

## Effectiveness of Pediatric Asthma Pathways for Hospitalized Children: A Multicenter, National Analysis

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**Objective** To determine if clinical pathways affect care and outcomes for children hospitalized with asthma using a multicenter study.

**Study design** This was a retrospective, multicenter cohort study using an administrative database, the Pediatric Health Information System. We evaluated the impact of inpatient pediatric asthma pathways on children age 2-17 years admitted for asthma from 2006 to 2015 in 42 children's hospitals. Date of pathway implementation for each hospital was collected via survey. Using generalized estimating equations with an interrupted time series approach (to account for secular trends), we determined the association of pathway implementation with length of stay (LOS), 30-day readmission, chest radiograph utilization, ipratropium administration >24 hours, and administration of bronchodilators, systemic steroids, and antibiotics. All analyses were risk-adjusted for patient and hospital characteristics.

**Results** Clinical pathway implementation was associated with an 8.8% decrease in LOS (95% CI 6.7%-10.9%), 3.1% decrease in hospital costs (95% CI 1.9%-4.3%), increased odds of bronchodilator administration (OR 1.53[1.21-1.95]) and decreased odds of antibiotic administration (OR 0.93[0.87-0.99]) (n = 189 331). We found no associations between pathway implementation and systemic steroid administration, ipratropium administration for >24 hours, chest radiograph utilization, or 30-day readmission.

**Conclusions** Clinical pathways can decrease LOS, costs, and unnecessary antibiotic use without increasing rates of readmissions, leading to higher value care. (*J Pediatr* 2018;■■■:■■■-■■■).

Asthma is a leading cause of pediatric hospitalizations,<sup>1</sup> at a cost of nearly \$1 billion annually in the US.<sup>2</sup> Inconsistent adoption of evidence-based guidelines by healthcare providers contributes to variability in quality of care and outcomes for children hospitalized for asthma, including rates of transfer to intensive care units, hospital readmissions, hospital length of stay (LOS), and healthcare expenditures.<sup>3-8</sup> Clinical pathways are operational versions of practice guidelines, aimed at inpatient management of common illnesses.<sup>9</sup> Pathways hold promise as a means to increase clinicians' adoption of evidence-based guidelines and to improve quality of care.

The number of hospitals implementing inpatient pediatric asthma pathways has grown substantially in recent years,<sup>10</sup> possibly driven by factors including the development of inpatient pediatric asthma performance metrics by the Joint Commission in 2007,<sup>11</sup> increasing pressures to publicly report quality metrics,<sup>12</sup> and/or changes in insurance reimbursement policies intended to incentivize higher value care.<sup>13</sup>

Studies of inpatient pediatric asthma pathways have demonstrated improvements in quality of care and reductions in LOS.<sup>14-24</sup> However, current evidence is limited to single-center or single health-system studies with limited duration of follow-up. Concluding that pathways are effective based on these studies alone could be subject to biases, including publication bias (ie, only successful pathway interventions are reported) and failure to account for secular trends (ie, LOS is

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APR-DRG	All Patient Refined Diagnosis Risk Group
EMR	Electronic medical record
GEE	Generalized estimating equation
ITS	Interrupted time series
LOS	Length of stay
PHIS	Pediatric Health Information System

declining in general). Our objective was to determine if clinical pathways affect care and outcomes for children hospitalized with asthma in a large national sample, accounting for secular trends.

## Methods

This retrospective, multicenter cohort study used an administrative database, the Pediatric Health Information System (PHIS).<sup>25</sup> PHIS includes approximately 30% of pediatric hospitalizations in the US. It contains data from 48 tertiary children's hospitals (including 26 states and the District of Columbia). The Children's Hospital Association and participating hospitals collaborate to ensure data reliability and quality. Data elements for each hospital discharge include patient demographics, dates of admission and discharge, discharge diagnoses, tests used, medications prescribed, and procedures performed. Patient identifiers are removed from the database, but each patient is assigned a unique identifier that permits capture of readmissions at the same hospital as the index admission.<sup>5</sup>

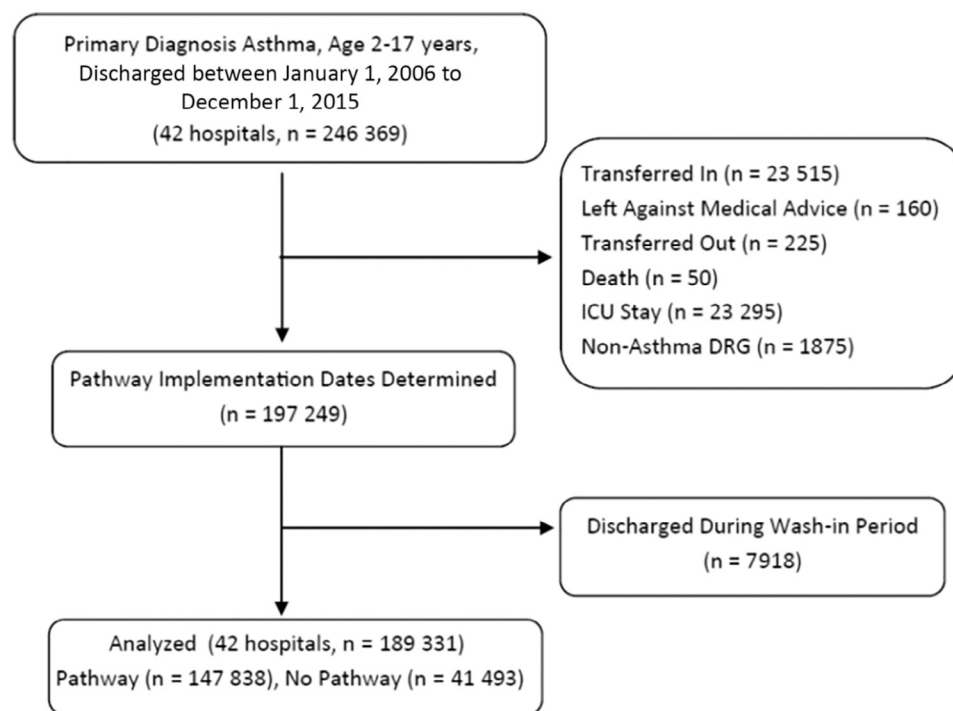
Selection of our study population is outlined in **Figure 1**. The 42 (88%) PHIS hospitals where pathway status was known were included for this analysis. We included children ages 2-17 years admitted for a primary diagnosis of asthma from January 1, 2006 to December 1, 2015. Asthma was defined using *International Classification of Diseases-Clinical Modification, Ninth Revision, and Tenth Revision* codes<sup>26</sup> as specified in the **Appendix** (available at [www.jpeds.com](http://www.jpeds.com)) and All Patient

Refined Diagnosis Risk Group (APR-DRG, 3M) of 141: Asthma. Children transferred into or out of the hospital were excluded due to inability to accurately determine LOS.<sup>27</sup> Children were excluded if they were discharged against medical advice, transferred to the intensive care unit, or died during the admission. This study was approved by the Institutional Review Board of the University of California, San Francisco, California.

## Defining Exposure to Pathways

As described previously, we contacted all PHIS hospitals via survey to determine whether the hospital had an inpatient asthma pathway, its date of initial implementation, and dates of any pathway improvements (quarter, year).<sup>10</sup> Our study team used an established definition of clinical pathways; to be classified as a pathway, the intervention had to satisfy 4 criteria: (1) be a structured multidisciplinary plan of care, (2) be used to translate guidelines or evidence into local structures, (3) detail the steps in a course of treatment or care in a plan, pathway, algorithm, guideline, protocol or other "inventory of actions," and (4) aim to standardize care for a specific population.<sup>28</sup> The **Appendix** provides an example of a pediatric inpatient asthma pathway.

Each asthma hospitalization was assigned an exposure status to pathways based on hospital and date of hospitalization, using the information we had gathered via survey. We assumed that the impact of pathway implementation would not be immediate. As a result, in our analysis, we allowed a 1-year wash-in period,<sup>29</sup> during which we excluded all records to account for the time taken for full pathway implementation (1 quarter



**Figure 1.** Flow diagram of selection of pediatric asthma admissions for analysis. *ICU*, intensive care unit.

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