

# Age-Related Differences in the Rate, Timing, and Diagnosis of 30-Day Readmissions in Hospitalized Adults With Asthma Exacerbation



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**BACKGROUND:** Reducing hospital readmissions has attracted attention from many stakeholders. However, the characteristics of 30-day readmissions after asthma-related hospital admissions in adults are not known. It is also unclear whether older adults are at higher risk of 30-day readmission.

**OBJECTIVES:** To investigate the rate, timing, and principal diagnosis of 30-day readmissions in adults with asthma and to determine age-related differences.

**METHODS:** Retrospective cohort study of adults hospitalized for asthma exacerbation using the population-based inpatient samples of three states (California, Florida, and Nebraska) from 2005 through 2011. Patients were categorized into three age groups: younger (18-39 years), middle aged (40-64 years), and older ( $\geq 65$  years) adults. Outcomes were 30-day all-cause readmission rate, timing, and principal diagnosis of readmission.

**RESULTS:** Of 301,164 asthma-related admissions at risk for 30-day readmission, readmission rate was 14.5%. Compared with younger adults, older adults had significantly higher readmission rates (10.1% vs 16.5%; OR, 2.15 [95% CI, 2.07-2.23];  $P < .001$ ). The higher rate attenuated with adjustment (OR, 1.19 [95% CI, 1.13-1.26];  $P < .001$ ), indicating that most of the age-related difference is explained by sociodemographics and comorbidities. For all age groups, readmission rate was highest in the first week after discharge and declined thereafter. Overall, only 47.1% of readmissions were assigned respiratory diagnoses (asthma, COPD, pneumonia, and respiratory failure). Older adults were more likely to present with non-respiratory diagnoses (41.7% vs 53.8%;  $P < .001$ ).

**CONCLUSIONS:** After asthma-related admission, 14.5% of patients had 30-day readmission with wide range of principal diagnoses. Compared with younger adults, older adults had higher 30-day readmission rates and proportions of nonrespiratory diagnoses.

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**KEY WORDS:** adults; asthma exacerbation; COPD; readmission

**ABBREVIATIONS:** HCUP = Healthcare Cost and Utilization Project; ICD-9-CM = International Classification of Diseases, Ninth Revision, Clinical Modification; SID = State Inpatient Databases

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Asthma remains an important public health problem in the United States, affecting 26 million Americans.<sup>1</sup> Asthma exacerbation accounts for a substantial portion of this burden (eg, 347,000 hospital admissions in 2013), with a direct cost of \$2.2 billion annually.<sup>2</sup> Despite the public health importance, post-hospitalization outcomes, such as 30-day readmission, have attracted surprisingly little attention in adults with asthma. By contrast, 30-day readmissions have been the focus of national improvement efforts for several other diseases, such as heart failure and COPD.<sup>3-5</sup> To the best of our knowledge, no studies have examined this issue after asthma-related hospital admissions in adults.

Although asthma affects individuals across the entire age spectrum, older adults with asthma represent a distinct phenotype.<sup>6</sup> The limited literature has reported a higher in-hospital morbidity and mortality in older adults hospitalized for asthma exacerbation.<sup>7</sup> However, it is

unknown whether, compared with younger adults, older adults hospitalized for asthma exacerbation are at higher risk of readmission within 30 days after hospital discharge. Additionally, it is also unknown whether, in the post-hospital period, older adults are vulnerable to a wide range of acute events requiring readmission, which is called post-hospital syndrome.<sup>3,8</sup> Determining age-related differences in the incidence and characteristics of readmission would inform targeted management strategies to improve outcomes and curb health-care utilization in adults with asthma.

In this context, we used large, population-based, multipayer databases from three US states to investigate the rate, timing, and principal diagnosis of 30-day readmissions in hospitalized adults with asthma exacerbation. We hypothesized that older adults have a higher rate of readmission than younger adults, different timing of readmission, and a broad range of readmission diagnoses besides asthma.

## Methods

### Study Design and Setting

We conducted a retrospective cohort study using the data from the Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases (SIDs). The data from California, Florida, and Nebraska SIDs from 2005 through 2011 were used. The HCUP is a family of health-care databases developed through a federal-state-industry partnership and sponsored by the Agency for Healthcare Research and Quality. HCUP includes the largest collection of longitudinal hospital care data in the United States, with all-payer, encounter-level information. The SID includes all inpatient discharges from short-term, acute care, nonfederal, general, and other specialty hospitals. Additional details of the HCUP SID can be found elsewhere.<sup>9</sup> These three states were selected for their geographic distribution, high data quality, and chiefly because their databases contain unique patient identifiers that enable follow-up of specific patients across years. The study period was chosen based on the availability of databases. The institutional review board of Massachusetts General Hospital approved this study (2013P002545).

### Study Population

Using the hospital admission data from all three states, we identified all adult patients (aged  $\geq 18$  years) with a principal discharge diagnosis of asthma exacerbation, as defined by the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis code of 493.xx. We excluded patients who left the hospital against medical advice, those who were transferred to another acute care facility, those who died in-hospital, and out-of-state residents.

### Measurements

The databases contain information on patient characteristics, including demographics (age, sex, and race/ethnicity), primary insurance type, estimated household income, urban-rural status, ICD-9-CM diagnoses, hospital length-of-stay, and patient comorbidities. Quartile classifications of estimated median household income of residents in the patient's ZIP code were examined. Urban-rural status of the patient residence was defined according to the National Center for

Health Statistics.<sup>10</sup> To adjust for potential confounding by patient mix, COPD (codes, 492.21, 492.22, 491.8, 491.9, 492.8, 493.20-493.22, and 496)<sup>11</sup> and Elixhauser comorbidity measures<sup>12</sup> were derived from the ICD-9-CM diagnosis codes in any previous hospital admissions within 1 year before the index hospital admission or during the index hospital admission.

### Primary Exposure

The primary exposure variable was patient age. Because of potential overlap and misclassification with COPD, patients were categorized into three age groups:<sup>13,14</sup> younger adults (18-39 years), middle-aged adults (40-64 years), and older adults ( $\geq 65$  years).

### Outcome Measures

The primary outcome measure was readmission attributable to any cause within 30 days of discharge from the index hospital admission for asthma exacerbation. For the current analysis, we considered only the first readmission within 30 days, similar to the Center for Medicare & Medicaid Services' hospital readmission measures<sup>11</sup> and previous research on other diseases.<sup>3,15,16</sup> Additional readmissions within a 30-day period were not counted as index hospital admission while, whereas subsequent admissions occurring after 30 days of discharge were counted as index hospital admissions if they met the inclusion criteria.

The secondary outcome measures were the timing of readmissions occurring each day over the 30-day period and principal diagnosis of readmissions. To make data presentation and interpretation more meaningful, the principal diagnoses ( $> 14,000$  ICD-9-CM diagnosis codes) were further consolidated into 285 mutually exclusive diagnostic categories using the Agency for Healthcare Research and Quality Clinical Classifications Software,<sup>17</sup> as done previously.<sup>18,19</sup>

### Statistical Analysis

Baseline characteristics were compared across the age groups using  $\chi^2$  and Fisher exact tests for categorical variables and the Mann-Whitney *U* test for continuous variables. To determine the association of age with the rate of 30-day readmission, we initially fit Cox proportional

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