by the government. The Ministry of Health and the government recommended not to travel outside the country and not to leave the house unless it was essential.³ For this reason, people's visit to hospitals for emergencies and face-to-face outpatient clinic visits were delayed, and most patients did not want to present to hospitals due to clinical problems.

In many centers, outpatient clinic visits were limited to particular situations during the peak of the COVID-19 pandemic. Accordingly, the pandemic has led to the emergence of alternative strategies to evaluate children with chronic conditions, and telephone visits were performed during this period. After the first peak of the pandemic in our country, on May 13th, children were allowed to go out again on the condition that their walking distances were limited, they obeyed social distancing rules, and wore masks. COVID-19 restrictions to reduce virus transmission also affected the outpatient visits of pediatric pulmonology clinics. In pediatric pulmonology practice, most diagnostic and therapeutic procedures including pulmonary function tests (PFTs), gastric aspirate and induced sputum, high-speed video microscopy analysis (HSVMA), flexible fiberoptic bronchoscopy (FFB) and, inhalation therapies have a high risk for aerosol transmission. These aerosol-generating procedures are associated with an increased risk of infection transmission to the patient and healthcare workers (HCWs), which is why the COVID-19 pandemic has made it difficult for respiratory teams to protect their patients and staff. It is also important to evaluate patients as to whether they have symptoms or contact history for COVID-19 before their routine clinical visits to reduce the spread of the virus.⁸

Here, we aimed to evaluate the effect of the COVID-19 pandemic on the clinical follow-up, laboratory procedures, and hospital visits of patients followed up at the pediatric pulmonology unit at a tertiary care reference centre.

2 | METHODS

2.1 | Study design

This study was an observational descriptive study performed at a tertiary care children's hospital's pediatric pulmonology unit between January 2019 and December 2020. Our centre is a reference centre

in our country, and we follow up children between 0 and 18 years mainly with cystic fibrosis (CF), primary ciliary dyskinesia (PCD), interstitial lung diseases (ILD), recurrent pneumonia, pleural effusion, tracheostomy, non-CF bronchiectasis, sleep disorders, difficult-to-treat asthma and immune deficiency. Annual outpatient visits, laboratory procedures including pulmonary function tests, diffusion capacity assessment, plethysmography, and lung clearance index (LCI), high-speed video microscopy, gastric aspirate sampling, and FFB during clinical follow-up were recorded for the comparison of 2019 and 2020. Pulmonary function testing is routinely used to assess lung disease in children and adolescents, they can help physicians in the decision-making process.⁹ High-speed video microscopy of ciliary beat frequency and pattern is used for the diagnosis of PCD using the nasal brushing method.¹⁰ Flexible bronchoscopy is a procedure enabling visualization, sampling, and treatment of the airways of children.¹¹ Gastric aspirate sampling is used in the differential diagnosis of tuberculosis in patients who may not be able to expectorate respiratory secretions.

Hospitalization numbers of patients and acute pulmonary exacerbations (APEX) of patients with chronic lung diseases, CF, ILD, and PCD were also recorded and the results were compared with the previous year.

Patients with CF who had at least four of any of the following were considered as having APEX: change in sputum; new or increased haemoptysis; increased cough; increased dyspnea; malaise, fatigue or lethargy; temperature above 38°C; anorexia or weight loss; sinus pain or tenderness, change in sinus discharge; change in physical examination of the chest; decrease in pulmonary function 10% by baseline, or radiographic changes indicative of pulmonary infection.¹²

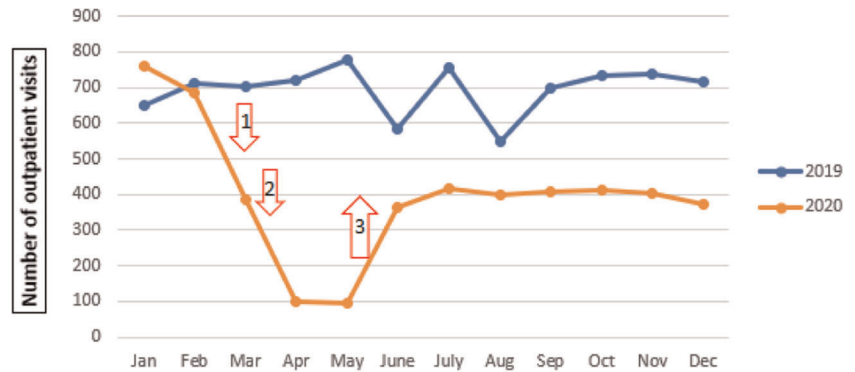
Patients with ILD who had at least two or more of the following criteria were considered as having APEX: increase in respiratory rate 20% from baseline, an increase in the development of dyspnea, newly developing or increased abnormalities on chest imaging, onset/increase in oxygen demand to attain the individual baseline saturation, need for an additional level of ventilator support, decrease in spirometry (10% from baseline for vital capacity), and reduced exercise tolerance.¹³

Three or more of the following definitions must be present with PCD to be considered as APEX: increased cough, change in sputum volume and/or colour, increased shortness of breath perceived by the patient or parent, the decision to start or change antibiotic treatment because of perceived pulmonary symptoms, malaise, tiredness, fatigue or lethargy, new or increased haemoptysis and temperature more than 38°C.¹⁴

2.2 | Statistical analysis

The SPSS V.22.0 (IBM Corp.) software was used for statistical analyses. Patient outpatient visits, hospitalization, and laboratory procedures are presented as numbers and percentages of the total. We compared the results with the year before the pandemic and during the COVID-19 outbreak.

FIGURE 1 The number of outpatient visits by month [Color figure can be viewed at wileyonlinelibrary.com]



The study was approved by the ethics committee of our institution (No:21/190).

3 | RESULTS

3.1 | Evaluation of outpatient and inpatients numbers

During the pandemic in 2020, compared with 2019, outpatient visits decreased by 42.2%, from 8324 patients to 4804 patients. The number of outpatient clinic visits by month is shown in Figure 1. After the first COVID-19 case was reported on March 11th, 2020, in our country, outpatient visits decreased significantly. The number of patients was the lowest in March, April, and May, and outpatient visits started to increase when summer started. The age range of patients who presented to the outpatient clinic throughout 2020 was 0–2 years (1052, 21.9%), 2–5 years ($n = 691$, 14.4%), 5–12 years ($n = 1208$, 25.14%), and 12–18 years ($n = 1698$, 35.3%). A total of 154 (3.2%) patients were aged over 18 years.

From March 11th, 2020, to today, outpatients have been questioned in terms of COVID-19 before attending outpatient clinic examinations. The assessment of each patient for COVID-19 is performed by each outpatient clinic. Children who are suspected of COVID-19 are first sampled for COVID-19 and undergo polymerase chain reaction (PCR) testing. During these 9 months, 43 children were tested and two (4.6%) were found positive for SARS-COV-2. One was a 16-month-old boy with systemic juvenile idiopathic arthritis who was referred to us for biologic agent therapy approval. The other was an 11-year-old girl with scoliosis. Both were tested because of fever.

Three hundred fifty patients with CF, 80 patients with ILD, and 265 patients with PCD are followed in our department. The number of hospitalizations due to pulmonary exacerbations in children with chronic lung disease did not noticeable change in 2020 compared with 2019. For 2019 and 2020, the number of patients hospitalized for a pulmonary exacerbation was 37 and 32 for CF, respectively, nine and five for ILD, and one and two for PCD, respectively. Additionally, two more patients with ILD were diagnosed by telephone visits as having APE and hospitalized at local facilities. Sampling for

COVID-19 was performed before the hospitalization of these patients due to pulmonary exacerbations, and none was positive for the COVID-19 virus. During hospitalization, only one patient with CF had COVID-19, she got SARS-CoV-2 from her mother. Further, two new patients were admitted to our hospital during this time and diagnosed as having ILD. One of had pneumothorax and was diagnosed as having usual interstitial pneumonia with an open lung biopsy, the other had respiratory failure and was diagnosed as having an ABCA3 mutation. Nine new patients were diagnosed as having CF and nine new patients were diagnosed as having PCD during 2020. The annual rates of new case for ILD, CF, and PCD were 0.4, 1.8, and 1.8 per 1000 visits, respectively, within the patients who visited the pediatric pulmonology unit in 2020.

Additionally, the number of hospitalized patients increased by 3% from 300 patients to 319 patients compared to 2 years. The most common diagnosis of patients apart from chronic lung diseases were pneumonia, pleural effusion, children with tracheostomy, non-CF bronchiectasis and immune deficiency.

3.2 | Evaluation of diagnostic procedures

PFTs: In 2020, compared with 2019, pulmonary function tests including spirometry decreased by 87.2%, from 2990 tests to 380 tests, diffusion capacity assessment tests decreased by 68%, from 172 to 55 tests, plethysmography tests decreased by 69.1%, from 172 to 53, and LCI tests decreased by 87.1%, from 70 to 9. The number of PFTs for both years are also shown in Figure 2.

High-speed video microscopy analysis: In 2020, compared with 2019, high-speed video microscopy analyses decreased by 64.3%, from 300 to 107 patients.

FFB: In 2020, compared with 2019, FFB procedures decreased by 59.1%, from 142 to 58 patients, and only 15 were after the first reported case of COVID-19 in our country throughout the remainder of 2020, and they were all for emergencies. The characteristics of patients who underwent FFB are shown in Table 1. Patients who underwent FFB had pretesting for COVID-19, and none was positive for the COVID-19 virus. Furthermore, the FFB team was limited in number, and all wore personal protective equipment (PPE).

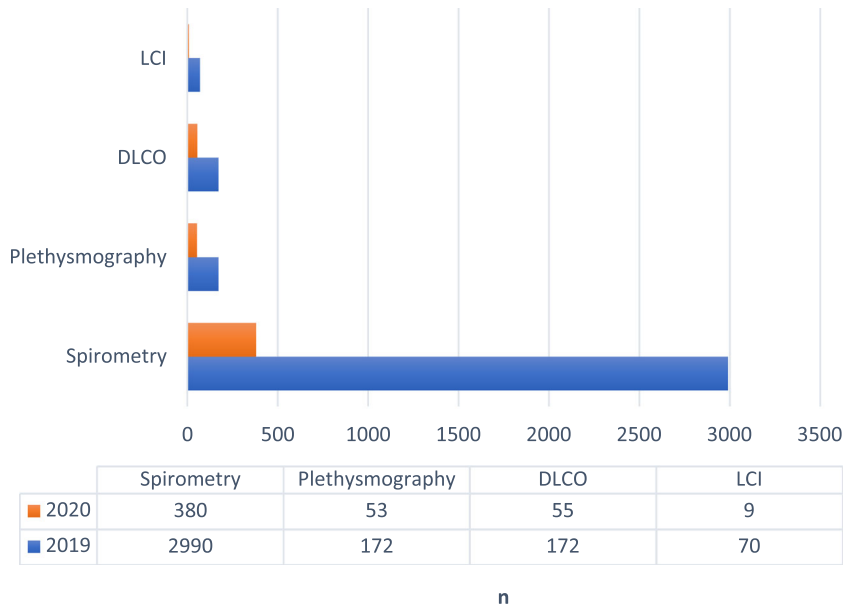


FIGURE 2 The numbers of pulmonary function tests during both years. DLCO, diffusion capacity assessment; LCI, lung clearance index [Color figure can be viewed at wileyonlinelibrary.com]

Gastric aspirate: In 2020, compared with 2019, gastric aspirate sampling for patients with suspected tuberculosis decreased by 75.5%, from 42 to 9 patients.

3.3 | Evaluation of therapeutic procedures

Nebuliser treatment: In 2020, compared with 2019; nebuliser treatment decreased by 66%, from 221 to 75 patients.

The staff who worked on aerosol-spreading procedures used PPE. To date, after these procedures, none of our staff has developed a COVID-19 infection.

4 | DISCUSSION

In pediatric pulmonology, most procedures and tests may result in an aerosol generation, causing a risk of exposure to HCWs and other patients, even asymptomatic patients can spread potentially infectious droplets. The COVID-19 outbreak has affected all aspects of clinical and laboratory services, particularly for pediatric lung medicine in light of this information. In this report, we wanted to point out the serious impact of COVID-19 and precautions on pediatric pulmonology practice which was not discussed to date in pediatric view.

Early in the pandemic, for our patient group with chronic lung disease, the National Institute for Health and Care Excellence recommended minimizing face-to-face contact by pausing unnecessary outpatient checkups.^{15,16} Later, many professional societies published recommendations for precautions during pediatric pulmonology procedures.¹⁷⁻¹⁹ Similarly, in this study, we saw that our outpatient clinic visits and pediatric pulmonology procedures significantly decreased and COVID-19 preevaluations of children before their routine clinical outpatient visits protected other patients and staff from the spread of the virus. In addition, telephone visits helped

us to make decisions about pulmonary exacerbations and direct these patients to hospitals where they lived.

First, we know that because COVID-19 mainly causes lung damage, children with chronic lung diseases and their parents have more anxiety and therefore do not want to attend their appointments.²⁰ Further, in the pandemic peak, there was a curfew, in which the outpatient numbers rapidly decreased. Apart from these, decreased outpatient visits and laboratory procedures can be related to less exposure of these children to respiratory viruses because of kindergarten and school closures. Pulmonary exacerbations are the cause of significant morbidity in patients with chronic lung diseases including CF, ILD, and PCD. Also, exacerbations have a considerable effect on quality of life and may lead to lung injury with late diagnosis.¹²⁻¹⁴ Therefore, these patients need close follow-up. Our findings showed that the number of hospitalizations due to pulmonary exacerbation in pediatric chronic lung disease did not noticeable change when compared with the previous year, furthermore two more patients were diagnosed with pulmonary exacerbation during the telephone visits. Previous reports also suggest that by the help of telemedicine and the distribution of medical care services to sick people remotely using communication and information technology would help early diagnosis and interventions in chronic lung diseases.²¹

In pediatric pulmonology practice, PFTs are routinely used to assess lung disease in children and adolescents, which can help physicians in the decision-making process.⁹ They are usually used to diagnose pulmonary exacerbations during the follow-up of chronic lung diseases.¹⁰ The American Thoracic Society (ATS) raised concerns about PFTs "as a potential avenue for COVID-19 transmission due to the congregation of patients with lung disease and because of the potential for coughing and droplet formation".²² The ATS recommended that PFTs be limited only to immediate treatment decisions, and PPE for HCWs should be discussed with local infection control teams. As these recommendations were taken into account,

TABLE 1 The characteristics of patients who underwent flexible fiberoptic bronchoscopy to date from pandemic started

Age	Presentation	Indication	Finding
17 years 5 months	FMF, TST+, atelectasis on chest CT	To exclude tuberculosis before starting a biologic agent	No finding
16 years 5 months	Prolonged wet cough	To exclude tuberculosis	<i>M. tuberculosis</i> growth in BAL
17 years 5 months	History of surgery TEF, prolonged wet cough, atelectasis on chest CT	To exclude re-fistula	Tracheobronchomalacia
13 years 5 months	Diagnosed LRBA gene defect	To exclude infection before BMT	No finding
15 years 5 months	A prolonged wet cough, RLL atelectasis and bronchiectasis on chest CT	To exclude congenital malformation	Granulation tissue at the entrance RLL to seconder foreign body aspiration
3 months	Respiratory failure, common ground-glass opacity on chest X-Ray	To exclude interstitial lung disease	No finding
8 years	Recurrent pulmonary infection, RUL&RML atelectasis on CT	To determine cause of atelectasis	Secretion
17 years 8 months	Diagnosed CF, cough, mucus plugging on chest CT	To exclude NTM	MSSA growth in BAL
3 years 8 months	Diagnosed CGD, TST+	To exclude tuberculosis before BMT	No finding
4 months	Respiratory failure, common ground-glass opacity on X-Ray	To exclude interstitial lung disease	No finding
6 months	Hiperaeration on the left lung	To exclude foreign body aspiration	Tracheobronchomalacia
11 years 4 months	Diagnosed CF, RUL&RML bronchiectasis and mucus plugging	To clear the mucus plug	MSSA growth in BAL, purulent secretion and endotracheal dornase alpha was used
6 years	Diagnosed difficult-to-treat asthma, bronchiectasis on CT	To determine the cause of bronchiectasis	No finding
8 years 2 months	Diagnosed STAT-3 mutation, suspect of polyp in trachea on CT	To exclude polyp	No finding
16 years 7 months	Diagnosed ALL in remission and NTM infection, new lung nodules on chest CT	To exclude new infection	No finding

Abbreviations: BAL: bronchoalveolar lavage; BMT, bone marrow transplantation; CF, cystic fibrosis; CGD, chronic granulomatous disease; CT, computerise tomography; FMF, familial mediterranean fever; LRBA, lipopolysaccharideresponsive and beigelike anchor protein; NTM, nontuberculosis mycobacteria; RLL, right lower lob; RUL, right upper lob; STAT, signal transducer and activator of transcription; TEF, tracheoesophageal fistula; TST, tuberculin skin test.

there was a significant decrease in PFTs in the pandemic year compared with previous years, including spirometry, in our clinic. In addition, all our staff wore PPE while performing PFTs, and none was infected with COVID-19.

Microbiologic diagnoses of diseases depend on the detection of microorganisms in respiratory samples. Regular comprehensive microbiologic evaluations of sputum samples taken from the lower respiratory tract are significant. From some patients who may not be able to expectorate respiratory secretions, samples can be collected using gastric aspirate and induced sputum or bronchoalveolar lavage.¹¹ During the pandemic, gastric aspiration may be preferred over induced sputum because it emits less aerosol.¹⁸ Also, the use of nebulisers should be avoided to decrease the risk of disseminating COVID-19 unless an airborne infection isolation room is available.²³ Our use of gastric aspirate and nebuliser notably reduced in the pandemic year.

Bronchoscopy is an essential and safe method to diagnose and treat airway and lung problems in infants and children.¹¹ FFB is an aerosol and droplet-generating procedure and poses a risk to the medical team. As such, elective FFBs were stopped soon after the SARS-CoV-2 outbreak. In addition to evaluating indications more critically so that only children with urgent or immediate need had bronchoscopy performed, the FFBs were modified to limit the spread of the virus. Before performing bronchoscopy in asymptomatic patients in an area where community transmission of COVID-19 infection is present, they are recommended to test COVID-19 infection. In all patients with negative results, the procedure is performed using PPE, including a face shield, gown, gloves, and N-95 respirators or powered air-purifying respirators.²⁴ Fifteen patients underwent FFB at our clinic after the first reported case of COVID-19 in our country, and they were all for emergencies.

Also, they were performed with pre-testing for COVID-19, and none was positive for the COVID-19 virus. Furthermore, the FFB team followed the recommended procedure; they wore face shields, gowns, gloves, and N-95 respirators. Among our patients, no complications were found during and after the procedure. Among the FFB team, none was infected with SARS-CoV-2.

Other procedures: ciliary examination with high-speed video microscopy is recommended as part of the PCD diagnostic testing panel uses nasal brushing, which is a crucial infection control issue during the COVID-19 outbreak. Our center is the reference center for high-speed video microscopy; therefore, we had to limit our testing, despite our experiences in this diagnostic tool.

Our study has a few limitations that should be addressed. No pediatric pulmonology clinic has shared its experience so far; therefore, there are insufficient data for use as a comparison with our experience. Because of the descriptive design of our study, we could not evaluate the other reasons affecting the outpatient visits and laboratory procedures. It is usually recommended to use home spirometry in chronic lung diseases; unfortunately, only three of our patients had home spirometry. Therefore, the decline in PFTs could not be evaluated during telephone visits. However, home spirometry has difficulties such as cost, and also patient compliance with the device is very significant.²⁵

In conclusion, the ongoing pandemic has affected the routine clinical follow-up and pediatric pulmonology procedures of patients remarkably, especially in non-COVID services. It is important to ask about the symptoms and contact history for COVID-19 before routine clinical visits. Furthermore, telemedicine and home spirometry in the follow-up of individuals with chronic lung disease may become more beneficial in the future; therefore, more studies on this subject are needed.

CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

AUTHOR CONTRIBUTIONS







Halime Nayir Buyuksahin: data curation (lead); methodology (lead); resources (lead); writing review & editing (lead). **Dilber Ademhan Tural:** data curation (supporting). **Beste Ozsezen:** data curation (supporting). **Birce Sunman:** data curation (supporting). **Ismail Guzelkas:** data curation (supporting). **Ebru Yalcin:** writing review & editing (supporting). **Deniz Dogru:** writing review & editing (supporting). **Ugur Ozcelik:** writing review & editing (supporting). **Nural Kiper:** writing review & editing (supporting).

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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