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Predictors of Hospitalization after Adult Asthma ED Visits

Trends and Predictors of Hospitalization after Emergency Department Asthma Visits among
U.S. Adults, 2006-2014

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MPL had full access to all of the data in the study and takes responsibility for the integrity of the
data and the accuracy of the data analysis. MPL, LDR and JDS conceived of the study. MPL and
CVT were responsible for data acquisition, cleaning, and analysis. MPL, CVT, JW, DS, JDS and
LDR contributed substantially to the study design, data analysis and interpretation, and the
writing of the manuscript. MPL takes responsibility for the study as a whole.

ABSTRACT

Background: Asthma hospitalizations are an ambulatory care-sensitive condition; a majority originate in emergency departments (EDs).

Objective: Describe trends and predictors of adult asthma hospitalizations originating in EDs.

Methods: Observational study of ED visits resulting in hospitalization using a nationally representative sample. We tested trend in hospitalization rates from 2006-2014 using logistic regression, then assessed the association between hospitalization rates and patient and hospital characteristics using hierarchical multivariable regression accounting for hospital-level clustering.

Results: Total ED asthma visits increased 15% from 2006-2014, from 1.06 to 1.22 million, while the likelihood of hospitalization decreased (20.9% to 18.2%, $p<0.01$). Adjusting for increased asthma prevalence, ED visit rates and hospitalization rates decreased by 10% and 21%, respectively. Hospitalization was independently associated with older age, female gender (OR=1.23, 95%CI 1.20-1.26), higher Charlson score (OR=1.99, 95%CI 1.97-2.01), Medicaid (OR=1.05, 95%CI 1.01-1.08) and Medicare (OR=1.26, 95%CI 1.22-1.31) insurance, and trauma centers (OR=1.34, 95%CI 1.12-1.60). Hospitalization was less likely for uninsured visits (OR=0.7, 95%CI 0.67-0.73), lower income areas (OR=0.89, 95%CI 0.85-0.93), non-metropolitan teaching hospitals (OR=0.83, 95%CI 0.71-0.96), Midwestern (OR=0.84, 95%CI 0.69-1.01) or Western regions (OR 0.69, 95%CI 0.56-0.83). Unmeasured hospital-specific effects account for 15.8% of variability in hospital admission rates after adjusting for patient and hospital factors.

Conclusions: Total asthma ED visits increased, but prevalence-adjusted ED visits, and ED hospitalization rates have declined. Uninsured patients have disproportionately more ED visits but 30% lower odds of hospitalization. Substantial variation implies unmeasured clinical, social and environmental factors accounting for hospital-specific differences in hospitalization.

Clinical Implications: Total adult ED asthma visits increased, but prevalence-adjusted ED visits, and hospitalizations from the ED have declined. Low-income and uninsured patients are less likely to be hospitalized, suggesting persistent health disparities. (30 words max)

Capsule Summary: Asthma hospitalizations may be preventable through high quality primary care. We demonstrate prevalence-adjusted U.S. adult ED asthma visits and hospitalization rates from the ED are decreasing, but still affected by several non-clinical patient and hospital factors.

Key Words: Asthma; Emergency Department; Emergency Service, Hospitalization.

Journal Subject Codes: Health Services; Quality and Outcomes; Asthma

Abbreviations: ED (emergency department)

Background

Asthma affects 1 in 12 U.S. adults and significantly impairs functional status and quality of life.¹ Even when well controlled, the disease course is characterized by periodic exacerbations,

leading to 1.9 million emergency department (ED) visits, 500,000 hospitalizations and \$18 billion in national health expenditures annually in the U.S.²⁻⁵ Asthma has been identified an ambulatory-care sensitive condition because prior evidence suggests hospitalizations can be avoided through high quality outpatient care, and adult asthma hospitalization rates have been proposed as a prevention quality indicator by the Agency for Healthcare Research and Quality.⁶

A majority of U.S. inpatient asthma hospitalizations originate in the ED; in 2005, nearly three-fourths of hospitalizations for asthma originated in the ED.⁷ Female sex and older age are associated with increased risk of admission from the ED for asthma;^{8,9} however, it is not known what hospital-level and socioeconomic factors are associated with hospitalization originating in the ED, or how the likelihood of being hospitalized from the ED visit varies across U.S. hospitals.

We used a nationally representative dataset of ED visits to describe trends in hospitalization after U.S. ED visits for asthma, identify patient and hospital characteristics that predict hospitalization, and describe variation in hospitalization rates after ED visits for asthma among U.S. hospitals.

Methods

We conducted a cross-sectional, descriptive, exploratory analysis of the Nationwide Emergency Department Sample (NEDS) using multiple variable hierarchical logistic regression to identify predictors of hospitalization after ED visits for asthma.¹⁰

Data Source

NEDS is the largest all-payer emergency department database in the U.S., containing an approximate 20-percent stratified sample of hospital-based EDs in the U.S. It is a component of the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality (AHRQ).¹⁰ NEDS contains data from billing records of 26 to 32 million ED visits per year from about 950 annually selected hospitals; details available in NEDS include patient demographics, visit disposition (home, transfer to another facility, admitted to hospital, or expired), up to fifteen diagnoses from the final setting (i.e., from the hospital bill if admitted, or from the ED bill), and hospital characteristics. By incorporating sampling weights provided in NEDS, we generated national estimates for ED utilization at both hospital and visit levels.

Study Population

We included ED visits by patients who had a Clinical Classification Software (CCS) code of asthma (128) as the principal diagnosis. CCS is an AHRQ tool for clustering International Classification of Diseases codes into clinically meaningful categories and has been utilized in prior studies of asthma utilization.¹¹

We excluded records with a disposition of neither discharge nor admission (left against medical advice, “not admitted, destination unknown”, and other transfer disposition), those who died in the ED, as well as records with missing values for age, gender, insurance, or income (overall 1.7% excluded). We tested for statistical significant differences between patient and hospital characteristics after exclusions.

Study Outcome and Variables

For each ED visit, the binary outcome of interest was probability of inpatient hospitalization (vs discharge) originating in the ED, hereafter referred to as “ED hospitalization rate.” ED visits were classified as admitted if they resulted in hospitalization or transferred to another hospital, because the decision to transfer a patient represents a similar higher use of resources rather than discharging the patient to outpatient management. Visits were classified as discharges if their disposition was “routine ED discharge,” “transfer to skilled nursing or intermediate care facility,” “home health care,” or “discharge or transfer to court or law enforcement.”

Patient and Hospital Variables

Patient characteristics included age (in 10-year intervals), gender, insurance status (private, Medicare, Medicaid, self-pay, or other type of insurance), median household income (national quartile within the patient’s home ZIP code), and comorbid illness using the index described by Charlson and colleagues.¹² Hospital characteristics included ED volume (less than 20,000; 20,000 to 50,000; greater than 50,000 annual visits), teaching status and setting (metropolitan teaching, metropolitan non-teaching, non-metropolitan), trauma center designation (vs. non-trauma center), and geographic region (Northeast, Midwest, South, West). Metropolitan statistical area was omitted because of overlap and collinearity with teaching status and setting. All variables were defined a priori.

Statistical Analysis

National estimates of ED visits and ED hospitalization rates for asthma were estimated accounting for NEDS’s complex sampling design and sampling weights. Trends in ED visits and

ED hospitalization rates from 2006 to 2014 were tested by applying logistic regression modeling with year as independent variable. In order to estimate the population-adjusted incidence of ED visits and hospitalizations among persons with asthma, we obtained national estimates of asthma prevalence, defined as “lifetime asthma, current asthma, and having one or more asthma attacks among those with current asthma” from the 2006-2014 National Health Interview Survey publicly available web tables, derived from surveys on non-institutionalized adults.¹³

In order to account for the correlation among patients presenting to the same hospital ED, we used hierarchical multivariate logistic regression to test the associations of patient and hospital characteristics with ED hospitalization rates and variation in hospitalization rates. We used mixed-effects logistic regression to model the log odds of binary outcome (admit vs. discharge) as a linear combination of the predictor variables when data are clustered or there are both fixed and random effects, as per prior studies examining admissions and readmissions.¹⁴ As hospital identifiers are not linked across years, we limited our analysis of hospital predictors to the 2014 NEDS dataset to prevent underestimating hospital variance due to overestimating the number of hospitals. As per HCUP recommendations, sampling weights were not used in multilevel modeling, as they add additional complexity without differences in findings.¹⁵

To account for differences in patient-mix across hospitals, risk-standardized admission rate (RSAR) is used to describe hospital variation. To estimate RSAR, we calculated the ratio of predicted to expected admissions for each hospital (RSAR ratio) and multiplied by the crude national admission rate. A hospital's predicted hospitalizations were the sum of admission probabilities for all patients in the hospital, applying each hospital's own specific effect on admission. Expected admissions were the sum of hospitalization probabilities for the same patient-mix, applying a national-average hospital effect on hospitalization.

Finally, we compared hospital factor variance to residual variance to estimate intra-class correlation (ICC) and determine the amount of variation explained by hospital effects on hospitalization probability. We applied this to models with and without adjustment for hospital characteristics. All analyses were performed in Stata 15. The study used only de-identified data and therefore was not human subjects research, and did not require Institutional Review Board review.

Results

Total ED visits for asthma increased from 1.06 million in 2006 to 1.22 million in 2014, representing an increase of 14.6% (**Table 1** and **Figure 1**). The total number of hospitalizations from the ED remained stable from 2006 to 2014. The likelihood of hospitalization originating from the ED decreased from 20.9% in 2006 to 18.2% in 2014 (2.7% decrease, $p < 0.001$). Mean patient age was 43.7 (+/- 17.2) years (**Table 2**). The majority of ED visits for asthma were among female patients (63.3%), and occurred at metropolitan teaching hospitals (57.3%) and those with the highest annual ED census (>50,000 annual ED visits, 57.3%). A plurality of ED visits were made by patients in the lowest income quartile (40.5%), with Medicaid (33.9%), or in the South (37.5%). Patients in the West (16.8%), top income quartile (12.9%), non-metropolitan (12.6%) and low ED volume hospitals (<20,000 annual visits, 10.2%) accounted for the lowest proportion of ED visits.

After accounting for the increasing prevalence of asthma among adults using age-specific CDC prevalence estimates from the 2014 National Health Interview Survey, the trend suggests a 10% decrease in the number of ED visits per 1000 persons with asthma, from 43.9 in 2006 to

39.9 in 2014, and an even larger 21% decrease in hospitalizations, from 9.2 per 1000 in 2006 to 7.3 per 1000 in 2014.

The 2014 multilevel model included 271,408 visits across 933 hospitals; there were no statistically significant differences in any patient or hospital characteristics between the analytic and original sample after exclusions. After adjusting for patient and hospital-level factors, hospitalization after an ED visit was independently associated with increasing age, female sex (OR 1.23, 95% CI 1.20 - 1.26), higher Charlson comorbidity tier (OR=1.99 per additional point increase, 95% CI 1.97 - 2.01), and public insurance (Medicaid (OR=1.05, 95% CI 1.01 - 1.08; Medicare OR=1.26, 95% CI 1.22- 1.31) relative to private insurance (**Table 3**). ED hospitalization was less likely for visits with self-pay or uninsured status (OR=0.7, 95% CI 0.67- 0.73) relative to commercially insured, and lower income quartile (OR=0.89, 95% CI 0.85 - 0.93). Among hospital characteristics, hospitalization was associated with hospital trauma status (OR=1.34, 95% CI 1.12 - 1.60), and annual ED visit volume >50,000 (OR=1.19, 95% CI 1.02 - 1.39), and less likely among hospitals in the West (OR=0.69, 95% CI 0.56 - 0.83) and Midwest (OR=0.84, 95% CI 0.69 - 1.01) relative to the Northeast.

Asthma ED hospitalization rates varied between hospitals. The median hospital risk-standardized hospitalization rate was 19.14 % (interquartile range 12.33% to 27.72%). The residual intra-class correlation coefficient (ICC) for variance in ED hospitalization rate by hospital site was 16.8% after adjusting for patient and hospital characteristics. After additionally adjusting for hospital variables, the residual ICC, or institution-specific effect was 15.8%, indicating hospital characteristics explained only a small part of the variation.

Discussion

We performed a cross-sectional study of the largest national ED dataset to describe trends and characteristics associated with ED visits and hospitalizations for asthma among U.S. adults from 2006 to 2014 and found a 15% increase in total ED visits, with a decrease in ED hospitalization rates, resulting in stable numbers of hospitalizations originating in the ED over the study period. After accounting for asthma prevalence in the NHIS, we observed a 10% decrease in prevalence-adjusted ED visits per thousand and 21% reduction in hospitalizations per thousand. This reduction in acute care utilization among adults with asthma represents a change from the 2001 to 2009 period, during which the incidence of ED visits and hospitalizations remained stable, suggesting improved outpatient management of chronic asthma has led to lower rates of acute care utilization for asthma. However, the rising disease prevalence and increase in total ED visits demonstrate the significant role the ED continues to play in the management of acute asthma.

The reduction in prevalence-adjusted ED visits and hospitalizations per thousand is likely multifactorial, and may be driven in large part by year-over-year increases in the incidence of asthma.¹⁶ The rise in prevalence (denominator) and reduction in acute care use (numerator) may also be explained by higher rates of diagnosis and control, as a result of improved adherence to asthma diagnosis and treatment guidelines,¹⁷ and improved access to primary care as a result of policies such as Medicaid expansion through the Affordable Care Act.¹⁸

Among patient characteristics, both Medicare and Medicaid were associated with increased likelihood of hospitalization, while patients who were uninsured or had lower income were less likely to be admitted. In fact, patients who were uninsured or self-pay were over 30% less likely to be admitted than patients with commercial insurance. Uninsured asthma patients may be more likely to visit the ED for lower acuity exacerbations as a result of barriers to

obtaining asthma medications or accessing health care in other outpatient settings; for example, insufficient primary care access has been previously reported as a reason for seeking ED care among asthma patients.¹⁹ Even after adjusting for insurance status, patients from zip codes with the lowest incomes were least likely to be admitted. While it is possible uninsured patients and/or those with lower income were more likely to decline hospitalization due to financial consequences, our findings could also be explained by lower acuity visits among low-income/uninsured patients. These findings are consistent with prior studies of asthma patients in a universal health care system, which demonstrated that poverty and associated low health literacy are significant barriers to navigating the health care system, resulting in reduced access and medication adherence despite having insurance.²⁰⁻²² It is less likely that patients with commercial insurance or higher income were selectively admitted for financial reasons, as the decision to admit is made by clinicians who are typically unaware of insurance status, though recent studies have suggested that uninsured or Medicaid patients requiring hospitalization for asthma are more likely than commercially insured patients to be transferred in the absence of obvious medical indication for transfer.²³ Prior studies have shown that certain patient demographic characteristics, including African-American race, female sex, older age, lower income and residence in a metropolitan area are associated with increased overall hospitalization rates among adults with asthma.^{8,9,24,25} Our finding that patients with Medicaid or Medicare insurance are more likely to be admitted from the ED is likely explained by the poorer health status associated with eligibility criteria for public insurance, including income below or near federal poverty level, or disability status.

Hospital factors independently associated with increased likelihood of hospitalization included metropolitan location, teaching status, trauma center designation, and Southern or

Northeastern region. ED visits occurring in the Northeast and South accounted for the largest proportion of ED visits and were independently more likely to result in hospitalization, despite slightly lower rates of asthma prevalence in these regions.¹³ This regional variation may be attributed to environmental factors affecting asthma severity and likelihood of requiring emergent care. Patients with asthma in the South have previously reported worse perceived health status compared to patients in other regions.²⁶ Metropolitan teaching and metropolitan non-teaching hospitals were associated with increased likelihood of ED hospitalization, adding to prior national studies demonstrating increased asthma morbidity among poor inner-city residents despite similar urban and rural asthma prevalence.²⁶ Higher ED hospitalization rates at urban teaching facilities may be related to case mix and socioeconomic factors not fully captured by standard comorbidity indices or administrative data or may be due to less efficient practice patterns described at teaching facilities.²⁷ The same factors that account for increased hospitalization rates among patients with asthma at metropolitan teaching hospitals may also explain the higher readmission rates observed at safety-net hospitals, which are more likely to be penalized by the Centers for Medicare and Medicaid Services (CMS) Hospital Readmission Reduction Program.²⁸ The regional patterns are consistent with prior studies of variation in regional care intensity, suggesting higher ED hospitalization rates for asthma in these areas may be driven by higher inpatient-based and specialist-oriented patterns of care, greater bed availability and physician supply, which have been identified as drivers of variation in Medicare expenditures.²⁹

Even after adjusting for patient and hospital characteristics, one-sixth of the variance in ED hospitalization rates for asthma (ICC of 15.8%) depends on the hospital at which the ED visit occurs. Unmeasured, potentially modifiable hospital-specific factors such as local practice

patterns, and less readily modifiable local factors, such as air quality, primary care availability, racial disparities in access to care likely explain this residual variation. Broader adoption of evidence-based interventions to improve asthma control and reduce asthma-associated ED visits and hospitalizations through care coordination, protocol-driven care, community health workers and/ or patient navigators may also reduce unexplained variation.^{30,31} Our findings reinforce prior research demonstrating unexplained variation in ED hospitalization rates at the hospital level, which represents an opportunity for quality improvement.³²

Limitations

Our findings are subject to several limitations. Asthma encompasses a broad clinical spectrum and the NEDS administrative dataset does not include clinical data regarding patients' severity at the time of initial ED presentation, such as their vital signs, which influences hospitalization rates. We did, however, adjust for age and comorbid conditions with the Charlson score, a well validated predictor of in-hospital mortality.^{12, 33} Additionally, NEDS does not include demographic variables such as race or ethnicity, which are known to be associated with disparities in asthma outcomes; however, we adjusted for income and insurance status to account for socioeconomic differences in health outcomes. Second, patients are not individually identified, so some may have accounted for multiple visits within the sample, but these account for a small proportion of the overall visit total. Third, NEDS includes only ED visits; therefore, our analysis is limited to patients admitted to the hospital through the ED. Patients admitted directly to the hospital (e.g. from a clinic) account for a minority (11%) of asthma hospitalizations and differ from hospitalizations originating in the ED with respect to patient and hospital characteristics.³⁴ To calculate utilization rates among persons with asthma, we used

NHIS estimates, which exclude institutionalized adults, potentially leading to a slight overestimate of ED visits and hospitalizations. However, institutionalized adults accounted for less than 4% of Medicare beneficiaries in 2015, and because the difference applies to all years, it does not alter our finding of a decrease in prevalence-adjusted ED and hospitalizations per thousand.³⁵ Additionally, the NEDS does not include observation care, which is technically classified as an outpatient level of care, and is an increasingly utilized pathway for the management of conditions that do not necessarily warrant inpatient hospitalization.³⁶ However, observation use likely had little effect on overall results, because in 2014 only 1.3% of ED visits resulted in observation use, a rise from 0.9% in 2006; this 0.4% increase does not account for the 2.7% decrease in hospitalization rates we observed.³⁷

Conclusion

From 2006 to 2014, total ED asthma visits increased, while prevalence-adjusted rates of ED visits and ED hospitalizations decreased. However, the likelihood of hospitalization was independently associated with several non-clinical factors, including income, insurance status, hospital type location, suggesting significant disparities and variation in the acute care of asthma. Our findings suggest a need for additional research to identify institutional practices or social and environmental factors that account for widespread variation in hospitalization rates for asthma. Further research is needed to determine if variation in ED hospitalization rates is associated with differences in patient outcomes.

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None.

Conflicts of Interest

No conflicts to disclose (all authors).

Disclosures

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https://www.cdc.gov/nchs/data/nhamcs/web_tables/2014_ed_web_tables.pdf. Accessed August 25, 2018.

Table 1. National Estimates of ED Volume and Hospital Hospitalization Rate for Asthma, (2006 – 2014).

Year	Total ED visits	ED visits per 1000 persons with asthma	Total hospitalizations originating in ED	Hospitalizations from ED per 1000 persons with asthma	ED hospitalization rate (% of ED visits admitted)
2006	1,064,305	43.9	222,062	9.2	20.9
2007	1,095,562	44.9	225,655	9.2	20.6
2008	1,142,187	40.4	252,469	8.9	22.1
2009	1,189,634	40.0	265,665	8.9	22.3
2010	1,205,781	41.5	248,640	8.6	20.6
2011	1,175,392	40.5	240,919	8.3	20.5
2012	1,240,726	41.8	237,140	8.0	19.1
2013	1,247,343	44.5	238,720	8.5	19.1
2014	1,220,180	39.9	222,672	7.3	18.2

Table 2. Patient and Hospital Characteristics for Asthma ED Visits, 2014.

	Weighted national Estimate (N)	% of ED Visits
All Visits	1,198,377	
Mean age (SD)		43.67(17.21)
Female	758,463	63.29
Male	439,914	36.71
Insurance		
Medicare	250,561	20.91
Medicaid	406,033	33.88

Private insurance	285,312	23.81
Self-pay/No charge	208,694	17.41
Other	47,777	3.99
Income*		
First quartile	485,275	40.49
Second quartile	333,129	27.80
Third quartile	225,437	18.81
Fourth quartile	154,536	12.90
Region		
Northeast	272,636	22.75
Midwest	274,796	22.93
South	449,455	37.51
West	201,489	16.81
Hospital location and teaching status		
Metropolitan, non-teaching	361,629	30.18
Metropolitan, teaching	686,226	57.26
Non-metropolitan	150,522	12.56
Trauma Center	351,038	29.29
Annual ED Visits		
<20,000	122,765	10.24
20,000-49,999	388,803	32.44
>=50,000	686,809	57.31

* National quartile of the median household income of the patient's home ZIP code

Table 3. Patient and Hospital Characteristics Associated with Hospitalization from ED, 2014.

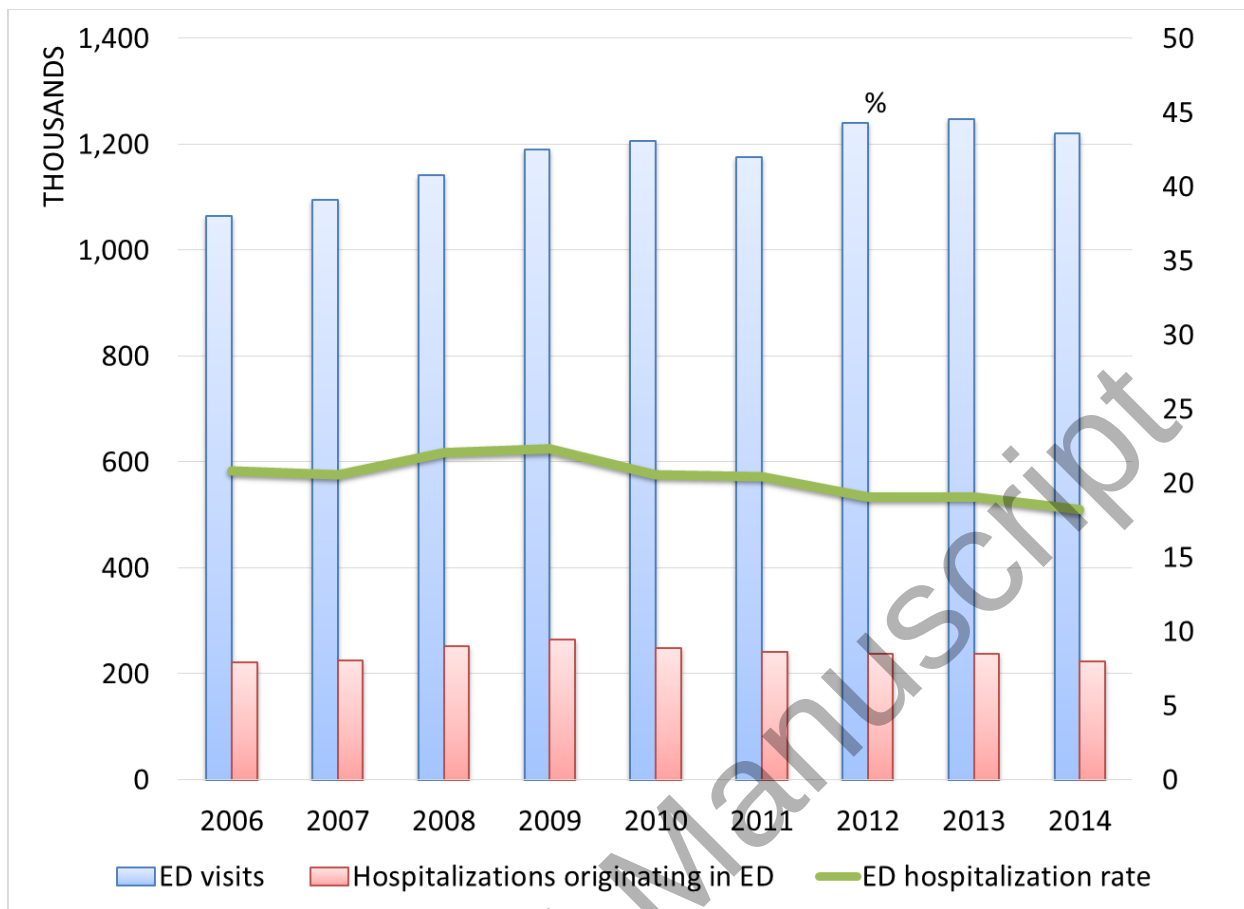
	Probability of Admission from ED	Unadjusted Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)
<i>Patient Characteristics</i>			
Age in years			
18-29	5.83%	ref	ref
30-39	9.73%	1.47***	1.46***
		(1.38 - 1.57)	(1.40 - 1.53)
40-49	16.21%	2.23***	2.30***
		(2.07 - 2.40)	(2.21 - 2.40)
50-59	24.62%	3.05***	3.14***
		(2.82 - 3.30)	(3.01 - 3.28)
60-69	34.86%	3.74***	3.92***
		(3.46 - 4.04)	(3.73 - 4.11)

70-79	45.81%	4.34***	4.38***
		(3.96 - 4.77)	(4.12 - 4.64)
80+	57.93%	6.37***	6.26***
		(5.72 - 7.09)	(5.85 - 6.69)
Sex			
Female	20.69%	1.28***	1.23***
		(1.22 - 1.33)	(1.20 - 1.26)
Primary Insurance Type			
Medicare	38.60%	1.28***	1.26***
		(1.21 - 1.36)	(1.22 - 1.31)
Medicaid	14.60%	1.04	1.045**
		(.97 - 1.13)	(1.01 - 1.08)
Uninsured or Self-Pay	7.80%	0.67***	0.70***
		(.60 - .74)	(.67 - .73)
Other No Charge	15.20%	1.09	1.06
		(.95 - 1.24)	(.99 - 1.13)
Commercial Private	14.80%	ref	ref
Income (increasing quartile of median income for zip code)			
1 st quartile (lowest)	17.80%	0.98	0.888***
		(.85 - 1.13)	(.85 - .93)
2nd quartile	18.30%	1	0.95*
		(.88 - 1.14)	(.91 - 1.00)
3 rd quartile	18.90%	1	0.98
		(.91 - 1.10)	(.94 - 1.03)
4 th quartile (highest)	21.40%	ref	ref
Increased Charlson risk point			
		1.82***	1.99***
		(1.75 - 1.89)	(1.97 - 2.01)
Hospital Characteristics			
Trauma center status	19.00%	1.06	1.336***
		(.86 - 1.31)	(1.12 - 1.60)
Teaching Status			
Metropolitan teaching hospital	19.30%	0.96	1.01
		(.81 - 1.14)	(.86 - 1.18)
Non-metropolitan hospital	13.60%	0.71***	0.83**
		(.60 - .83)	(.71 - .96)
Metropolitan Non-teaching hospital	19.30%	ref	ref

Region			
Midwest	18.40%	0.80*	0.84*
		(.63 - 1.00)	(.69 - 1.01)
South	19.50%	0.86	0.96
		(.68 - 1.08)	(.81 - 1.15)
West	16.20%	0.59***	0.69***
		(.47 - .74)	(.56 - .83)
Northeast	19.30%	ref	ref
Annual ED Visits			
50,000 or more	19.20%	1.08	1.12
		(.87 - 1.34)	(.92 - 1.36)
20,000-49,999	18.60%	1.05	1.19***
		(.88 - 1.27)	(1.02 - 1.39)
< 20,000	15.10%	ref	ref
Group variable = hosp_ed			933
Number of strata		86	
Number of PSUs (primary sampling unit)		933	
Number of observations	271,040	271,040	271,040
Population size		1,198,377	
*Hospital ED variance			1.85*** (0.07)
			(0.55 - 0.69)
LR test vs. logistic model			
		chibar2(01) = 11502.66	Wald chi2(23) = 42026.71
		Prob >= chibar2 = 0.0000	Prob > chi2 = 0.0000
Residual intraclass correlation			
Level	ICC	Std. Err.	95% Conf. Interval
Hospital ED	0.1578879	0.0077938	(.1432056 - .1737703)

*** p<0.01, ** p<0.05, * p<0.1

Figure 1. National Trends in Adult Asthma ED Visits, Inpatient Hospitalizations Originating in the ED , and Likelihood of Hospitalization Originating in ED (2006 – 2014).



* See **Table 1** for values.