Childhood Asthma Hospital Discharge Medication Fills and Risk of Subsequent Readmission

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Objective To assess the relationship between posthospitalization prescription fills for recommended asthma discharge medication classes and subsequent hospital readmission.

Study design This was a retrospective cohort analysis of Medicaid Analytic Extract files from 12 geographically diverse states from 2005-2007. We linked inpatient hospitalization, outpatient, and prescription claims records for children ages 2-18 years with an index hospitalization for asthma to identify those who filled a short-acting beta agonist, oral corticosteroid, or inhaled corticosteroid within 3 days of discharge. We used a multivariable extended Cox model to investigate the association of recommended medication fills and hospital readmission within 90 days.

Results Of 31 658 children hospitalized, 55% filled a beta agonist prescription, 57% an oral steroid, and 37% an inhaled steroid. Readmission occurred for 1.3% of patients by 14 days and 6.3% by 90 days. Adjusting for patient and billing provider factors, beta agonist (hazard ratio [HR] 0.67, 95% CI 0.51, 0.87) and inhaled steroid (HR 0.59, 95% CI 0.42, 0.85) fill were associated with a reduction in readmission at 14 days. Between 15 and 90 days, inhaled steroid fill was associated with decreased readmission (HR 0.87, 95% CI 0.77, 0.98). Patients who filled all 3 medications had the lowest readmission hazard within both intervals.

Conclusions Filling of beta agonists and inhaled steroids was associated with diminished hazard of early readmission. For inhaled steroids, this effect persisted up to 90 days. Efforts to improve discharge care for asthma should include enhancing recommended discharge medication fill rates. *(J Pediatr 2015;166:1121-7)*.

See editorial, p 1107

Asthma is a leading cause of childhood hospitalization and the most common cause of preventable hospitalization.[1,2] Although the proportion of asthma hospitalizations resulting in an immediate readmission may be lower than other diagnoses,[3,4] asthma represents a common cumulative cause of childhood readmission and an expensive, potentially avoidable outcome. For over 2 decades,[5] the National Asthma Education and Prevention Program (NAEPP) has recommended a number of posthospitalization care medications, including continuation of inhaled short-acting beta-agonists and oral steroids, along with continuation or consideration of initiation of a preventive controller medication such as an inhaled corticosteroid.[6] Single center or state studies of these individual medications reveal a broad range of prescribing or fill rates, ranging from 38%-71%,[7-9] however, adherence with this set of recommended asthma discharge medications and the relationship with readmission have not been evaluated on a large scale. Given the current lack of useful quality indicators for inpatient care of asthma[3,10] and a shifting focus toward accountable care, empirical evidence demonstrating the relationship of discharge medication fills and outcomes would be valuable to providers, payers, and policymakers.

In this study, we sought to determine the proportion of patients who filled recommended discharge prescriptions within 3 days of pediatric asthma hospital discharge and to assess the relationship between filling these prescriptions and hospital readmission. Given the timing of their physiologic effects, we hypothesized that filling of short-acting beta agonists and oral steroids within 3 days of hospital discharge would be associated with reduction in short-term readmission and that filling of inhaled steroids would influence readmission at later intervals.

Methods

We conducted a retrospective cohort study of Medicaid analytic extract (MAX) claims data for 12 states from 2005-2007. The protocol for the conduct of this

ED	Emergency department
HEDIS	Healthcare Effectiveness Data and Information Set
HR	Hazard ratio
MAX	Medicaid analytic extract
NAEPP	National Asthma Education and Prevention Program

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study was reviewed and determined not to be human subjects' research by the Children's Hospital of Philadelphia Institutional Review Board. MAX claims include distinct files for personal summary data, inpatient, outpatient drug, and other services' claims, the last of which includes outpatient and emergency department (ED) visits. For the purposes of this study, individual patient claims were linked across these 4 MAX claims files using a Medicaid unique identifier. The 12 states selected for this analysis included a geographically diverse sample with at least 2 states from each of the 4 census regions of the US. We included the most populous state from each census region (New York, Illinois, Texas, and California), and 8 states reported to have research quality MAX inpatient and drug encounter claims data.[11] Encounter claims represent provider-patient interactions or services under capitated payment delivery systems for which individual fee-for-service payments are not received.

Patients ages 2-18 years with claims for inpatient hospitalizations with primary diagnoses of asthma (*International Classification of Diseases, Ninth Revision* Code 493.XX) from January 1, 2006 to September 30, 2007 were included. This allowed for a 365-day look-back period to assess prior care and a 90-day observation period following discharge to assess for subsequent medication fills and hospitalizations. For those patients with multiple hospitalizations, we used only the first admission as the index admission. We excluded patients <2 years of age because other wheezing illnesses such as bronchiolitis may confound the diagnosis of asthma. In addition, we excluded patients who died during their index hospitalization or were discharged to care other than home or self-care.

The outcome of interest was time to inpatient readmission for a principal or secondary diagnosis of asthma within 90 days of index hospital discharge. We included secondary diagnoses of asthma to include readmissions for all asthma-related conditions. Our predictors of interest were pharmacy claims for: (1) short-acting beta agonists; (2) oral corticosteroids; and (3) inhaled corticosteroids or a combination inhaled steroid and long acting beta agonist between one day prior and 3 days subsequent to hospital discharge. We identified claims for asthma medication fills in the pharmacy dataset (which includes only outpatient medication dispensing) using the 9-digit National Drug Codes for medications within each category using the 2011 Healthcare Effectiveness Data and Information Set (HEDIS) lists.[12] Overall, there were 206 distinct codes for short-acting beta agonists, 1301 for oral steroids, and 143 for inhaled steroids.

Covariates included patient characteristics, including demographics, prior utilization and index hospitalization factors, and billing provider number. The billing provider represents the entity that submitted the inpatient claim, which could be either an individual physician or an institution. Demographic variables were age, sex, race/ethnicity, and enrollment in a Medicaid managed care plan at the time of index hospitalization. To account for forms of prior health care use that have been associated with subsequent hospitalization,[13,14] we queried the inpatient, other services, and pharmacy records in the 365 days preceding index admission for asthma-related hospitalizations, ED visits, oral steroid fills, and total non-oral steroid asthma medication fills. To account for severity of disease in the prior year, we assessed presence of persistent asthma by the HEDIS criteria[15] and presence of complex chronic condition within the prior year, the latter of which has been associated with readmission.[16] Covariates related to the index hospitalization included length of stay and the 5 most prevalent comorbid diagnoses during that stay. Lastly, to account for potential volume-outcome relationships, we calculated the volume of discharges per hospitalization billing provider and generated an ordinal variable for billing provider volume with 4 categories.

Statistical Analyses

We computed the proportion of immediate prescription fills for each of the 3 discharge medication categories, both overall and by individual covariate. To assess the general pattern of readmission over the 90-day interval following index discharge and the unadjusted relationships between medication fills and readmission, we constructed Kaplan-Meier failure curves depicting time to readmission with and without each medication. In further bivariate analysis, we assessed the relationship between individual independent variables and immediate medication fills for each medication, as well as 0- to 14- and 15- to 90-day readmission, using χ^2 tests for categorical variables and Student t tests for continuous variables.

We used a multivariable extended Cox model to investigate the association of recommended medication fills and hospital readmission. We assessed the proportional hazards assumption by visually inspecting the estimated log(−log) survival curves, which diverged around 14 days for all 3 medication exposure variables and then tested the statistical significance of time by medication interaction terms. The extended Cox model allowed for nonproportional hazards and provided relative measures of effect of the medication fills between 0-14 days and between 15-90 days. Extended Cox models used robust SEs at the billing provider level to account for the correlation between repeated measures within billing provider.

To estimate the cumulative risk of readmission for the treated relative to untreated groups for the primary exposure variables, we used a logistic regression model including the same covariates to derive estimated probabilities of readmission at 0-14 days and 15-90 days both with and without medication fills. The difference between the probability of readmission with fill and without fill is the absolute risk difference estimate and the relative risk difference is the quotient of the absolute risk difference and probability without fill.

Anticipating specific sources of bias and confounding, we performed a number of sensitivity analyses. To assess for interval censoring, we restricted our analysis to children who had at least 33 of 36 months of Medicaid enrollment and applied the same extended Cox model. Next, because some patients may have filled prescriptions for inhalers