Original Article

Pediatric asthma control in tertiary care setting using telemedicine during COVID-19 era

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Background: During the coronavirus disease 2019 (COVID-19) pandemic, national measures have affected health care services. Children with asthma were a vulnerable population who were advised to avoid needless hospital visits. Telemedicine was utilized in this circumstance. However, data in Thailand is limited. This study aimed to evaluate asthma control in patients who were followed up by telemedicine compared with in-person visits at an outpatient clinic in Thailand's tertiary academic medical center.

Methods: This was a retrospective study among pediatric patients with asthma who were followed up in the pediatric pulmonary and allergy clinic of Srinagarind Hospital from 1 January to 31 May 2021. We offered telemedicine (telephone visit) and in-person visits at the hospital by their willingness during this period. All patients were asked about asthma clinical control symptoms, medication compliance, exacerbation events, and hospital admissions by pediatric pulmonologists and allergists. Then, we decided to prescribe in controller medications. In the telemedicine groups, we used the postal service to deliver controller medicine to patients.

Results: Among 195 asthmatic children, 83 (42.56%) were followed up by telemedicine. Children who were followed up by telemedicine had more controlled symptoms than the in-person visit group [adjusted relative risk (aRR): 1.219; 95% confidence interval (CI): 1.062–1.400; P value =0.005]. In the in-person visit group, children had more asthma exacerbation events than telemedicine (5 *vs.* 0, respectively, P value =0.073).

Conclusions: During the COVID-19 pandemic, telemedicine follow-up in asthmatic children resulted in well-controlled symptoms and few asthma exacerbation events.

Keywords: Asthma; pediatric; telemedicine; asthma control; coronavirus disease 2019 (COVID-19)

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Introduction

Since March 2020, the coronavirus disease 2019 (COVID-19) pandemic has been spreading over the globe (1). The World Health Organization (WHO) recommends nonpharmaceutical interventions (NPIs) such as personal protective, environmental, physical distance, and travel-related measures to reduce the spread of this disease (2). Since December 2020, the second wave of outbreaks in Thailand

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has spread to various areas. As the COVID-19 epidemic continues and the number of cases increases, the Ministry of Public Health delineates danger zones based on the number of infected people. To prevent the spread of COVID-19, it was suggested that travelers from high-risk locations be subject to limitations. To maintain social distance, every hospital restricts the number of outpatients and visitors. These measures resulted in significant cuts to health care, especially for children who had not received the COVID-19 vaccine (3). Consequently, telemedicine is frequently used in Thailand to treat numerous chronic ailments. Telemedicine is a health care service that employs communication technologies to communicate information between a remote physician and patient for the diagnosis, treatment, and prevention of disease (4). It is subdivided into various categories, one of which being synchronous telemedicine, where clinicians and patients receive information concurrently (5). Asthma is a chronic illness that requires regular monitoring (6). Adherence to asthma control medications is related with greater asthma control, a lower risk of asthma exacerbations, and fewer hospitalizations (7). Asthmatic patient evaluations and follow-ups required a detailed medical history, physical examination, peak flow measurement, and spirometry monitoring. Some of these assessments are easily available via telemedicine. Due to the increased danger of getting severe COVID-19 during the global spread of COVID-19, asthmatic patients avoided hospitalization (8). According to the Centers for Disease Control and Prevention (CDC), patients with moderate-to-severe or uncontrolled asthma were hospitalized more frequently for COVID-19 (9). According to current standards, asthma management medication should be continued during the pandemic (10). Telemonitoring enhances asthmatic patients' follow-up care. It can reduce patient travel, job absenteeism, and overall costs (11). There was evidence that telephone-based care of adults with severe asthma reduced readmission rates (12,13). Nonetheless, the Cochrane review found no evidence of significant differences in exacerbations, asthma control, or quality of life between face-to-face and remote asthma check-ups (14). Despite evidence that telemedicine can be used to monitor and treat asthmatic patients, data on the effectiveness of asthma telemonitoring and treatment from a health care professional in asthma control, exacerbation, and hospital stay in low- and middle-income countries during the COVID-19 pandemic remain scarce. Thus, we sought to compare the asthma control of patients who were monitored via telemedicine to those who visited the outpatient clinic of Thailand's tertiary academic medical institution in person. We present the following article in accordance with the STROBE reporting checklist (available at https://tp.amegroups.com/article/view/10.21037/tp-22-287/rc).

Methods

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Center for Ethics in Human Research, Khon Kaen University's institutional review board (No. HE641327). Informed consent was waived by Center for Ethics in Human Research, Khon Kaen University since this study did not involve personal identifiable data. Patients with asthma under the age of 18 were identified retrospectively using electronic medical information (EMRs). According to the Global Initiative for Asthma (GINA) (6), all asthmatic patients were diagnosed by pediatric pulmonologists or allergists. Patients who attended the pediatric asthma and allergy clinic of Srinagarind Hospital on a regular basis from January to May 2021 were included. As standard care, they received the same basic asthma information and training on the proper use of metered-dose or dry-powder inhalers from the pediatric respiratory nurse. For each patient, a detailed emergency action plan was prepared. After the initial visit, we excluded patients who were lost to follow-up and those with a different lung illness.

Srinagarind Hospital, Khon Kaen University, is a tertiary academic medical center in Thailand's northeastern region. According to GINA, our pediatric respiratory and allergy clinic treats patients with asthma ranging in severity from mild to severe (6). The majority of them were cared for by caregivers in a remote area far from our hospital. Since the second wave of COVID-19 arrived in Thailand in December 2020, outpatient clinics at Srinagarind Hospital have been urged to minimize patient visits. As a result, the pediatric respiratory and allergy clinic began to employ phone visits during this time period. In January 2021, our clinic began calling patients and providing them with the option of selecting the sort of follow-up based on their willingness. For follow-ups, we separated our patients into two groups: telephone and in-person visits. To standardize the conversation, we administered the GINA asthma control symptoms assessment to all patients in both groups who visited our clinic to identify their asthma control symptoms as controlled, partly controlled, or

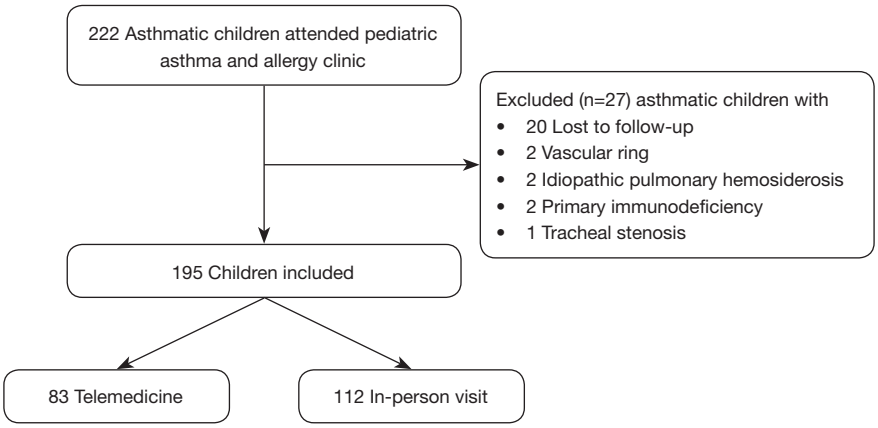

Figure 1 Flow of patient inclusion.

uncontrolled (6). For each visit in both modes of care, they were also asked about medication adherence, exacerbation events, emergency room visits, and hospital admissions due to exacerbation. Both groups advised using controller medication on a regular basis. Medication adherence was calculated by dividing the day of controller medicine use by the day of follow-up. The patient data were entered into the asthma clinic chart and the hospital EMR. Following the conclusion of the conversation and physical examination, pediatric pulmonologists or allergists opted to prescribe in controller medications. In the telemedicine groups, we used the postal service to deliver controller medicine to patients (*Figure 1*). In both groups, the interval of visit was separated by the same amount of time, and the subsequent session was always scheduled 6 weeks later. The average amount of time between patient visits at our facility was 6 weeks. This was a result of the constraints imposed by the patient's health insurance policy, which was a government-sponsored universal coverage program.

Statistical analysis

We collected the data from the asthma clinic chart and EMR. The demographic data included the patient's age, sex, and comorbidities. We classified asthma severity as GINA into mild, moderate, and severe based on the controller medicine usage preceding the first visit during this period (6). At 12 weeks after receiving each type of follow-ups, we collected asthma control symptoms to evaluate the primary outcome. The exacerbation events, emergency room visits, hospital admission, and corticosteroids used were also collected from EMR. We compared demographic data between telemedicine and in-person visits using chi-square or Fisher's exact tests for categorical variables and independent *t*-test for continuous variables. Values of $P<0.05$ were considered to indicate statistical significance between 2 types of follow-ups. Multivariable logistic regressions were used to demonstrate the association between follow-up type and asthma control and presented as an adjusted relative risk (aRR) with a 95% confidence interval (CI). We divided the primary outcome of asthma control into dichotomous data, a well-controlled group, and partly with an uncontrolled group. Variables that have been shown to be associated in previous studies or were associated with good asthma control in bivariate analysis at a significance level of $P<0.2$ were used as covariates. We used Fisher's exact test for the association of follow-up type and asthma exacerbation due to our findings' low prevalence of asthma exacerbation. All statistical analyses were performed using STATA software version 10 (StataCorp LP).

Results

A total of 222 asthmatic children attended our clinic during the study period. Twenty-seven children were excluded due to loss to follow-up and other comorbid pulmonary conditions. We reported on 195 predominantly male patients, which accounted for 65.13%. Mean age of the patients was 96.46±48.27 months. Most of them had at least one comorbid condition, and allergic rhinitis was the most common (93.33%). Before this duration, they had well-controlled symptoms with controller treatment and were classified as mild (31.28%), moderate (49.74%), and severe asthma (18.97%). The mean adherence to controller medications of overall children in this study was 98.23%±6.23%.

Table 1 Data on demographic characteristics

Characteristics	Total (n=195)	Types of visits		P value
		In-person (n=112)	Telemedicine (n=83)	
Gender, n (%)				
Male	127 (65.13)	72 (64.29)	55 (66.27)	0.774
Female	68 (34.87)	40 (35.71)	28 (33.73)	
Age (months)				
Mean ± standard deviation	96.46±48.27	95.62±48.05	97.59±48.83	0.779
<12, n (%)	50 (25.64)	28 (25.00)	22 (26.51)	0.920
12 to 60, n (%)	109 (55.90)	64 (57.14)	45 (54.22)	
>60, n (%)	36 (18.46)	20 (17.86)	16 (19.28)	
Comorbidities, n (%)				
Allergic rhinitis	182 (93.33)	105 (93.75)	77 (92.77)	0.786
Atopic dermatitis	7 (3.59)	6 (5.36)	1 (1.20)	0.242
Obstructive sleep apnea	15 (7.69)	7 (6.25)	8 (9.64)	0.423
Asthma severity, n (%)				
Mild	61 (31.28)	33 (29.46)	28 (33.73)	0.815
Moderate	97 (49.74)	57 (50.89)	40 (48.19)	
Severe	37 (18.97)	22 (19.64)	15 (18.07)	
Adherence to controller medications (%, mean ± standard deviation)	98.23±6.23	97.18±7.80	99.64±2.44	0.006

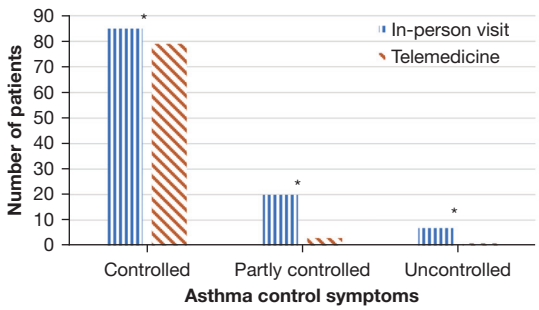

Figure 2 Asthma control in telemedicine compared to the in-person visit group. *, P value =0.001.

From 195 children included in our study, there were 112 children (57.44%) with in-person visits and 83 children (42.56%) using telemedicine (*Figure 1*). Two third of children in both in-person visits and telemedicine were male gender (64.29% and 66.27%; P value =0.774). Children who attended in-person visits and telemedicine follow-up had not statistically significant in mean age, 95.62±48.05 and 97.59±48.83 months, respectively (P value =0.779). Their co-morbidities: allergic rhinitis, atopic dermatitis, and obstructive sleep apnea were presented with no statistical difference in both in-person visit and telemedicine follow-up (P value =0.786, 0.242, and 0.423). Half of children in in-person and telemedicine visits had moderate severity of asthma which not found significant different (P value =0.815). Children who followed up by telemedicine had slightly better mean adherence to controller medications than in-person visits (97.18%±7.80% and 99.64%±2.44%, P value =0.006) (*Table 1*).

Of them, 164 children (84.10%) had well-controlled symptoms. Children who were followed up by telemedicine and in-person visits had well-controlled asthma 79/83 (95.18%) and 85/112 (75.89%), respectively (*Figure 2*). The telemedicine group had more well-controlled asthma symptoms than the in-person visits group adjusted for age, sex, asthma severity, and compliance (aRR: 1.219; 95% CI: 1.062–1.400; P value =0.005).

The asthma exacerbation in the in-person and

telemedicine groups was 5 and 0, respectively (P value =0.073). Of all exacerbations, 3 had visited the emergency room and needed systemic corticosteroids. Only 1 of 3 children who visited the emergency room had been admitted to the hospital.

Discussion

The COVID-19 pandemic has impacted numerous healthcare services. Patients were limited to accessing the physician due to the preventive measures for COVID-19 spreading. These disrupt patients with asthma, a chronic disease requiring a multimodalities approach, such as assessing asthma control and severity, appropriate controller therapy, monitoring for correct usage of medications, environmental controls, and spirometry. Due to this consequence, telemedicine was rapidly implemented to manage asthmatic children worldwide during this period. There are many methods to follow-up on asthmatic patients in developed countries, such as applications, devices, or computers. In our center, a tertiary academic medical center in the northeastern region of Thailand, most pediatric patients have been cared for by elderly caregivers who stay in rural areas and cannot use smartphones. Because of the high expense of internet connection and the fact that many of the guardians were elderly, we conducted telemedicine consultations by telephone instead. Telephones are readily available in all households. Therefore, this is the first study to evaluate the outcome of asthma control among children in a limited-resource country. Although this study is a retrospective study, our clinic had standard follow-up by a checklist of asthma control, so we collected almost all data on asthma control from patients. Our study has shown that telemedicine benefited asthma control noninferiority to in-person follow-up. We have shown that most of our patients had well-controlled asthma. The results were the same as those of a recent systematic review study (15). Although we contacted patients by telephone, the asthma control was similar to video call follow-up in a previous study that was no different in Asthma Control Test (ACT), Childhood Asthma Control Test (C-ACT), and Test for Respiratory and Asthma Control in Kids (TRACK) from usual follow-up children (16). This is probably caused by the reduction in other respiratory tract infections and allergen exposure after the implementation of nonpharmaceutical measures of COVID-19 (17). Although we did not evaluate spirometry due to the COVID-19 pandemic, a previous study in moderate to severe asthmatic adults reported that patients who were followed up with telephone had a higher forced expiratory volume in 1 second (FEV1%) predicted at 6 months (65.2±3.2, 56.5±2.8; P value <0.01) than at the in-person follow-up (18).

This study also found that all children's adherence to controller medication was higher than 90%. This was parallel to a previous study in Jordan that reported improved adherence to medications and spacer use during the COVID-19 pandemic (19). Obviously, the adherence to controller medications in the telemedicine group was higher than that in the in-person group. The excellent adherence to controller medications in the telemedicine group may make our patients have better control of asthma than the others. Another reason may be caregivers' anxiety and fear of severe COVID-19 in asthmatic children (20). This makes them choose to follow-up by telemedicine and adhere to controller medication.

Several factors lessened asthma exacerbation during the COVID-19 pandemic. Due to the fact that our study was not conducted during the rainy season, recent research indicates that rainwater enhances the release of inhalable particles and asthma exacerbation (21). In any case, the incidence of asthma exacerbations in children after the COVID-19 pandemic decreased dramatically from the year before the pandemic, even during the rainfall (22). Our research revealed that only 5 of 195 children experienced asthma exacerbation. In addition, school closures during the COVID-19 pandemic may have reduced the incidence of respiratory tract infections in children, the leading cause of asthma exacerbations (23). In this study, no patients receiving telemedicine follow-up suffered asthma exacerbations, compared to 5 children receiving in-person care. Telemedicine was associated with greater adherence to controller medications than face-to-face groups (7).

There are several limitations to this study. First, this study only focused at telephone telemedicine follow-up, which did not account for the outcome in other instances, such as video conversations or applications that were not extensively used in Thailand. Second, because it was an aerosol-generating operation that was restricted during the COVID-19 pandemic, peak expiratory flow rate and pulmonary function test results were not included. Finally, while the observational duration for this research is brief due to the timeframe of telemedicine, future studies should compare whole-year data and analyze spirometry after telemedicine follow-up.

Conclusions

Telemedicine follow-up in previously well-controlled asthmatic children helped to control their asthma symptoms. The number of asthma exacerbations among telemedicine patients was lower than in in-person visits. Telemedicine in asthmatic children may help maintain symptom control throughout the COVID-19 epidemic and should be considered as a new normal in certain families, particularly when in-person visits are not possible.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://tp.amegroups.com/article/view/10.21037/tp-22-287/rc

Data Sharing Statement: Available at https://tp.amegroups.com/article/view/10.21037/tp-22-287/dss

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://tp.amegroups.com/article/view/10.21037/tp-22-287/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Center for Ethics in Human Research, Khon Kaen University's institutional review board (No. HE641327). Informed consent was waived by the Center for Ethics in Human Research, Khon Kaen University since this study did not involve personal identifiable data.

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