Journal of Asthma and Allergy

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

Implementation of an Institutional Asthma Care Guideline in Hospitalized Children: Effects on Clinical Outcomes and Healthcare Resource Utilization

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Background: Acute asthma exacerbations are a major cause of pediatric hospitalization and healthcare utilization. Despite the availability of standard guidelines, variability in inpatient management persists and may affect both clinical outcomes and resource use.

Objective: To evaluate the impact of an institutional inpatient asthma care guideline on treatment processes, clinical outcomes, and hospitalization costs in children.

Methods: This retrospective quality improvement cohort study included children aged 1–15 years hospitalized for acute asthma between 2016 and 2024. Patients were categorized into three phases: pre-implementation, post-implementation, and post-revision. The institutional guideline standardized bronchodilator escalation, respiratory support, and discharge planning, and was implemented using Plan–Do–Study–Act (PDSA) cycles.

Results: A total of 220 children were included. Compared across the three phases, time to first bronchodilator decreased significantly (117 vs 104 vs 70 minutes, $P < 0.001$), with increased use of selected interventions, including nebulized steroids and high-flow nasal cannula (both $P < 0.001$). Differences in 24-hour clinical respiratory score reduction were observed across study phases, with adjusted analyses demonstrating greater improvement following guideline implementation. However, resource utilization increased after implementation, with longer hospital length of stay (47.5 vs 58.6 vs 67.3 h, $P = 0.004$) and higher hospitalization costs (249.7 vs 460.6 vs 447.0 USD, $P < 0.001$).

Conclusion: Implementation of an institutional asthma care guideline was associated with improved treatment timeliness and early clinical improvement but was also associated with increased length of stay and hospitalization costs, suggesting a trade-off between clinical management and resource utilization.

Keywords: acute asthma, pediatric, clinical practice guideline, inpatient management, pre–post intervention study

Introduction

Asthma exacerbation (AE) is one of the leading cause of emergency visits and hospitalizations in pediatric practice worldwide[1] and also associated with significant morbidity and, in severe cases, may result in respiratory failure or death if not promptly and appropriately managed.[2] Many international and national evidence-based guidelines[3,4] similarly provide recommendations for the management of pediatric AE, focusing on prompt initiation of oxygen therapy, bronchodilators, and systemic corticosteroids for hospitalized patients with exacerbations. Despite the availability of such guidelines, translating recommendations into routine inpatient practice remains challenging. Previous studies and systematic reviews have demonstrated considerable variation across institutions in the assessment of disease severity, escalation of bronchodilator therapy, and use of respiratory support.[2] This variability may be associated with differences in clinical outcomes and resource use, including hospital length of stay and costs.

https://doi.org/10.2147/JAA.S605374
Received: 9 March 2026
Accepted: 8 June 2026
Published: 15 June 2026

Several studies from high-income settings have shown that institutional implementation of clinical pathways or standardized protocols can improve care delivery. Johnson et al[5] reported reductions in hospital length of stay, intensive care utilization, and treatment costs following implementation of a standardized asthma protocol. Similarly, a multicenter analysis by Kaiser et al[6] demonstrated reductions in hospital stay, costs, and unnecessary medication use. Despite these findings, important gaps remain. The evidence on the real-world impact of institutional guidelines in middle-income or resource-constrained settings remains limited. In particular, data evaluating both clinical outcomes and healthcare resource utilization, including hospitalization costs, are still insufficient.

At Songklanagarind Hospital, prior to 2021, inpatient asthma management was largely based on individual physician experience, with limited standardization or systematic documentation of care processes, clinical outcomes, or costs. To address this gap, the hospital introduced the "PSU Hospitalized Asthma Exacerbation Care Guideline" in 2021, adapted from national recommendations to better fit the local clinical context. The guideline focused on standardizing key aspects of care, including severity assessment using standardized scoring system, stepwise adjustment of bronchodilator therapy, and criteria for escalation of respiratory support. It also incorporated structured monitoring by nursing staff and a discharge process that included an asthma action plan and follow-up arrangements. The guideline has been continuously monitored and refined, with a major update in 2023 based on implementation experience and quality improvement feedback.

This study aimed to evaluate the impact of an institutional inpatient asthma care guideline on the quality of care and resource utilization among hospitalized children with asthma exacerbation.

The primary objective was to assess changes in specific clinical outcomes. Secondary outcomes included hospital length of stay (LOS), Intensive care unit (ICU) admission, and direct hospitalization costs. The findings may inform quality improvement efforts and guide optimization of pediatric asthma care in similar settings.

Materials and Methods

This study was conducted at Songklanagarind Hospital in Southern Thailand. The hospital provides pediatric inpatient services, including general wards, pediatric ICU and moderate respiratory care unit (PMCU) which is capable of caring for patients requiring advanced respiratory care eg high-flow nasal cannula (HFNC) therapy. Pediatric patients are managed all day and night by board-certified pediatricians—such as pediatric pulmonologists and intensivists—and pediatric residents under supervision. A team of nurses trained in asthma care is also involved in the management of children hospitalized with asthma exacerbations. All clinical data are documented in an electronic medical record (EMR) system, which allows for standardized and comprehensive data retrieval.

Study Design and Population

This study was a retrospective quality improvement study. We included pediatric patients aged 1 to 15 years who were hospitalized with a diagnosis of asthma exacerbation between 2016–2024. Eligible patient encounters were identified based on hospital number and discharge diagnosis of asthma according to ICD-10 codes. Encounters associated with alternative diagnoses that could potentially confound the clinical presentation—such as foreign body aspiration, anaphylaxis, acute laryngotracheobronchitis, or viral croup—were excluded from the study. Manual review was done for all eligible patients to confirm having a physician-diagnosed asthma or a history of receiving continuous inhaled corticosteroid (ICS) therapy as controller for at least 3 months. For children aged <5 years, the diagnosis of asthma was based on clinical criteria included recurrent episodes of wheezing or respiratory distress responsive to bronchodilator therapy, with exclusion of alternative diagnoses. Supportive features, such as a history of atopy or asthma in first-degree relatives, were also considered.[4]

Patients were excluded if they had any of the following comorbidities: congenital heart disease, chronic lung disease, cerebral palsy, severe developmental delay with feeding difficulties, primary or secondary immunodeficiency, chromosomal abnormalities, or syndromic disorders. In addition, patients who discharged and referred for follow-up at other hospitals were excluded due to the inability to assess final outcomes. Finally, all eligible encounters were consecutively screened, and only the first admission per patient was included in the analysis.

The study compared three time periods corresponding to phases of guideline implementation: pre-implementation (2016–2021), post-implementation (2021–2023), and post-revision (2023–2024).

Intervention: PSU Hospitalized Asthma Exacerbation Care Guideline

The PSU Hospitalized Asthma Exacerbation (AE) Guideline was developed based on the 2020 Thai National Asthma Guideline and adapted for local inpatient practice. The guideline focused on standardizing key components of acute asthma management, including severity assessment, bronchodilator therapy, escalation of respiratory support, and discharge planning.

Upon admission, patients were assessed using a clinical respiratory score (CRS) shown in Table 1, which was a validated scoring system for acute respiratory failure[7] and used to guide treatment decisions and monitor response to therapy. The CRS evaluates six clinical domains (Table 1): respiratory rate, oxygen saturation on room air (SpO_2), general condition, accessory muscle use, skin color, and auscultatory findings from the lungs. Based on the total score, asthma exacerbation severity was categorized as mild (CRS 0–3), moderate (CRS 4–7), and severe (CRS 8–12).

Bronchodilator treatment followed a stepwise approach, starting with intermittent short-acting beta-agonists (SABA), escalating to more frequent dosing or combination therapy with ipratropium bromide, and progressing to continuous nebulization in more severe cases. Bronchodilator weaning was protocolized based on clinical improvement, with gradual extension of dosing intervals and de-escalation of respiratory support once CRS improved and remained stable.

Escalation to advanced respiratory support such as HFNC, non-invasive ventilation or intubation with mechanical ventilation was guided by clinical severity and CRS. Nursing assessments were standardized, with CRS reassessed at regular intervals (every 4–6 hours or more frequently if clinically indicated), and treatment adjustments were made according to predefined CRS-based thresholds.

This guideline was implemented in 2021 and subsequently refined in 2023 to optimize bronchodilator weaning and escalation protocols based on local practice experience. The 2023 revision introduced more explicit criteria for bronchodilator escalation and weaning compared with the initial 2021 version, including clearer thresholds for transitioning between intermittent and continuous nebulization, and more structured guidance for respiratory support initiation and de-escalation. A detailed version of the institutional asthma care guideline, including specific treatment algorithms, escalation and weaning criteria, and respiratory support protocols, is provided in the Supplementary Material (Supplementary Table S1).

The guideline was implemented within a quality improvement framework and underwent periodic review to ensure feasibility and adherence in routine clinical practice. Key areas targeted during implementation included standardizing clinical assessment, bronchodilator escalation and weaning, and criteria for initiation of respiratory support. The underlying drivers of care variation and corresponding change strategies are summarized in Figure 1. These efforts aimed to reduce variability in care delivery and improve overall consistency of inpatient asthma management.

Table 1 Clinical Respiratory Score

Clinical Respiratory Score (CRS)			
	0	**1**	**2**
Respiratory rate	<1 year ≤50/min 1–5 years ≤40/min >5 years ≤30/min	<1 year = 50–60/min 1–5 years = 40–50/min >5 years = 30–40/min	<1 year ≥60/min 1–5 years ≥50/min >5 years ≥40/min
SpO_2 (room air)	≥ 95%	90–94%	<90%
General condition	Active	Irritable	Lethargic
Accessory muscle use	• Mild/no use of accessory muscles • Mild to no retractions or nasal flaring on inspiration	• Mild to moderate use of accessory muscles, nasal flaring • Moderate intercostal retractions	• Severe intercostal and substernal retractions, nasal flaring
Skin color	Pink	Pale	Cyanosis
Lung signs	• Good air movement, minimal expiratory wheezing or crepitation	• Depressed air movement • Inspiratory and expiratory wheezes or rales/crackles	• Diminished or absent breath sounds • Severe wheezing or rales/crackles or markedly prolonged expiration
Total score = 0–12 (Mild: 0–3, Moderate: 4–7, Severe: 8–12)			

Abbreviations: CRS, clinical respiratory score; SpO_2, peripheral oxygen saturation.

https://doi.org/10.2147/JAA.S605374

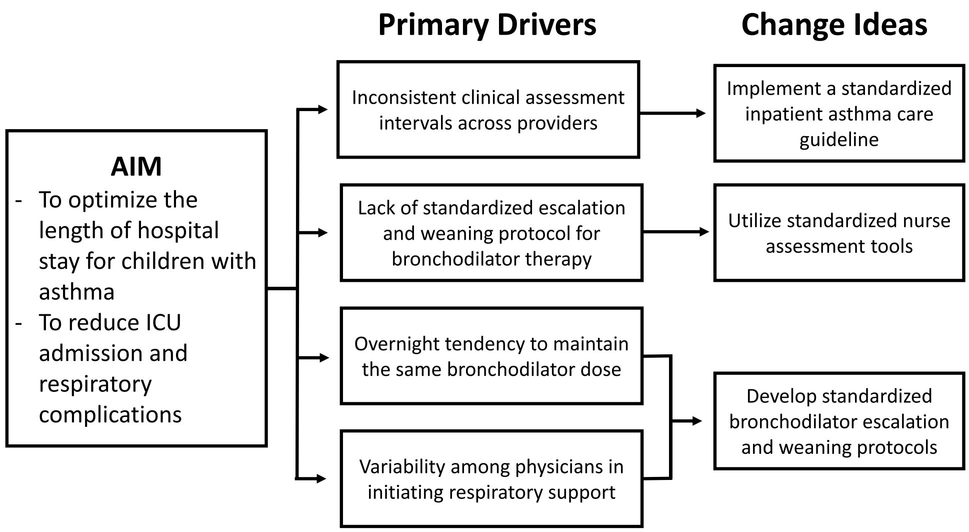

Figure 1 Driver diagram for hospitalized asthma exacerbation care guideline development.

Measures and Outcomes

To evaluate the effectiveness of the pediatric asthma care guideline, both outcome and process measures were assessed. The primary outcome was the reduction in the 24-hour CRS.

The CRS was recorded at two time points—at hospital admission and again at 24 hours post-admission—to assess changes in respiratory status following guideline implementation. CRS was routinely recorded as part of standard clinical assessment during hospitalization, using a standardized scoring system applied consistently across study periods. Nursing staff were trained to perform CRS assessment as part of routine monitoring.

The secondary outcomes included hospital length of stay (LOS), recorded in hours; ICU admission and the 30-day morbidity, which was defined as any revisit to the emergency department, outpatient department, or unplanned hospital readmission within 30 days following discharge; and hospitalization cost per admission. Hospitalization cost was derived from hospital billing records and represented the total cost per admission. This included room and board charges, medications administered during hospitalization, discharge medications, medical supplies, diagnostic investigations, medical equipment use (eg, high-flow nasal cannula or mechanical ventilation), and nursing service fees.

All data were collected retrospectively through systematic review of electronic medical records.

Data Analysis

This study was conducted as a retrospective quality improvement study using routinely collected clinical data. All patients who met the inclusion criteria during the study period were included; therefore, no formal sample size calculation was performed.

Descriptive statistics were used to summarize demographic and clinical characteristics. Continuous variables are presented as medians with interquartile ranges (IQR), while categorical variables are reported as frequencies and percentages.

Comparisons across the three study groups (pre-implementation, post-implementation, and post-revision) were performed using the Kruskal–Wallis test for continuous variables and the Chi-square test or Fisher's exact test for categorical variables, as appropriate. When overall differences among the three groups were statistically significant, post-hoc pairwise comparisons with Bonferroni correction were performed.

In addition, adjusted analyses were performed for key outcomes, including reduction in 24-hour CRS, length of hospital stay, and hospitalization cost, controlling for age, initial respiratory score, and viral identification status. Quantile regression models were used to estimate adjusted associations for continuous outcomes because several outcome variables demonstrated non-normal distributions. A two-sided p-value of <0.05 was considered statistically significant.

As this was an observational pre–post study, the findings should be interpreted as associations rather than causal effects. There were minimal missing data, and complete case analysis was applied.

All analyses were performed using R software version 4.5.0. Trends in clinical outcomes were visualized using line graphs. These visualizations illustrated temporal changes across the pre- and post-intervention periods and were generated to support the interpretation of longitudinal data.

Ethical Considerations

The study was approved by the Ethics Committee of the Faculty of Medicine, Prince of Songkla University (REC-65-025-1-1, approved on January 27, 2022) and was conducted in accordance with the principles of the Declaration of Helsinki. Due to the retrospective nature of the study, the requirement for written informed consent was waived. All patient data were anonymized and handled confidentially.

Results

Population and Demographic Characteristics

A total of 220 pediatric patients were included in the study, comprising 69 patients in the pre-implementation phase, 67 in the post-implementation phase, and 84 in the post-revision phase as Table 2. The median age of patients did not differ significantly across the three phases (5.5, 5.1, and 4.9 years; p = 0.993). The sex distribution was comparable, with an overall predominance of males (65.9%, p = 0.655). The prevalence of atopy (15.4%) and parental asthma history (20%) did not differ significantly between groups (p = 0.927 and p = 0.054).

The proportion of patients who had been received controller medication in past 3 month was 68.2%, with no statistically significant difference among groups (p = 0.539). Approximately one-third (28.9%) of patients had experienced AE within the preceding 12 months. The median number of AEs per patient was 2 in all groups (interquartile range 1–3), with no statistically significant difference (p = 0.613).

Regarding prior hospitalization due to AE, 60.5% of patients had been admitted within the past year, without significant variation between groups (p = 0.338). There was a statistically significant difference in the rate of previous

Table 2 Baseline Characteristics of Participants (N = 220)

	Pre-Implementation (N = 69)	Post-Implementation (N = 67)	Post-Revision (N = 84)	P value
Age (year) (median, IQR)	5.5 (3.0–7.2)	5.1 (3.1–6.6)	4.9 (3.1–7.4)	0.993
Male (%)	45 (65.2)	47 (70.1)	53 (63.1)	0.655
Asthma controller use in previous 3 months (%)	45 (65.2)	44 (65.7)	61 (72.6)	0.539
Exacerbation in previous 12 months (%)	55 (79.7)	41 (62.1)	59 (71.1)	0.079
Hospitalization in previous 12 months (%)	28 (40.6)	21 (31.8)	36 (43.4)	0.338
Previous intubation (%)	3 (4.3)	7 (10.4)	6 (7.1)	0.391
Previous ICU admission (%)	1 (1.4)	5 (7.5)	23 (27.4)	<0.001
History of atopy (%)	10 (14.5)	11 (16.4)	14 (16.7)	0.927
History of parental asthma (%)	11 (15.9)	20 (29.9)	13 (15.5)	0.054
CRS at admission (median, IQR)	2.0 (1.0–3.0)	2.0 (1.0–3.0)	2.0 (1.0–3.0)	0.871
Asthma exacerbation severity (%)				0.878
Mild	58 (84.1)	58 (86.6)	69 (83.1)	
Moderate	11 (15.9)	8 (11.9)	13 (15.7)	
Severe	0 (0.0)	1 (1.5)	1 (1.2)	
Absolute eosinophil count blood (median, IQR)	104.0 (0.0–349.0)	36.0 (4.5–287.5)	121.5 (2.0–260.2)	0.898
Any virus identification (%)	3 (4.8)	15 (24.6)	29 (15.8)	0.008
RSV positive (%)	3 (4.3)	3 (4.5)	9 (10.7)	< 0.001
Influenza positive (%)	3 (4.3)	3 (4.5)	1 (1.2)	0.011
Respiratory panel positive (%)	0 (0.0)	8 (11.9)	6 (7.1)	0.017

Abbreviations: CRS, clinical respiratory score; ICU, intensive care unit; IQR, interquartile range.

https://doi.org/10.2147/JAA.S605374

ICU admission among groups (p < 0.001). Post-hoc pairwise comparisons demonstrated significantly higher rates in both the post-implementation and post-revision phases compared with the pre-implementation phase, while no significant difference was observed between the post-implementation and post-revision phases.

CRS scores at admission were comparable across the three phases, with the majority classified as mild to moderate severity. There was no significant difference in median scores (p = 0.871).

Blood eosinophil count, did not differ significantly among groups (p = 0.898). In contrast, virological testing revealed significant differences among study phases. Overall respiratory pathogen identification differed significantly across groups (p = 0.008), with post-hoc analysis demonstrating a significant difference between the pre-implementation and post-revision phases. RSV positivity differed significantly between the post-implementation and post-revision phases, whereas influenza positivity differed significantly between the pre-implementation and post-revision phases.

In-Patient Management

Implementation of the institutional asthma guideline led to significant improvements in several aspects of inpatient management (Table 3). The median time to first bronchodilator administration differed significantly across study phases (p < 0.001). Post-hoc pairwise comparisons demonstrated a significantly shorter time in the post-revision phase compared with the pre-implementation phase, decreasing from 117 minutes (IQR 83.5–177.0) to 70 minutes (IQR 49.0–98.5). However, there was no significant difference in the median time to first systemic steroid administration across the three periods (p = 0.851).

The total number of bronchodilator doses administered during the first 24 hours differed significantly across study phases (p < 0.001). Post-hoc pairwise comparisons demonstrated significantly higher bronchodilator use in the post-revision phase compared with both the pre-implementation and post-implementation phases. This finding may reflect greater adherence to standardized escalation protocols following guideline refinement. Continuous nebulization use differed significantly across study phases (p = 0.001). Post-hoc pairwise comparisons demonstrated significantly greater use in the post-revision phase compared with the pre-implementation phase, increasing from 0% to 12.0%.

Nebulized steroid use also differed significantly among groups (p < 0.001). Post-hoc analysis demonstrated significantly higher use during the post-implementation phase compared with both the pre-implementation and post-revision phases.

Regarding respiratory support, there was a significant shift in the highest level of respiratory support provided across study phases (p < 0.001). Post-hoc pairwise comparisons demonstrated significantly greater use of HFNC in both the post-implementation and post-revision phases compared with the pre-implementation phase. HFNC use increased from 4.3% pre-implementation to 35.8% and 34.5% during the post-implementation and post-revision phases, respectively. In contrast, oxygen cannula use decreased, while mechanical ventilation remained infrequent throughout the study period.

Oseltamivir use remained low and did not differ significantly across study phases (p = 0.913). In contrast, antibiotic use differed significantly among groups (p < 0.001). Post-hoc pairwise comparisons demonstrated significantly higher antibiotic use in both the post-implementation and post-revision phases compared with the pre-implementation phase.

Table 3 Treatment Practices Across Pre-Implementation, Post-Implementation, and Post-Revision Phases (N = 220)

	Pre-Implementation (N = 69)	Post-Implementation (N = 67)	Post-Revision (N = 84)	P value
Time to first bronchodilator (min) (median, IQR)	117.0 (83.5–177.0)	104.0 (73.5–160.0)	70.0 (49.0–98.5)	<0.001
Time to first systemic steroids (h) (median, IQR)	4.0 (2.4–6.0)	4.7 (2.4–6.4)	4.6 (2.4–6.1)	0.851
Total dose of bronchodilator in first 24 hours (dose) (median, IQR)	6.0 (5.0–9.0)	7.0 (6.0–11.0)	10.0 (7.0–15.0)	<0.001
Continuous nebulization use (%)	0 (0.0)	2 (3.0)	10 (12.0)	0.001
Nebulized steroid use (%)	0 (0.0)	27 (40.3)	5 (6.0)	<0.001
High flow nasal cannula use (%)	3 (4.3)	24 (35.8)	29 (34.5)	<0.001
Oseltamivir use (%)	2 (2.9)	3 (4.5)	3 (3.6)	0.913
Antibiotic use (%)	8 (11.6)	21 (31.3)	39 (46.4)	<0.001

Abbreviations: HFNC, high-flow nasal cannula; ICU, intensive care unit; IQR, interquartile range.

Table 4 Clinical Outcomes Between Pre- and Post-Guideline Implementation (N = 220)

	Pre-Implementation (N = 69)	Post-Implementation (N = 67)	Post-Revision (N = 84)	P value
Reduction of 24-hour CRS (median, IQR)	1 (0, 2)	1 (0, 2)	1 (0, 1)	0.001
Length of hospital stay (hour) (median, IQR)	47.5 (40.7–69.3)	58.6 (41.6–93.4)	67.3 (52.1–91.3)	0.004
Intensive care unit admission (%)	0 (0.0)	3 (4.5)	4 (4.8)	0.183
30-day morbidity (%)	7 (10.1)	5 (7.5)	5 (6.0)	0.624
Hospitalization cost (USD) (median, IQR)	249.7 (180.0–343.5)	460.6 (299.9–746.9)	447.0 (302.2–722.5)	<0.001

Abbreviations: CRS, clinical respiratory score; ICU, intensive care unit; IQR, interquartile range; USD, United States dollar.

Primary Outcome: Reduction of 24-Hour Clinical Respiratory Score

Clinical severity, as measured by reduction in the 24-hour CRS, differed significantly across study phases (p = 0.01). Post-hoc pairwise comparisons demonstrated a significant difference between the pre-implementation and post-revision phases. Median CRS reduction was 1 point (IQR 0–2) in both the pre-implementation and post-implementation phases, compared with 1 point (IQR 0–1) in the post-revision phase.

In adjusted analyses controlling for age, initial respiratory score, and viral status, significant differences in CRS reduction remained across study phases.

Secondary Outcomes

Length of Hospital Stay (LOS)

The median LOS increased across the three study phases, from 47.5 hours (IQR 40.7–69.3) in the pre-implementation phase to 58.6 hours (IQR 41.6–93.4) in the post-implementation phase and 67.3 hours (IQR 52.1–91.3) in the post-revision phase (p = 0.004) (Table 4). Post-hoc pairwise comparisons demonstrated a significant difference between the pre-implementation and post-revision phases. In adjusted analyses controlling for age, initial CRS, and viral identification status, the post-revision phase remained significantly associated with longer LOS compared with the pre-implementation phase.

ICU Admission

The proportion of patients requiring ICU admission remained low throughout all periods: 0% in pre-implementation phase, 4.5% in post-implementation phase, and 4.8% in post-revision phase (p = 0.18). These findings are detailed in Table 4.

30-Day Morbidity

30-day morbidity showed no statistically significant difference across the three groups: 10.1%, 7.5%, and 6.0%, respectively (p = 0.624, Chi-square test) (Table 4). Yearly trend analysis, however, revealed a spike in morbidity around the initial implementation period in 2021, followed by a sharp decline in subsequent years (Figure 2).

Hospitalization Cost

Median hospitalization cost increased significantly across study phases, from 249.7 USD (IQR 180.0–343.5) in the pre-implementation phase to 460.6 USD (IQR 299.9–746.9) in the post-implementation phase and 447.0 USD (IQR 302.2–722.5) in the post-revision phase (p < 0.001) (Table 4). Post-hoc pairwise comparisons demonstrated significant differences between the pre-implementation and post-implementation phases, as well as between the pre-implementation and post-revision phases. In adjusted analyses controlling for age, initial respiratory score, and viral status, hospitalization costs remained significantly different across all study phases. Trends in hospitalization cost over time are illustrated in Figure 3.

Discussion

This retrospective quality improvement study evaluated the impact of implementing a local inpatient asthma care guideline on clinical practice patterns, patient outcomes, and resource utilization in a tertiary care academic hospital. Through a retrospective analysis comparing data before and after guideline implementation, the study revealed both strengths and limitations of standardized care delivery in real-world pediatric asthma management.

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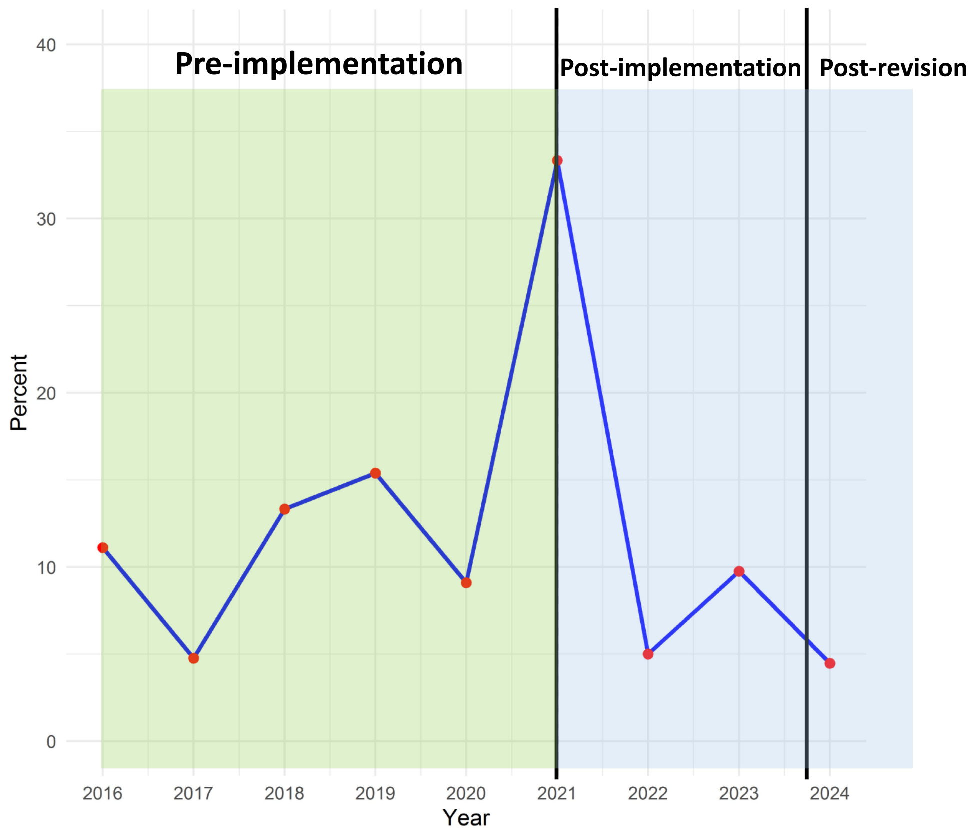

Figure 2 The 30-day morbidity before and after guideline implementation.

Following guideline implementation, several indicators of clinical care quality improved significantly. Physicians administered bronchodilators more promptly, delivered higher total doses during the first 24 hours, and more frequently used nebulized corticosteroids. These findings suggest increased adherence to evidence-based practice guidelines and greater standardization of inpatient asthma management.

The differences in 24-hour CRS reduction were modest but statistically significant across study phases. This reflects earlier and more standardized intervention following guideline implementation. However, the observed reduction in 24-hour CRS in our study may have been influenced by the expanding use of HFNC as an adjunctive respiratory support. Apart from guideline implementation, a marked increase in clinical familiarity and confidence regarding HFNC utilization has been observed, especially following the COVID-19 pandemic in our institution. HFNC itself may have contributed to the observed improvement in early respiratory status through several mechanisms, including reduction in work of breathing, improved oxygen delivery, generation of low levels of positive airway pressure, and enhanced secretion clearance.[8] Recent studies have supported the role of HFNC in improving clinical respiratory parameters across various pediatric respiratory conditions, although evidence regarding cost-effectiveness remains limited.[8,9]

It is also important to distinguish between process measures and patient-centered outcomes. Improvements in time to bronchodilator administration, increased use of standardized therapies, and enhanced monitoring likely reflect successful implementation of the guideline. In contrast, patient outcomes such as LOS and ICU admission may be influenced by multiple factors beyond the guideline. The ICU admission rate and 30-day morbidity remained low and did not differ significantly throughout the study periods. The low baseline PICU admission rate may have limited the ability to detect differences following implementation, yet also suggests that most exacerbations can be successfully managed without escalation when timely and standardized inpatient care is available. In addition, approximately two-thirds of our population had received asthma controllers in the previous 3 months which contributed to mild AE severity, low ICU

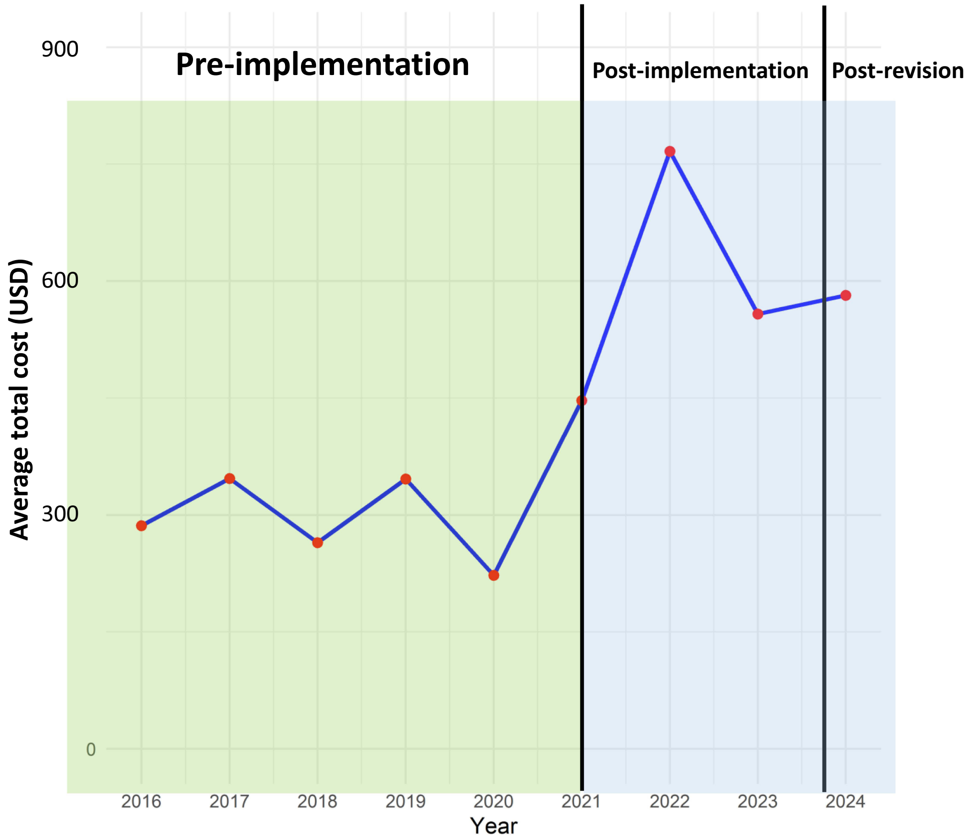

Figure 3 Trend of hospitalization cost before and after guideline implementation.

admission rate, and low short-term morbidity observed across study periods. Previous studies have identified regular use of ICS as an independent protective factor against poor asthma control and severe acute exacerbation in children.[10]

Unlike previous studies evaluating asthma care pathways,[5] our study found a statistically significant increase in LOS after implementation despite a statistically significant difference in 24-hour CRS reduction. The difference of a few points in CRS reduction may not have been clinically significant enough to substantially influence physician decision-making regarding escalation or de-escalation of care or to facilitate earlier hospital discharge. Furthermore, LOS is usually influenced not only by clinical status, but also by local institutional practices, physician caution, family concerns, and resource organization. The early use of high-dose bronchodilators, HFNC and closer monitoring—particularly in a setting such as the pediatric moderate care unit—may have led to a more cautious and gradual de-escalation of treatment. Previous studies evaluating HFNC have similarly suggested that its use may increase healthcare utilization and monitoring burden, with variable effects on hospital length of stay depending on the clinical context and local care practices.[9] Therefore, the development of a structured HFNC weaning pathway along with bronchodilator de-escalation protocol may help optimize the duration of respiratory support and potentially reduce unnecessary prolongation of hospitalization for AE.

In resource-constrained healthcare systems, a primary concern when implementing new clinical practice guidelines is cost-efficiency. The substantial increase in total admission cost following implementation was also demonstrated in this study. Cost increases were observed across several domains, including medications, investigations, medical devices, and nursing services. Greater intensity of care, eg, more frequent assessment or continuous monitoring, as well as evolving respiratory support practices such as HFNC, may have contributed to the increased costs. Previous studies have demonstrated that HFNC implementation may increase resource use, monitoring requirements, and overall treatment-related costs depending on institutional practice and patient population.[11,12]

Many previous studies[13–15] demonstrated improvements in treatment efficiency, reductions in hospital LOS, and lower healthcare costs following implementation of standardized asthma pathways. These benefits were commonly

 https://doi.org/10.2147/JAA.S605374

attributed to structured severity assessment, therapist-driven bronchodilator weaning protocols, and streamlined discharge processes. Findings in our study add real-world implementation evidence from a tertiary-care setting over a prolonged period. This reflects how such guidelines function in routine clinical practice, particularly in a middle-income context.

This study has limitations that should be considered. As a retrospective study, the findings may be influenced by unmeasured confounding and temporal changes in clinical practice. Although adjusted analyses were performed for key clinical outcomes, residual confounding may remain. The extended study period over 9 years represents both a strength and a limitation. While it allows for the assessment of meaningful clinical and operational outcomes, it also increases susceptibility to temporal confounding. Changes in respiratory care practices, healthcare infrastructure, and clinician behavior over time may have influenced the observed outcomes independently of the intervention. In particular, evolving respiratory support practices, including increased use of high-flow nasal cannula and changes following the COVID-19 pandemic, may have contributed to differences across study periods.

Taken together, these findings suggest that implementation of inpatient asthma pathways may involve important operational and resource-related considerations alongside improvements in clinical care delivery. While guideline implementation was associated with improved treatment timeliness, greater standardization of care, and selected measures of early respiratory improvement, these changes were accompanied by increased healthcare utilization, including longer hospitalization and higher admission costs. These observations underscore the importance of balancing clinical process improvement with efficient resource utilization, particularly in resource-constrained healthcare settings. Ongoing refinement of institutional care pathways, including optimization of respiratory support practices and monitoring strategies, may help preserve early clinical benefits while minimizing unnecessary prolongation of hospitalization and excess resource use.

Clinical Applications

A key factor underpinning effective implementation lies in the development of institutional guidelines that are tailored to the specific context of each hospital, taking into account differences in resources, workforce capacity, and system infrastructure. At the same time, the establishment of standardized protocols plays an equally important role, as it enhances treatment fidelity and may support earlier clinical stabilization.

In addition, the introduction of semi-critical supportive modalities, such as high-flow nasal cannula (HFNC), has the potential to improve patient care. However, their use must be carefully aligned with available resources to avoid imposing an unsustainable burden, particularly in settings where financial and human resources are constrained.

Overall, these findings highlight the ongoing challenge of achieving a delicate balance between improving quality of care and maintaining cost-efficiency, a tension that is especially pronounced in resource-limited health systems.

Conclusion

Implementation of a local inpatient asthma care guideline was associated with improvements in clinical treatment patterns and selected measures of early clinical improvement. However, these changes occurred alongside increased length of stay and higher hospitalization costs, without significant differences in ICU admission or short-term morbidity.

These findings reflect a trade-off between more standardized inpatient asthma management and increased healthcare resource utilization. They highlight the need to balance standardization of care with efficient use of resources, particularly in real-world clinical settings.

Future work should focus on evaluating cost-effectiveness, sustainability of implementation, and whether refinement of the care pathway can preserve potential clinical benefits while minimizing unnecessary prolongation of hospitalization and resource use.

Abbreviations

AE, asthma exacerbation; BiPAP, bilevel positive airway pressure; CPW, clinical pathway; CRS, clinical respiratory score; HFNC, high-flow nasal cannula; ICS, inhaled corticosteroid; ICU, intensive care unit; IQR, interquartile range; LOS, length of stay; PICU, pediatric intensive care unit; PMCU, pediatric moderate care unit; PDSA, Plan–Do–Study–Act; RSV, respiratory syncytial virus.

 https://doi.org/10.2147/JAA.S605374

Data Sharing Statement

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

Ethics Approval and Informed Consent

Ethics committee approval from the Faculty of Medicine, Prince of Songkla University (REC-65-025-1-1, approved on January 27, 2022) was obtained prior to study initiation. The study was conducted in accordance with the principles of the Declaration of Helsinki. Due to the retrospective nature of the study, the requirement for written informed consent was waived.

Acknowledgments

We thank the pediatric ward nurses and staff at Songklanagarind Hospital for their collaboration in implementing the local in-patient asthma exacerbation management guideline throughout the study period.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This work was supported by the Faculty of Medicine, Prince of Songkla University (grant number REC-65-025-1-1). The sponsor had no involvement in the study design, analysis and interpretation of data, or in the decision to submit the article for publication.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Gutierrez-Albaladejo N, Jimenez-Garcia R, Albaladejo-Vicente R. et al. Trends in hospital admissions among children with asthma in Spain (2011-2020). *Eur J Pediatr*. 2023;182(5):2409–2419. doi:10.1007/s00431-023-04873-w
2. Manti S, Licari A, Leonardi S, et al. Management of asthma exacerbations in the paediatric population: a systematic review. *Eur Respir Rev*. 2021;30(161):200367. doi:10.1183/16000617.0367-2020
3. Global Initiative for Asthma. Pocket guide for asthma management and prevention (for adults and children older than 5 years). [updated 2025]. Available from: https://ginasthma.org/pocket-guide-for-asthma-management-and-prevention/. Accessed October 5, 2025.
4. Pediatric Asthma Working Group; Thai Pediatric Pulmonology Society; Pediatric Allergy and Immunology Society of Thailand. *Clinical Practice Guideline for Diagnosis and Management of Asthma in Children in Thailand: Full Version 2021*. Bangkok, Thailand: The Royal College of Pediatricians of Thailand; 2021.
5. Johnson DP, Arnold DH, Gay JC, et al. Implementation and improvement of pediatric asthma guideline improves hospital-based care. *Pediatrics*. 2018;141(2):e20171630. doi:10.1542/peds.2017-1630
6. Kaiser SV, Rodean J, Bekmezian A, et al; Pediatric Research in Inpatient Settings (PRIS) Network. Effectiveness of pediatric asthma pathways for hospitalized children: a multicenter, national analysis. *J Pediatr*. 2018;197:165–171. doi:10.1016/j.jpeds.2018.01.084
7. Nayani K, Naeem R, Munir O, et al. The clinical respiratory score predicts paediatric critical care disposition in children with respiratory distress presenting to the emergency department. *BMC Pediatr*. 2018;18:339. doi:10.1186/s12887-018-1317-2
8. Kuitunen I, Salmi H, Wärnhjelm E, et al. High-flow nasal cannula use in pediatric patients for other indications than acute bronchiolitis: a scoping review of randomized controlled trials. *Eur J Pediatr*. 2024;183(2):863–874. doi:10.1007/s00431-023-05234-3
9. Gannon B, Franklin D, Vo V, et al. Cost-effectiveness of nasal high-flow in children with acute hypoxaemic respiratory failure. *J Paediatr Child Health*. 2024;60(6):229–239. doi:10.1111/jpc.16558
10. Shen R, Yang S, Zhou Y, et al. Analysis of the characteristics of blood inflammatory cytokines and their influencing factors in acute exacerbations of allergic asthma in children. *Front Pediatr*. 2025;13:1571556. doi:10.3389/fped.2025.1571556
11. Biggerstaff S, Markham JL, Winer JC, et al. Impact of high flow nasal cannula on resource utilization in bronchiolitis. *Hosp Pediatr*. 2021:e2021005846. doi:10.1542/hpeds.2021-005846
12. Carroll OU, Grieve R, Kiguli S, et al. A cost-consequence analysis of the children's administration oxygenation strategies trial (COAST) in severe pneumonia. *PLOS Glob Public Health*. 2026;6(1):e0005654. doi:10.1371/journal.pgph.0005654
13. Bartlett KW, Parente VM, Morales V, et al. Improving the efficiency of care for pediatric patients hospitalized with asthma. *Hosp Pediatr*. 2017;7(1):31–37. doi:10.1542/hpeds.2016-0108

14. Magruder TG, Narayanan S, Walley S, et al. Improving inpatient asthma management: the implementation and evaluation of a pediatric asthma clinical pathway. *Pediatr Qual Saf*. 2017;2(5):e041. doi:10.1097/pq9.0000000000000041
15. Miller AG, Breslin ME, Pineda LC, et al. An asthma protocol improved adherence to evidence-based guidelines for pediatric subjects with status asthmaticus in the emergency department. *Respir Care*. 2015;60(12):1759–1764. doi:10.4187/respcare.04011