



Published in final edited form as:

Acad Pediatr. 2015 ; 15(2): 225–230. doi:10.1016/j.acap.2014.10.011.

Children's Emergency Department Use for Asthma, 2001–2010

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Abstract

Objectives—Though the emergency department (ED) provides essential care for severely ill or injured children, past research has shown that children often visit the ED for potentially preventable illnesses, including asthma. We sought to determine how children's rate of ED visits for asthma has changed over the last decade, and analyze what factors are associated with a child's potentially preventable ED visit for asthma.

Methods—We retrospectively analyzed ED visits by children aged 2–17 from 2001–2010 using data from the National Hospital Ambulatory Medical Care Survey. Visits were classified as potentially preventable asthma visits by mapping ICD-9-CM diagnosis codes to the Agency for Healthcare Research and Quality's asthma pediatric quality indicator. We examined trends in the annual rate of ED visits for asthma per 1000 children using a weighted linear regression model. Finally, we used multivariate logistic regression to determine what demographic, clinical, and structural factors were associated with a child's ED visit being for a potentially preventable asthma crisis.

Results—The rate of children's ED visits for asthma increased 13.3% between 2001 and 2010, from 8.2 to 9.3 visits per 1000 children ($p=0.26$). ED visits by children who were younger, male, racial or ethnic minorities, insured with Medicaid/CHIP, and visiting between 11pm – 7am were more likely to be for potentially preventable asthma crises.

Conclusions—Though the overall rate of potentially preventable ED visits for asthma did not significantly change over the last decade, racial, insurance-based, and other demographic disparities in the likelihood of a preventable asthma-related ED visit persist.

Keywords

asthma; emergency department utilization; National Hospital Ambulatory Medical Care Survey

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Conflicts of interest: The authors have no conflicts of interest to report.

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Introduction

In 2011, 19% of all U.S. children had at least one visit to the emergency department (ED), amounting to a total of 25 million ED visits by children annually.^{1,2} While the ED represents an essential point of healthcare access for severely ill or injured children, many children seek treatment in the ED for potentially preventable reasons.³

Due to the high cost of ED care and the strained emergency care system, recent focus has been directed towards reducing ED visits that could have been either treated in a primary care setting or prevented by improved access to and quality of primary care.^{4,5} Children, who account for one in five ED visits nationally, have not been immune to these efforts.² One condition often highlighted as a driver of preventable ED use is childhood asthma. Asthma can be effectively managed by medication and high-quality primary care,⁶ but can also quickly escalate into a respiratory crisis requiring emergency care if not controlled.⁷

Emergency department visits for asthma are often used as an adverse outcome for studies of the effectiveness of different asthma control therapies and practices,⁷⁻⁹ as well as those looking at the influence on the environment on children's asthma.^{10,11} However, studies of trends in and predictors of ED visits for asthma as measures of public health or the effectiveness of preventive care at the population level have mainly been limited to cross-sectional,¹² purely descriptive,^{13,14} or more dated analyses.^{15,16}

In the last decade, numerous initiatives and promising advances have been made in efforts to reduce asthma crises and associated preventable acute care use. The National Asthma Education and Prevention Program (NAEPP) of the National Institutes of Health's National Heart, Lung, and Blood Institute updated guidelines in 1997 and 2007 with scientific evidence describing diagnostic and treatment guidelines for physicians, including long-term strategies for monitoring and controlling asthma and preventing complications.¹⁷ There have been federally funded efforts to introduce initiatives to reduce ED visits for asthma, ranging from school asthma control programs to widespread dissemination of evidence-based guidelines.^{18,19} There have also been extensive state and local efforts to increase preventive medication use for asthma²⁰ and reduce acute care use.⁹

To see whether these efforts have made an impact on preventable outpatient acute care use, we analyze the trends in ED visits by children for asthma from 2001 to 2010. We also identify the demographic, clinical and structural characteristics associated with pediatric ED visits for a potentially preventable asthma crises over this time period. The trajectory of and factors associated with children's ED use for asthma can help identify trends in children's access to and quality of preventive asthma care, and target areas to reduce these potentially preventable ED visits.

Methods

Study Design and Data Sources

We conducted a retrospective analysis of hospital emergency department visits by children using data from the 2001–2010 National Hospital Ambulatory Medical Care Survey

(NHAMCS). NHAMCS is a survey of ambulatory care visits to nonfederal, general, short-stay US hospitals conducted annually by the National Center for Health Statistics (NCHS). To generate a national probability sample of ED visits, NHAMCS employs a three-stage sampling design: 112 geographic primary sampling units, approximately 480 hospitals within primary sampling units, and patient visits within EDs at each hospital.^{21,22}

For each sampled visit, US Census Bureau field representatives or hospital staff complete a patient record form based on the patient's medical record. The data collected includes demographic information as well as clinical variables such as vital signs, cause of injury, diagnoses, medications, and discharge status. SRA International, Inc., Durham, NC performed the data processing. A 10% sample is independently coded for quality assurance; typical error rates found from the resulting comparison are 0.3–0.9%.

The survey data was analyzed using sampled visit weights provided by NCHS. The weights are the product of the sampling fractions at each stage of the design, and take into account non-response rates within geographic region, time of year, demographic oversampling, and urban/rural and ownership designations. The final weighted visit counts represent national estimates of ED visits and associated characteristics. When computing rates of ED use per population, we used corresponding population denominator numbers from the U.S. Census Bureau.

The NCHS Research Ethics Review Board approves the NHAMCS annually. This study was exempt from review by the Committee on Human Research at the University of California San Francisco, as only de-identified data was used.

Sample Selection

We included all ED visits by children 17 years and under. Within this group, we excluded children covered by Medicare (4.5%), as they are typically severely ill and disabled and their ED use is therefore not comparable to our remaining sample. To limit the range of the clinical severity of visits, we also excluded patients who died in the ED (0.01%). Finally, per the specifications of AHRQ's potentially preventable asthma measure, we excluded patients younger than two years old.

Outcome

Our primary outcome was ED visits by children with a principal ICD-9-CM diagnosis code for asthma, as specified in the Agency for Healthcare Research and Quality's (AHRQ) asthma pediatric prevention quality indicator.²³ While the measure was primarily intended to measure preventable hospitalizations for asthma, the corresponding adult asthma measure has been used with ED visits in the past.^{24,25} In addition, similar categorizations of asthma diagnoses have been used as a measure of preventable asthma crises requiring acute care in previous studies.^{26,27}

Covariates

We defined numerous demographic and clinical visit characteristics that could be associated with a child's ED visit was for asthma a priori, based largely on previous literature.^{12,28} We

examined demographics including patient age (2–5, 6–9, 10–13, and 14–17 years old), insurance coverage (private, Medicaid/CHIP, self-pay/uninsured, and other), gender, and race (non-Hispanic White, non-Hispanic Black, Hispanic, and other).^{12,29} We also examined basic visit characteristics including arrival method (ambulance, walk-in), arrival day (weekend, weekday), arrival time (7am–3pm, 3pm–11pm, 11pm–7am), whether the patient was discharged from hospital within the previous seven days, and whether the patient had been seen at that ED in the last 72 hours. In addition, we examined clinical variables including triage level (need to be seen in <15 min, 15min–1hr, 1–2hrs, 2–24hrs; corresponding to immediate/emergent, urgent, semi-urgent, and non-urgent classifications) as determined by a triage nurse, and if the patient had any abnormal vital signs (pulse rate, blood pressure, temperature, or respiratory rate) given their age.^{30–32} Finally, we included the hospital's geographic region (Northeast, Midwest, South, West), and whether the hospital was in a urban or rural Metropolitan Statistical Area (MSA).

Statistical Analysis

Using denominators from the US Census Bureau, we computed annual rates of ED visits for asthma per 1000 US children ages 2–17 and examined trends in the rates descriptively. We then analyzed the change in pediatric ED visit rates for asthma from 2001 to 2010 using a linear regression model weighted for population. Finally, we analyzed the association of the previously described demographic and structural factors with pediatric ED visits for asthma using a multivariate logistic regression model, which also incorporated NHAMCS sampling weights. Analyses were performed using SAS (version 9.2; SAS Institute, Cary, North Carolina) and SUDAAN (version 10.0; RTI International, Research Triangle Park, North Carolina).

Results

We analyzed 62,849 pediatric ED visits between 2001 and 2010, representing 211 million visits nationally. Just under three percent of the visits were for potentially preventable asthma crises, with the weighted annual count rising 16% from 531,374 visits for asthma in 2001 to 615,958 in 2010. However, when adjusted for population, there was no significant trend in the rate of ED visits for asthma per 1000 children ages 2–17 from 2001 to 2010 ($p=0.26$). Though the absolute change from 2001 to 2010 was 13.3%, there were significant fluctuations year to year and no definitive direction was noted upon analysis with weighted linear regression (Figure 1). Similarly, the rate of ED visits for non-asthma diagnoses also exhibited no significant trend between 2001 and 2010 ($p=0.16$).

As shown in Table 1, in an unadjusted descriptive comparison visits for asthma were more likely to be by younger, male patients, racial or ethnic minorities, children with Medicaid insurance, children visiting from 11pm–7am and children seen at urban hospitals compared to non-asthma visits. Children presenting with asthma were also more often admitted and had shorter triage times compared with those visiting the ED for another condition.

Our multivariate logistic regression showed that numerous demographic and clinical visit characteristics increased the odds that a visit was for a potentially preventable asthma crisis, even after adjustment for other influential factors (Table 2). For instance, ED visits by

younger children and male children were more likely to be for potentially preventable asthma crises, as were visits by black and Hispanic children compared with white children. In addition, visits by children covered by Medicaid/CHIP had higher odds of being for potentially preventable asthma concerns than visits by privately insured children. Finally, pediatric ED visits with shorter triage times, visits at urban hospitals, visits occurring between 11pm and 7 am, and visits resulting in admission all had higher odds of being for a potentially preventable asthma crisis.

Discussion

Over the last decade, we found that minority race, Medicaid insurance, younger age, and arrival between 11pm and 7am, for example, were associated with increased odds of an ED visit being for a potentially preventable asthma crisis. Rural residence and female gender, on the other hand, were associated with decreased odds of an ED visit being for a potentially preventable asthma crisis. These results provide updated evidence that disparities continue to persist in access to quality preventive asthma care and preventable acute care use for asthma.

Our findings align with previous literature detailing the higher self-reported rates of ED visits for asthma among Black,³³ Hispanic,³⁴ and younger children.¹⁶ They also correspond with previous studies showing higher overall ED visits by children with Medicaid insurance,²⁵ as well as lower healthcare use for asthma by girls,¹⁶ but stand in contrast to the evidence on worse primary care access for preventive asthma care in rural areas.³⁵

Many of the demographic groups that we find have higher odds of an ED visit being for potentially preventable asthma crises have higher prevalence of asthma, including racial minorities,³³ male children,¹⁶ children in urban areas,³⁵ and low-income children likely to qualify for Medicaid,¹⁴ which likely drives a portion of the higher likelihood of potentially preventable ED visits for asthma.

However, our finding that ED visits by otherwise similar children between 11pm and 7am had higher odds of being for potentially preventable asthma crises than visits occurring during the day suggests that these visits are related to a lack of primary care access, as most physician offices and clinics are closed during these hours. Past research has found that lack of after-hours access to primary care is consistent driver of ED use,³⁶ and that better self or parent-reported after-hours access to care is associated with lower ED use by children and adults.^{37,38} This evidence suggests continued room for improved asthma care delivery in the primary care setting to reduce potentially preventable acute care use, especially among vulnerable demographic groups.

We also found that visits during 3pm–11pm, during which time many primary care clinics are closed for at least a portion of the time, were significantly less likely to be for asthma than those between 7am and 3pm. This discrepancy could be due to other factors, including slightly extended hours by many clinics and potentially the limited availability of urgent care centers.

Overall, the rate of emergency department use by children ages 2–17 for asthma rose from 8.20 visits per 1000 US children in 2001 to 9.29 visits per 1000 in 2010, but the change was not statistically significant and involved many fluctuations over the decade. A number of factors may have contributed to the generally stable trend. For instance, despite an increase in the prevalence of asthma in children from 8.7% in 2001 to 9.4% in 2010,^{39,40} the numerous initiatives and promising advances to reduce asthma crises and associated preventable acute care use in this past decade may have had some effect. For example, in 1999 the CDC launched the National Asthma Control Program, which invested over \$238 million between 2001 and 2012 in territorial and state asthma control programs, school asthma control programs, national surveillance, and developing and disseminating best practices and evidence based guidelines.¹⁸ This huge effort was adapted locally in all states and implemented with different partners and stakeholders,⁴¹ and could have potentially affected the trajectory of potentially preventable ED visits for asthma.

In addition, environmental and behavioral trends during our study period, including improvements in air quality,⁴² and decreasing smoking prevalence,⁴³ should have reduced the prevalence of asthma triggers and the associated number of preventable asthma crises and ED visits. Finally, from 2001–2010 the proportion of children with private insurance dropped from 70% to 60%, while the proportion of children covered by Medicaid and CHIP/SCHIP programs rose from 23% to 36%.⁴⁴ Given overwhelming evidence that children with Medicaid have more difficulty accessing high-quality primary care than privately insured children,^{38,45,46} and perhaps the resulting evidence of their higher rate of potentially preventable ED use,^{25,47} this population-level insurance transition may have driven up the rate of ED use for potentially preventable asthma crises over time.

Limitations

There are several limitations to our study. First, because there is no linkage between visits in NHAMCS, we could not identify multiple visits by the same child. Therefore, our results only reflect rates of ED visits per 1000 children, not the proportion of the population with an ED visit. Second, as with all administrative data, there are limitations in the accuracy and ability to verify clinical data due to a combination of chart abstraction and keying errors.⁴⁸ However, there is no other nationally representative dataset that allows an analysis over this length of time to be performed. Because the purpose of this study is to present trends reflecting changes in the ability of the pediatric primary care system to prevent the need for ED use, we feel it is an appropriate use of the data.

Conclusion

Though the overall rate of potentially preventable ED visits for asthma by children did not change significantly between 2001 and 2010, ED visits by younger, male children, racial minorities, those enrolled in Medicaid/CHIP programs, and those visiting between the hours of 11pm – 7am had higher odds of being for potentially preventable asthma crises. Our findings that populations vulnerable to poor healthcare access continue to be the most likely to make preventable ED visits for asthma potentially suggest that efforts to decrease barriers to quality preventive care for asthma may be more effective when targeted more specifically at certain sub-populations.

Acknowledgments

Project Support: This project was supported by the National Center for Advancing Translational Sciences, National Institutes of Health, through UCSF-CTSI Grant Number KL2 TR000143 (R.Y.H), and the Robert Wood Johnson Foundation Physician Faculty Scholars Program (R.Y.H.). The sponsors had no role in the design and conduct of the study, in the collection, analysis, and interpretation of data, or in the preparation, review, or approval of the manuscript.

We especially thank Judy Maselli, MSPH, for her assistance with data analysis for this project.

Abbreviations

AHRQ	Agency for Healthcare Research and Quality
ED	emergency department
NCHS	National Center for Health Statistics
NHAMCS	National Hospital Ambulatory Medical Care Survey

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What's New

ED visits between 2001 and 2010 by children traditionally vulnerable to poor healthcare access were more likely to be for potentially preventable asthma crises than ED visits by their demographic counterparts, suggesting room for improvements in asthma care delivery.

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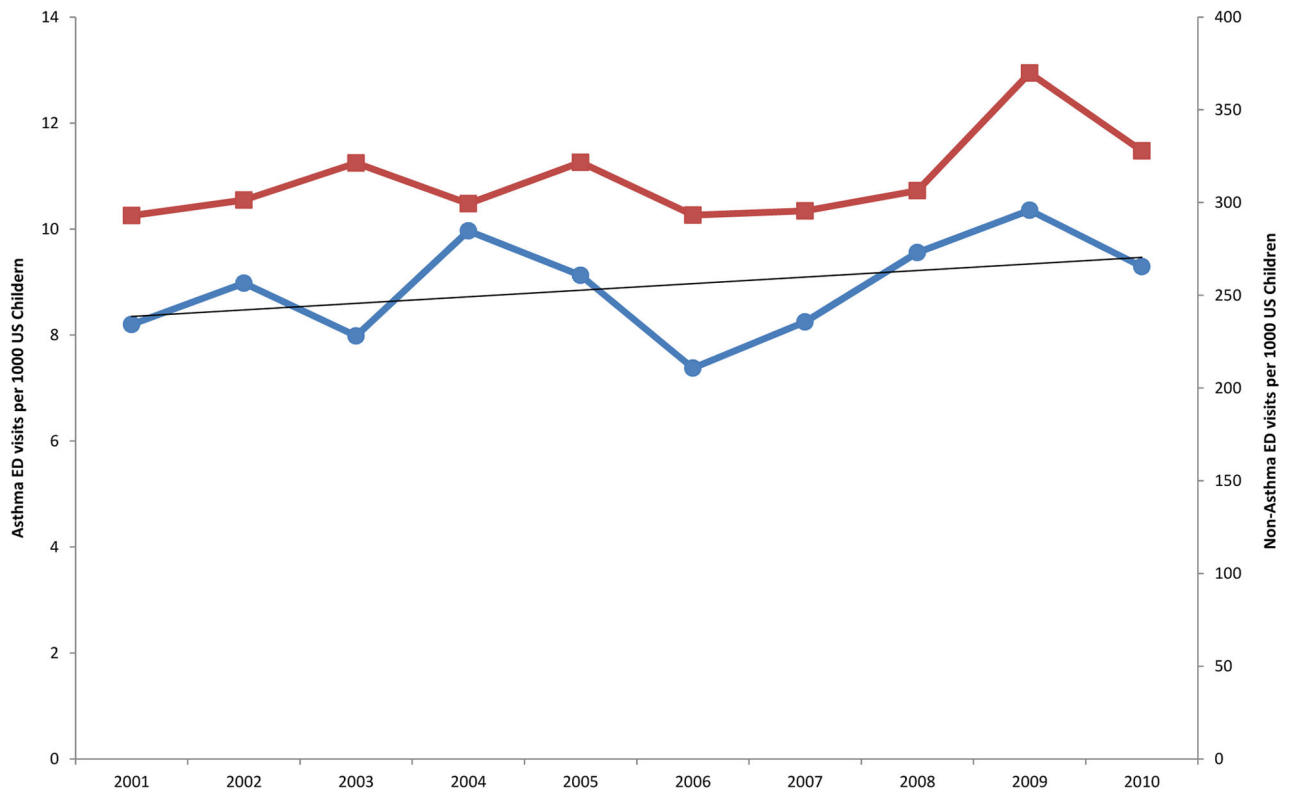


Figure 1.

Rates ED visits for potentially preventable asthma and non- potentially preventable asthma diagnoses by children ages 2–17, 2001–2010

Legend: Though ED visit rates for potentially preventable asthma diagnoses (blue line) rose from 8.2 per 1000 children in 2001 to 9.3 per 1000 in 2010 (13.3%) and other diagnoses (red line) diagnoses rose from 293 to 323 per 1000 (11.9%), there were many fluctuations and neither was statistically significant ($p = 0.26$ and 0.16 , respectively).

Table 1

Characteristics of pediatric ED visits by asthma classification, 2001–2010

	Asthma	Non-Asthma	
	No. of visits (col %)	No. of visits (col %)	p value
Total	5,841,628 (100%)	205,232,589 (100%)	
Age			
2–5 years	2,189,485 (37.5%)	68,221,554 (33.2%)	<0.01
6–9 years	1,534,378 (26.3%)	41,849,082 (20.4%)	
10–13 years	1,093,068 (18.7%)	40,619,837 (19.8%)	
14–17 years	1,023,697 (17.5%)	54,542,116 (26.6%)	
Gender			
Female	2,321,433 (39.7%)	97,888,803 (47.7%)	<0.01
Male	3,520,195 (60.3%)	107,343,786 (52.3%)	
Race			
NH white	2,287,741 (39.2%)	116,309,200 (56.7%)	<0.01
NH black	2,208,561 (37.8%)	45,987,147 (22.4%)	
Hispanic	1,172,623 (20.1%)	36,548,807 (17.8%)	
Other	172,703 (3.0%)	6,387,435 (3.1%)	
Geographic Region			
Northeast	1,297,980 (22.2%)	36,502,022 (17.8%)	<0.01
Midwest	1,415,000 (24.2%)	47,145,755 (23.0%)	
South	2,320,729 (39.7%)	86,059,909 (41.9%)	
West	807,919 (13.8%)	35,524,903 (17.3%)	
MSA			
Urban	5,218,664 (89.3%)	170,167,814 (82.9%)	<0.01
Rural	622,964 (10.7%)	35,064,775 (17.1%)	
Insurance			
Private	2,143,936 (36.7%)	88,055,285 (42.9%)	<0.01
Medicaid/CHIP	2,621,898 (44.9%)	78,519,895 (38.7%)	
Self-pay/uninsured	566,043 (9.7%)	19,640,080 (9.6%)	
Other [^]	180,931 (3.1%)	7,058,809 (3.4%)	
Missing	328,820 (5.6%)	10,958,520 (5.3%)	
Arrival			
Ambulance	117,958 (2.0%)	2,844,930 (1.4%)	0.29
Walk-in	1,076,776 (18.4%)	40,972,632 (20.0%)	
Unknown	4,646,894 (79.5%)	161,415,027 (78.6%)	
Arrival Time			
7am–3pm	2,041,342 (34.9%)	68,148,287 (33.2%)	<0.01
3pm–11pm	2,424,912 (41.5%)	107,944,134 (52.6%)	
11pm–7am	1,334,589 (22.8%)	27,214,840 (13.3%)	

	Asthma	Non-Asthma	
	No. of visits (col %)	No. of visits (col %)	p value
Unknown	40,785 (0.7%)	1,925,328 (0.9%)	
Triage			
<15 minutes	1,236,284 (21.2%)	21,978,909 (10.7%)	<0.01
15min–1 hr	2,511,213 (43.0%)	68,325,771 (33.3%)	
1hr–2hr	1,019,028 (17.4%)	58,182,384 (28.3%)	
2hr–24hr	266,361 (4.6%)	25,584,006 (12.5%)	
Unknown	808,742 (13.8%)	31,161,519 (15.2%)	
Arrival Day			
Weekend	1,886,067 (32.3%)	63,103,434 (30.7%)	0.36
Weekday	3,955,561 (67.7%)	142,129,155 (69.3%)	
Discharged w/in 7 days			
Yes	35,216 (0.6%)	1,454,745 (0.7%)	0.52
No	2,135,931 (36.6%)	78,874,421 (38.4%)	
Unknown	3,670,481 (62.8%)	124,903,421 (38.4%)	
Seen Before			
Yes	112,275 (1.9%)	4,527,958 (2.2%)	0.65
No	4,922,905 (84.3%)	173,743,578 (84.7%)	
Unknown	806,448 (13.8%)	26,961,053 (13.1%)	
Abnormal Vitals ^a			
Any abnormal	240,260 (4.1%)	10,443,419 (5.1%)	0.21
All normal	5,124,216 (87.7%)	176,126,614 (85.8%)	
Any missing	477,152 (8.2%)	12,662,556 (9.1%)	
Discharge Status			
Transfer	79,405 (1.4%)	2,922,524 (1.4%)	<0.01
Admitted to hospital	431,009 (7.4%)	6,452,480 (3.1%)	
Discharged/left	5,291,277 (90.6%)	193,591,559 (94.4%)	
Unknown	39,937 (0.7%)	2,215,299 (1.1%)	

^aThe range of normal for breaths per minute is 22 to 34 for those 2 to 5 years old, 18–30 for those 6 to 12 years old, and 12–16 for those older than 12 years. The range of normal for heart beats per minute is 80 to 140 for those 2 to 5 years old, 70 to 120 for those 6 to 12 years old, and 60 to 100 for those older than 12 years. The range of normal systolic blood pressure is 70 to 95 mm Hg for children 2 to 8 years old, and 90 to 140 mm Hg for those older than 8 years. Values that fell outside (above or below) these ranges were considered abnormal. Abnormal temperature was defined as a recorded temperature above 38°C/100.4°F. (see citations # 30 & 31)

Table 2

Results of multivariate logistic regression model of factors associated with potentially preventable ED visits for asthma by children ages 2–17, 2001–2010

	Adjusted OR (95% CI)
Age	
2–5	ref
6–9	1.2 (1.1, 1.4)
10–13	0.9 (0.8, 1.1)
14–17	0.6 (0.5, 0.7)
Gender	
Female	0.7 (0.6, 0.8)
Male	ref
Race	
Non-Hispanic white	ref
Non-Hispanic black	2.2 (1.9, 2.6)
Hispanic	1.4 (1.2, 1.7)
Other	1.2 (0.8, 1.7)
Geographic region	
Northeast	1.5 (1.2, 1.9)
Midwest	1.4 (1.1, 1.8)
South	1.1 (0.9, 1.4)
West	ref
MSA	
Urban	ref
Rural	0.7 (0.5, 0.9)
Insurance	
Private	ref
Medicaid/CHIP	1.2 (1.1, 1.4)
Self-pay/uninsured	1.2 (0.9, 1.5)
Other	1.0 (0.6, 1.7)
Missing	1.1 (0.8, 1.5)
Arrival	
Ambulance	1.0 (0.6, 1.7)
Walk-in	ref
Unknown	0.9 (0.8, 1.5)
Arrival time	
7am–3pm	ref
3pm–11pm	0.8 (0.7, 0.9)
11pm–7am	1.6 (1.3, 1.9)
Unknown	0.8 (0.4, 1.4)

	Adjusted OR (95% CI)
Triage	
<15 minutes	5.5 (3.8, 7.8)
15min–1 hr	3.6 (2.6, 5.1)
1hr–2hr	1.7 (1.2, 2.5)
2hr–24hr	ref
Unknown	2.5 (1.7, 3.7)
Arrival day	
Weekend	1.1 (0.9, 1.3)
Weekday	ref
Discharged w/in 7 days	
Yes	0.6 (0.3, 1.4)
No	ref
Unknown	1.0 (0.9, 1.2)
Seen before	
Yes	0.9 (0.6, 1.4)
No	ref
Unknown	1.0 (0.9, 1.3)
Abnormal vitals	
Any abnormal	0.9 (0.6, 1.3)
All normal	ref
Any missing	0.9 (0.7, 1.2)
Discharge status	
Transfer	0.8 (0.5, 1.5)
Admitted to hospital	1.9 (1.5, 2.4)
Discharged [^]	ref
Unknown	0.6 (0.3, 1.3)

[^] Includes left without being seen