Literature Review: Prediction Modeling of Emergency Department Disposition Decisions for Children with Acute Asthma Exacerbations

Abstract:
Emergency department (ED) visits and hospitalization are common, costly and the greatest disease burden to children with asthma. Admission rates for asthma vary substantially by site and ED provider. Disease heterogeneity and ED provider uncertainty surrounding likelihood of successful discharge contribute to potentially avoidable hospitalizations. New approaches to improve ED disposition decision-making could improve patient care and reduce waste associated with unnecessary hospitalizations. Several asthma severity scores and asthma prediction models have been evaluated for their ability to predict ED disposition for childhood asthma. Our objective is to review prior studies that modeled predictors of disposition outcomes for children treated in ED settings for acute asthma exacerbations.

Keywords:
asthma; prediction modeling; hospitalization; emergency department; pediatrics

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Acute asthma exacerbations result in 700,000 emergency department (ED) visits annually and are the leading cause of childhood hospitalization.[1-7] Hospitalizations are the most expensive component of the annual $4-10 billion in US healthcare expenditures for childhood asthma.[1-5,8] ED providers are responsible for the decision to admit for 76% of all childhood asthma hospitalizations. Despite evaluating children with acute asthma exacerbation often, ED providers have difficulty predicting the need for hospitalization or safe discharge.[6,9-11]

Difficulty in predicting need for hospitalization is partly attributable to variable asthma phenotypes. Complex environmental and genetic interaction in asthma results in a wide range of clinical presentations and response to treatment,[12] thus challenging clinicians in hospitalization decision-making. Hospitalization rates for asthma exacerbations amongst US children's hospitals are highly variable (median 24%, interquartile range 19 – 29%, range 12 – 52 %) and lead to potentially avoidable hospitalizations.[2,6,13-18] One approach to reducing practice variation and improving decision-making for asthma is clinical guidelines. Although the existing National Institutes of Health (NIH) expert panel clinical guidelines are based on considerable expertise and experience of panel members, they acknowledge that decisions to admit or to discharge are subjective and rely on variable clinical judgment due to a lack of evidence-based disposition decision criteria.[19]

Unnecessary admissions increase the burden of disease on children and their families, waste health care resources, overwhelm hospital capacity, and introduce iatrogenic risk such as exposure to hospital-acquired infections.[16] Reducing unnecessary admission is a shared focus for policymakers,[7,20] payers[21] and investigators alike.[22-24] For health conditions in which inappropriate discharge carries a high risk of morbidity (such as abdominal pain or fever without a source) the dominant domain in assessing quality of discharge decision-making is safety.

In conceptualizing the quality issues relevant to disposition discharge decisions, we used the National Institute of Medicine's construct.[25] For pediatric asthma exacerbations, quality of ED disposition decision is less related to safety, as mortality (one death for every 25,000 asthma-related ED visits) is rare.[26] Instead, the relevant domains are efficiency (avoiding excess use of resources) and effectiveness (avoiding under and overuse of services): how well do disposition decisions avoid excess length of stay, excess hospitalizations and excess return visit admissions? Return visits occur at a rate of 2-10% of ED discharges within a

2-14 day timeframe from the index visit.[27] Return visits resulting in admission occur at an even lower rate of 1.9-2.8% of ED discharges, using a 7-10 day timeframe from the index visit.[27] An accurate prediction model would thus help improve the rate of efficient and effective disposition decisions for children with acute asthma exacerbations. In this review, our objective is to summarize the findings of published studies involving prediction of disposition outcomes among children in the ED for acute asthma exacerbations. We also review the studies' limitations and evidence behind individual predictors to provide actionable knowledge to inform next-generation guidelines with a validated, objective prediction rule for appropriate discharge.

METHODS: ELIGIBILITY CRITERIA AND DATA COLLECTION

We used MESH search criteria in PubMed to identify all English-language studies that met the following inclusion criteria: (1) the patient population was children with acute asthma exacerbations; (2) the setting was the ED; (3) an outcome measured was either actual ED disposition or a composite measure related to disposition; (4) at least one patient-level independent variable measured during the ED stay was modeled in association with the disposition-related outcome.

For each eligible study, we summarized data on the disposition-related outcomes measured, the independent variables found to be predictive of those outcomes, and their strength of the association.

RESULTS

Study Characteristics

We identified nine existing prediction model studies for asthma hospitalization risk among children treated in the ED for asthma that met eligibility criteria. (Table 1) Publication dates ranged from 1994 through 2016. All nine studies were prospective, cohort studies with a majority (6/9) of the studies using multiple logistic regression analyses to model the disposition outcome.[28-33] Ages of children included ranged from 12 months to 18 years, however most (4/9) limited the study to include age 2 years to 17 years.

The study population for all nine studies was generally defined as a child with a history of asthma or wheezing presenting to the ED for acute asthma exacerbation. However, the studies varied in their definition of acute asthma exacerbation, some