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ORIGINAL RESEARCH

Adherence to Pediatric Asthma Guidelines in Children with Asthma Exacerbation at the Emergency Department

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Purpose: Pediatric asthma exacerbation guidelines were implemented in the emergency department (ED) of the Songklanagarind Hospital in March 2021. The primary outcome was physician adherence to the guideline. Secondary outcomes included comparisons of selected ED quality indicators.

Patients and Methods: This single-center retrospective before–after study included children aged <15 years who presented with asthma exacerbation at the ED. Data were collected before guideline implementation (January 1, 2020, to February 28, 2021) and after implementation (March 1, 2021, to December 31, 2022). Guideline adherence was described as proportions. Between-period comparisons were analyzed using multivariable logistic regression to estimate odds ratios with 95% confidence intervals (CI).

Results: A total of 313 pediatric patients met the inclusion criteria with 135 and 178 patients in the pre-and post-guideline groups, respectively. Overall adherence to the guidelines was approximately 42.1%. After implementation, patients were more likely to have scheduled outpatient follow-up on the next calendar business day (adjusted OR 4.82, 95% CI 2.33–10.38) and less likely to be admitted to the hospital (adjusted OR 0.30, 95% CI 0.11–0.76).

Conclusion: Following the introduction of the guidelines in the ED, physician adherence was partial and was associated with significant improvements in some aspects of care quality. Ongoing review, feedback, education, and monitoring of time-sensitive care processes may help sustain and further improve the care of children with asthma exacerbations.

Keywords: asthma, exacerbation, children, guideline adherence, emergency

Introduction

Asthma is a chronic inflammatory disease of the airways characterized by recurrent episodes of airflow obstruction caused by airway edema, bronchospasm, and increased mucus production.[1] It is defined by a history of respiratory symptoms, such as wheezing, shortness of breath, chest tightness, and cough, which vary in frequency and intensity accompanied by variable expiratory airflow limitation.[2] Exacerbations represent episodes of symptoms and lung function worsening that often require urgent medical intervention.[2] Acute asthma exacerbations are commonly managed in emergency departments (EDs).[3] Standard treatments include oxygen supplementation, inhaled beta$_2$-agonists and anticholinergics,[4] systemic and/or inhaled corticosteroids,[5–7] and terbutaline in severe cases.[8,9]

A 2012 study demonstrated that implementing an asthma management protocol in a pediatric ED improves adherence to national guidelines and increases the efficiency of bronchodilator and corticosteroid administration. These improvements can potentially lead to reduced hospital admissions, time to clinical improvement, incidence of respiratory failure, and ED length of stay.[10] Therefore, adherence to evidence-based pediatric asthma guidelines in emergency settings is clinically important because delayed or suboptimal management may be associated with increased intensive care unit admissions, morbidity, and mortality.

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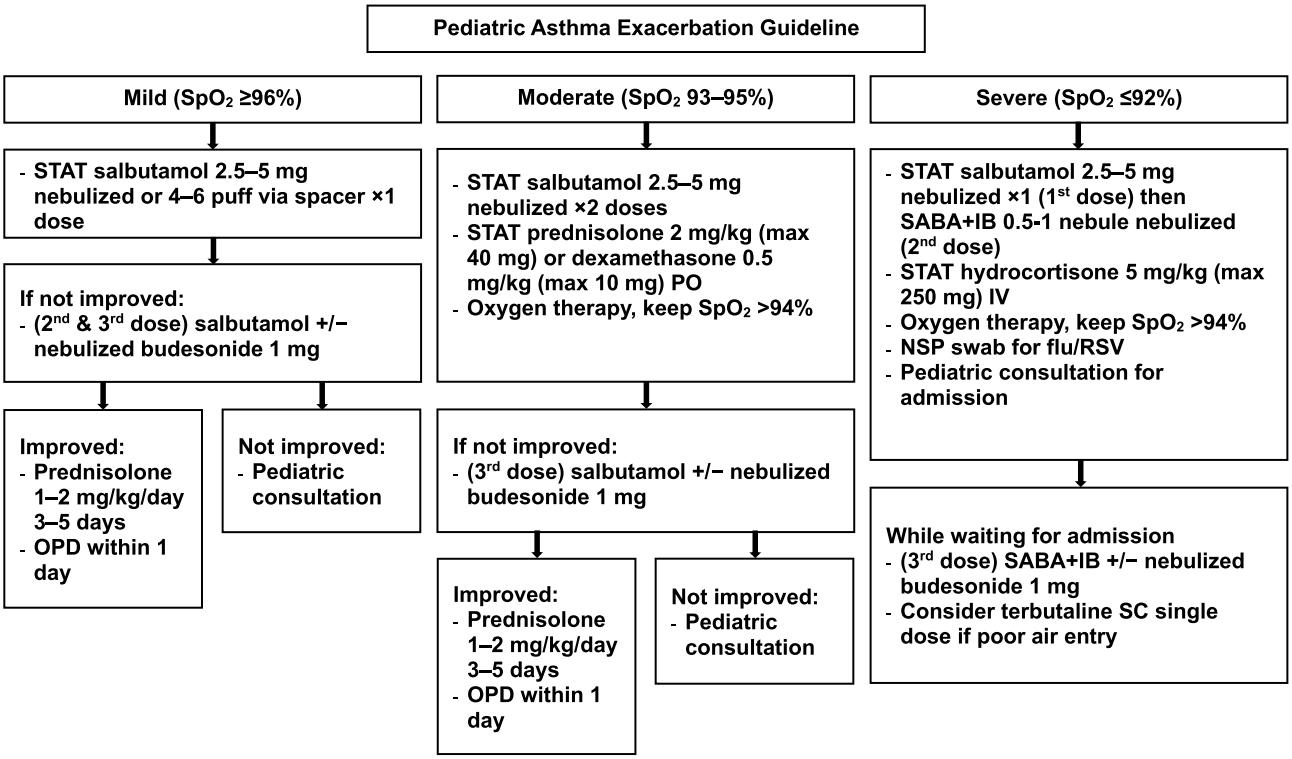

Figure 1 Songklanarind Pediatric Asthma Exacerbation Guidelines.

The ED of Songklanagarind Hospital, a university-affiliated teaching hospital in Hat Yai, Songkhla Province, Thailand, manages approximately 50,000 patient visits annually, including about 7,500 pediatric patients ≤15 years of age, and is staffed by attending emergency physicians and emergency medicine residents. Management of asthma exacerbation in children had previously relied on individual physician judgment, leading to inconsistencies in care. These included delayed corticosteroid administration, untimely pediatric consultations, and lack of scheduled outpatient follow-up.

To standardize care and enhance treatment quality for pediatric patients with asthma exacerbations, guidelines were implemented in 2021. These guidelines were adapted from established international recommendations, including the Global Initiative for Asthma (GINA),[2] as well as national guidelines from the Royal College of Pediatricians of Thailand,[11] to better suit the local hospital context. For example, asthma exacerbation severity was assessed using oxygen saturation alone to classify mild, moderate, and severe exacerbations, allowing rapid initiation of appropriate emergency treatment. The timing of outpatient follow-up was shortened from 1–2 weeks to the next calendar business day to allow earlier assessment of treatment response (Figure 1).

Following the implementation of these adapted guidelines, this study primarily evaluated adherence to pediatric asthma guidelines, with secondary outcomes including comparisons of ED care quality metrics, such as revisit rates, follow-up appointments, hospital admissions, and ED length of stay, before and after guideline implementation.

Materials and Methods

Study Design and Setting

This single-center retrospective before–after study was conducted in the ED of Songklanagarind Hospital, Thailand.

Study Population and Eligibility Criteria

The study included children aged ≤15 years with a known history of asthma or prior use of corticosteroids or montelukast for 4–12 weeks who presented to the ED with asthma exacerbation, defined as acute dyspnea requiring an inhaler or

nebulization. The exclusion criteria comprised patients with other chronic respiratory diseases, those with a final diagnosis other than asthma exacerbation, those referred from other hospitals, those who received partial treatment by medical providers prior to ED arrival, and those with incomplete medical records who were missing key variables required for outcome assessment.

Study Period and Guideline Implementation

Data were collected during two periods: the pre-guideline period (January 1, 2020 to February 28, 2021) and the post-guideline period (March 1, 2021 to December 31, 2022). The pediatric asthma guideline was formally implemented on March 1, 2021, following a brief period of review and training for physicians and nurses approximately 1 week prior to implementation. No formal wash-in period was applied, and all ED visits occurring after the launch date were classified as post-guideline. The post-guideline period was longer than the pre-guideline period because the early post-guideline phase coincided with the COVID-19 pandemic, during which ED visit volumes were substantially reduced. Extending the post-guideline period was therefore necessary to ensure an adequate sample size and stable estimates of guideline adherence and clinical outcomes.

Data Collection and Variables

Data were obtained from routinely documented electronic medical records, including triage, physician notes, and medication administration records. The collected variables included chief complaints, triage time, level of treating physician, treatment modalities, time from triage to medication (defined as the interval between the triage timestamp and the documented time of medication administration recorded in the ED medical chart), diagnosis, pediatric consultation, ED length of stay, discharge medications, and follow-up appointments.

Cases were identified from electronic medical records using predefined ICD-10 codes related to asthma and wheezing (T48.6, Y55.6, J45.x, and R06.2). All consecutive ED visits meeting the inclusion criteria during the study periods were screened. Eligibility and guideline adherence were assessed using predefined, objective clinical data routinely recorded in the medical records, including oxygen saturation at triage, timing of medication administration, and discharge prescriptions. Data were obtained from routinely documented ED records, including triage, physician notes, and medication administration records.

Triage and Severity Classification

Upon arrival at the ED, all patients were triaged by trained triage nurses. Vital signs, including oxygen saturation (SpO_2), were measured using pulse oximetry on room air before initiation of treatment. Asthma exacerbation severity was classified based on the initial SpO_2 values according to the institutional guideline (Figure 1) as mild (≥96%), moderate (93–95%), or severe (≤92%). Treating physicians subsequently provided management directions according to the assigned severity category.

Charts were reviewed and data abstracted by two physician investigators with experience in pediatric asthma guidelines. The first investigator abstracted all data from the electronic medical records using a standardized data collection form applied uniformly to all study patients. The second investigator reviewed all completed forms to ensure accuracy and completeness. Any discrepancies were resolved by consensus. Inter-rater reliability was not calculated because data abstraction was not independently performed by multiple reviewers. Data abstraction was not blinded to the study period; however, adherence assessment was based exclusively on predefined, objective, and time-stamped clinical variables.

Outcome Definitions

Primary Outcome

The primary outcome was physician adherence to the pediatric asthma guidelines in the post-guideline period, evaluated based on the following severity-specific criteria (Figure 1):

1. Mild exacerbation: Adherence was defined by meeting all of the following:

   a. Administration of the first inhaled or nebulized salbutamol within 1 h after triage;
   b. Prescribed a short course of systemic corticosteroids upon discharge (3–5 d of oral prednisolone or 1–2 d of oral dexamethasone);
   c. Scheduled follow-up appointments at the pediatric outpatient clinic on the next calendar business day for patients discharged from the ED.
2. Moderate exacerbation: Adherence was defined by meeting all of the following:
   a. Administration of the first nebulized salbutamol within 1 h after triage;
   b. Administration of systemic or nebulized corticosteroids within 1 h after triage in the ED, followed by a short course of systemic corticosteroids upon discharge;
   c. Oxygen supplementation provided to hospitalized patients to maintain oxygen saturation above 94%;
   d. Scheduled follow-up appointments at the pediatric outpatient clinic on the next calendar business day for patients discharged from the ED.
3. Severe exacerbation: Adherence was defined by meeting all of the following:
   a. Administration of the first nebulized salbutamol within 1 h after triage;
   b. At least one dose of the combination of salbutamol and ipratropium bromide administered;
   c. Intravenous corticosteroids administered within 1 h after triage;
   d. Oxygen supplementation provided after initial bronchodilator therapy to maintain oxygen saturation above 94%;
   e. Pediatric team consultation for hospital admission or referral to another hospital.

Patients were considered adherent if all the criteria for their severity levels were fulfilled. Any missing criteria were classified as non-adherence.

Secondary Outcomes

The secondary outcomes included comparisons of the following quality indicators between the pre- and post-guideline periods:

1. Administration of first bronchodilator within 1 h after triage;
2. Administration of systemic or nebulized corticosteroids within 1 h in moderate to severe cases;
3. Prescription of short-course systemic corticosteroids;
4. ED length of stay within 2 h;
5. Scheduled outpatient follow-up on the next calendar business day only for patients discharged from the ED;
6. Unscheduled revisit within 72 h;
7. Hospital admission rate.

Sample Size Estimation

The sample size was estimated a priori based on a previous study,[10] which reported post-protocol adherence to guideline-recommended treatments ranging from 54% to 87%. An expected adherence rate of 85% was used to estimate the primary outcome. Assuming a 10% absolute precision, the minimum required sample size was 54 patients.

For secondary outcomes, the estimation was informed by prior data[10] demonstrating an increase in bronchodilator administration from approximately 60% in the pre-protocol period to 77% in the post-protocol period. Using a two-sided α of 0.05 and power of 80%, 116 patients were required in each group. After adding 10% for incomplete data, the required sample size was 128 patients per group, which exceeded that of the primary outcome.

Statistical Analysis

Data were analyzed using R version 4.5.0. Continuous variables with normal distribution are reported as means with standard deviations and were compared using Student's *t*-test. Non-normally distributed variables are reported as medians with interquartile ranges and were compared using the Wilcoxon rank-sum test. Categorical variables are presented as

frequencies and percentages and were compared using Pearson's chi-square test or Fisher's exact test, as appropriate; Fisher's exact test was used when expected cell counts were small.

Univariable and multivariable logistic regression analyses were performed to examine the association between guideline implementation (post- vs pre-guideline period) and secondary outcomes. The guideline period was included as the main exposure, and models were adjusted for clinically relevant patient- and system-related factors, including age, asthma severity, physician experience level, time of ED visit (shift), business day versus weekend, and pediatric team consultation. Crude and adjusted odds ratios with 95% confidence intervals were reported. A two-sided P-value < 0.05 was considered significant.

Ethical Approval

This study was approved by the Research Ethics Committee of the Faculty of Medicine, Prince of Songkla University (REC. 65–028-20-4). The requirement for informed consent was waived due to the retrospective nature of the study. All medical records were accessed only by the research team and kept confidential, in accordance with the principles of the Declaration of Helsinki.

Results

In total, 313 pediatric patients met the inclusion criteria during the study period after applying the predefined exclusion criteria (Figure 2), with 135 and 178 patients in the pre- and post-guideline groups, respectively. Most patients were men, with a median age of approximately 5 years. Most visited the ED during business days and evening shifts (4:00 PM to midnight). Most patients presented with mild asthma exacerbations and were discharged from the ED without pediatric consultation.

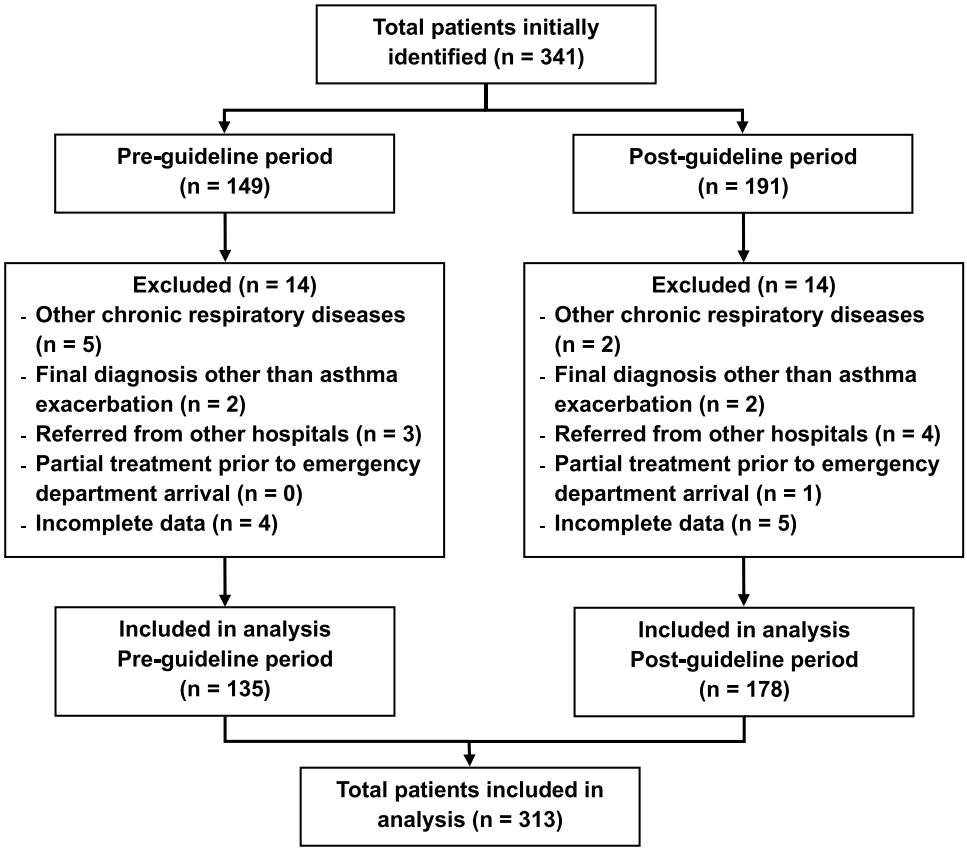

Figure 2 Flow Diagram of Patient Selection.

A notable difference between groups was observed in the level of treating physicians. During the pre-guideline period, most patients were managed by third-year residents. In contrast, during the post-guideline period, the number of third-year residents decreased, leading to a higher proportion of cases being managed by first-year residents (Table 1).

The overall adherence rate to the pediatric asthma exacerbation guidelines in the post-guideline group was 42.1% (75 of 178 cases). Adherence was the highest among patients with mild exacerbations (51.9%) and the lowest among those with severe exacerbations (0%). In the mild group, nonadherence was primarily due to the lack of a scheduled follow-up visit on the next calendar business day. In contrast, nonadherence among patients with moderate and severe exacerbations was mostly attributed to failure to receive corticosteroids within 1 h after triage, which occurred in 72.7% and 66.7% of the cases, respectively (Table 2).

A comparison of patient management before and after implementation of the guidelines is presented in Table 3. In the post-guideline period, patients were more likely to have scheduled outpatient follow-up on the next calendar business day and less likely to be admitted to the hospital compared with the pre-guideline period. Following multivariable adjustment, guideline implementation was associated with higher odds of scheduled follow-up on the next calendar business day (adjusted OR 4.82, 95% CI 2.33–10.38) and lower odds of hospital admission (adjusted OR 0.30, 95% CI 0.11–0.76) (Table 3).

Table 1 Baseline Patient Characteristics

Characteristic	Pre-Guideline 135	Post-Guideline 178	Total 313	P-value
Sex				0.227
Male	82 (60.7)	121 (68.0)	203 (64.9)	
Female	53 (39.3)	57 (32.0)	110 (35.1)	
Age (Years), Median (Interquartile Range)	5 (3, 8)	5.5 (4, 8)	5 (4, 8)	0.531
Visit				0.227
Morning (8.00–15.59)	32 (23.7)	58 (32.6)	90 (28.8)	
Evening (16.00–23.59)	65 (48.1)	75 (42.1)	140 (44.7)	
Night (00.00–07.59)	38 (28.1)	45 (25.3)	83 (26.5)	
Date type				0.606
Business Day	80 (59.3)	115 (64.6)	195 (62.3)	
Weekend	43 (31.9)	48 (27.0)	91 (29.1)	
Holiday	12 (8.9)	15 (8.4)	27 (8.6)	
Severity of Exacerbation				0.186
Mild	104 (77.0)	131 (73.6)	235 (75.1)	
Moderate	25 (18.5)	44 (24.7)	69 (22.0)	
Severe	6 (4.4)	3 (1.7)	9 (2.9)	
Physicians				
Intern	5 (3.7)	2 (1.1)	7 (2.2)	0.145
Resident 1	7 (5.2)	29 (16.3)	36 (11.5)	0.004
Resident 2	37 (27.4)	58 (32.6)	95 (30.4)	0.388
Resident 3	86 (63.7)	87 (48.9)	173 (55.3)	0.012
Attending	0 (0)	2 (1.1)	2 (0.6)	0.508
Pediatric Consultation				0.246
Yes	55 (40.7)	60 (33.7)	115 (36.7)	
No	80 (59.3)	118 (66.3)	198 (63.3)	

Notes: P-values were calculated using Student's *t*-test or Wilcoxon rank-sum test for continuous variables and chi-square or Fisher's exact test for categorical variables, as appropriate.

Table 2 Adherence to the Pediatric Asthma Exacerbation Guideline

Severity and Criteria	Adherence N (%)	Non-Adherence N (%)
Mild exacerbation (N = 131)		
First bronchodilator within 1 h (N = 131)	130 (99.2%)	1 (0.8%)
Steroids before discharge (N = 111)[a]	97 (87.4%)	14 (12.6%)
Follow up in 1 day (N = 111)[a]	74 (66.7%)	37 (33.3%)
Overall adherence	68 (51.9%)	63 (48.1%)
Moderate exacerbation (N = 44)		
First bronchodilator within 1 h (N = 44)	44 (100%)	0 (0%)
Steroids within 1 h (N = 44)	12 (27.3%)	32 (72.7%)
Steroids before discharge (N = 26)[a]	21 (80.8%)	5 (19.2%)
Oxygen therapy before admission (N = 18)[b]	13 (72.2%)	5 (27.8%)
Follow up in 1 day (N = 26)[a]	17 (65.4%)	9 (34.6%)
Overall adherence	7 (15.9%)	37 (84.1%)
Severe exacerbation (N = 3)		
First bronchodilator within 1 h (N = 3)	3 (100%)	0 (0%)
Ipratropium bromide use (N = 3)	2 (66.7%)	1 (33.3%)
IV steroids within 1 h (N = 3)	1 (33.3%)	2 (66.7%)
Oxygen therapy before admission (N = 3)	2 (66.7%)	1 (33.3%)
Pediatric consultation	2 (66.7%)	1 (33.3%)
Overall adherence	0 (0%)	3 (100%)
Total (N = 178)	75 (42.1%)	103 (57.9%)

Notes: [a]Discharge-related outcomes (steroids before discharge and follow-up on the next calendar business day) were calculated only among patients discharged from the ED. [b]Oxygen therapy outcomes were calculated only among hospitalized patients. Percentages were calculated using the number of eligible patients for each outcome as the denominator.

Table 3 Comparison of Patient Data Before and After Guideline Implementation

	Pre-Guideline N = 135	Post-Guideline N = 178	P-value	Crude OR (95% CI)	Adjusted OR (95% CI)
Bronchodilator within 60 min after triage	132 (97.8)	177 (99.4)	0.319	4.02 (0.51,81.82)	5.47 (0.66,114.63)
Bronchodilator within 30 min after triage	122 (90.4)	159 (89.3)	0.909	0.89 (0.42,1.86)	1.12 (0.49,2.49)
Corticosteroids within 60 min after triage in moderate to severe exacerbation	13 (41.9)	12 (25.5)	0.283	0.52 (0.18,1.47)	0.65 (0.19,2.23)
Systemic corticosteroids across all severities	115 (85.2)	155 (87.1)	0.752	1.17 (0.61,2.24)	1.17 (0.59,2.29)
ED length of stay within 120 min	59 (43.7)	72 (40.4)	0.644	0.87 (0.56,1.38)	0.64 (0.36,1.11)
Follow-up scheduled on the next calendar business day	31 (35.2)	92 (66.7)	<0.001	3.83 (1.97,7.58)	4.82 (2.33,10.38)
ED revisit within 72 h	2 (1.5)	7 (3.9)	0.309	2.72 (0.65,18.47)	3.28 (0.69,25.8)
Admission rate	47 (34.8)	40 (22.5)	0.022	0.54 (0.33,0.89)	0.3 (0.11,0.76)

Notes: Univariable and multivariable logistic regression analyses were used for all outcomes. Crude and adjusted odds ratios with 95% confidence intervals are reported.

Discussion

Following the implementation of the pediatric asthma guidelines in the ED of Songklanagarind Hospital, the overall adherence rate was 42.1%. This relatively low rate may reflect challenges associated with introducing the first local

protocol at the institution, as the shift from individualized to protocol-based care likely resulted in unfamiliarity among physicians during the initial implementation phase.

A similar adherence rate was reported in a 2021 study from the United States, where pediatric EDs followed national asthma guidelines in only 42% of cases and general EDs in 31%.[12] Several factors may explain the lack of adherence. A study in Saudi Arabia categorized contributing factors into three domains: organizational issues (eg., staffing and bed shortages), protocol-related factors (eg., lack of dissemination or clear implementation strategies), and provider-related factors (eg., lack of familiarity or disagreement with recommendations).[13] Understanding these factors is essential to develop strategies to enhance adherence.

A potential confounding factor in this study was the shift in physician experience levels between the pre- and post-guideline periods. In the post-guideline phase, a higher proportion of patients were managed by first-year residents, whereas the proportion managed by third-year residents decreased (Table 1). This physician-level shift likely biased time-sensitive outcomes, particularly time to corticosteroid administration, toward longer delays. Consequently, the lack of improvement in corticosteroid administration within 1 h after triage may partially reflect this confounding effect rather than true ineffectiveness of the guideline itself. The impact of this bias is likely small to moderate, as other time-sensitive measures, such as bronchodilator administration, remained high in both periods. This interpretation is supported by a recent Japanese study in 2024 showed that emergency care delivered by less experienced physicians was associated with longer times to assessment and prolonged ED stays compared to care provided by specialists or more experienced nonspecialists.[14]

Another confounding factor during our study period was the COVID-19 pandemic. Changes in routine ED practice included extended time to perform PPE, need for isolation rooms for respiratory cases, and limitations on nebulized treatments, which may have delayed timely care. Similar patterns of delayed investigation and treatment during the COVID-19 pandemic have been reported for other medical emergencies, including sepsis, stroke, and acute coronary syndrome.[15–17] This external factor may have confounded the interpretation of the post-guideline improvements.

In this study, patients with mild asthma exacerbation demonstrated the highest adherence rate (51.9%), likely because mild cases comprised the majority (73.6% of all cases in the post-guideline period). These cases were more familiar to physicians, involved simpler management, and were generally less time-sensitive than more severe cases. For instance, the administration of corticosteroids within 1 h after triage is not required for mild cases but is essential for moderate-to-severe exacerbations, which can be difficult to achieve in a crowded ED. A study from the University of California also found that ED crowding was significantly associated with delayed corticosteroid administration in children with moderate to severe asthma exacerbations.[18]

The implementation of the guidelines was associated with significant improvements in two aspects of ED quality of care: the rate of outpatient follow-ups on the next calendar business day and lower hospital admission rates. Early follow-ups provide an opportunity to assess treatment effectiveness and reinforce medication adherence and proper inhaler technique.[2] A similar reduction in admission rates was reported in a previous study from the United States, which showed that children with asthma exacerbations treated by ED physicians with lower adherence to the guidelines had higher admission rates, longer ED length of stay, and increased healthcare costs. However, following the implementation of interventions to improve guideline adherence, such as provider education, audits, and feedback, along with efforts to support patient compliance, the admission rates significantly decreased after 1 year.[19] However, given the retrospective observational design of this study, causal relationships between guideline implementation and these improvements could not be definitively established.

Other outcomes, such as bronchodilator administration within 1 h after triage (or even within 30 min) and 72-h revisit rates, did not significantly change, likely because performance in these areas was already high prior to the implementation of the guidelines. However, time-sensitive aspects of care, such as corticosteroid administration within 1 h, did not improve. This may reflect system-level limitations, including ED crowding, varying levels of staff experience, and external factors, such as inpatient bed availability or referral processes. A previous study conducted at Songklanagarind Hospital found that failure to administer corticosteroids during ED visits or prescribing them only at discharge was associated with an increased risk of unscheduled ED revisits within 72 h.[20] Additionally, a Canadian study demonstrated that administering systemic corticosteroids within 75 min of triage significantly reduced hospital admission rates and

shortened the duration of active treatment by approximately 0.7 h in children with moderate to severe asthma exacerbations.[21] These findings reinforce the importance of timely corticosteroid administration to improve the outcomes of pediatric patients with asthma.

Despite the high pre-guideline rate of systemic corticosteroid prescription (85.2%), this only marginally increased post-guideline (87.1%, aOR 1.17, 95% CI 0.59–2.29). This indicates the need for further improvement as the GINA guidelines recommend prescribing systemic corticosteroids for all asthma exacerbations to accelerate recovery and reduce the risk of relapse.[2]

To address these gaps, several targeted quality improvement interventions may be considered. These include structured asthma-focused educational sessions for junior residents at the beginning of each ED rotation, implementation of standardized asthma management checklists embedded in the electronic medical record, and process-level changes such as nurse-initiated corticosteroid order sets for moderate-to-severe exacerbations. Real-time audit and feedback systems tracking time to medication administration may help sustain improvements in time-sensitive care.

This study had some limitations. First, it was conducted in the ED of a single hospital, which may limit the generalizability of the findings. Future multicenter studies involving EDs from different hospitals are needed to confirm these results.

Second, as a retrospective analysis, the study may be subject to selection and information biases, including incomplete documentation and the evolving clinical knowledge of the physicians. Although the overall sample size exceeded a priori estimates, some secondary outcomes were only relevant for a relatively small numbers of patients. For example, analyses of corticosteroid administration within 1 h among patients with moderate to severe exacerbations were based on small subgroup counts in both the pre-guideline and post-guideline periods (Table 3), which may have limited the statistical power to detect modest between-group differences. In addition, we did not examine individual- or physician-level predictors of guideline adherence, which should be explored in future studies with larger sample sizes.

Third, differences in physician experience levels between the pre- and post-guideline periods represent a potential confounding factor that may have influenced time-sensitive care processes. Finally, the COVID-19 pandemic introduced several public health measures, including lockdowns, remote learning, social distancing, frequent handwashing, and widespread use of surgical masks, which led to a noticeable reduction in pediatric visits for acute respiratory complaints, including asthma exacerbations. After the situation stabilized in 2022 and children resumed normal activities, the number of ED visits increased substantially. These fluctuations in patient volume may have introduced additional confounding and influenced both the study methodology and data collection. However, a specific pandemic-period indicator was not available in the dataset and therefore could not be included in the regression models; residual confounding related to pandemic-related changes may remain.

Conclusion

The rate of adherence to the pediatric asthma guidelines was approximately 42.1%. Guideline implementation was associated with significant improvements in scheduled outpatient follow-up appointments and lower hospital admission rates. Although causal inference is limited, structured guideline implementation may contribute to more timely care and a reduced need for inpatient visits. To strengthen causal inference, future studies should aim to analyze larger samples and include more comprehensive adjustment. Regular medical record reviews, constructive feedback, continuous education, and ongoing monitoring of time-sensitive care processes are essential to sustain quality improvements in the care of children with asthma exacerbations.

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Disclosure

The authors report no conflicts of interest in this work.

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