Chronic Diseases – International

Open Access

Austin Publishing Group

Research Article

The Burden of Asthma: Delineation of Acute Healthcare Utilization among Asthma Patients in Missouri, 2007-2009

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Received: July 16, 2016; **Accepted:** August 25, 2016; **Published:** August 26, 2016

Abstract

Many people with asthma experience exacerbations. This study was conducted to describe the acute care utilization among patients with asthma in the state of Missouri and associated charges. Using the Patient Abstract System, records for Emergency Department (ED) visits; observation status; and hospital discharges with the principal diagnosis of asthma for a 3-year period (2007-2009) were linked for each patient using deterministic matching. The single record for each person was used in counting patients and in the analysis. There were a total of 115,299 acute care asthma visits for Missouri residents. The total number of ED visits, when ED visits plus hospitalization and ED visits plus observations were included was 106,443, or 20.1% higher than the 88,622 ED only visits to 73,162 total patients. Children aged ≤ 17 comprised 24.1% of Missouri's population, but represented more than 41.9% of patients using these services. Of the 68,792 patients with an ED visit, 75.8% had a single visit during the 3 years. Of those with ≥ 2 ED visits (n=16,644), African Americans (11.17 per 1,000, 95% CI 11.03-11.31) and children aged 0-4 (10.19 per 1,000, 95% CI 10.00-10.37) had the highest rates. Overall, 26.1% of the total patients were hospitalized, accounting for > 70% of the total $394.8 million. MO Health Net (Medicaid) was the most frequent expected pay source. Uncontrolled asthma places a heavier toll on emergency departments than previously published. Increased application of evidence-based asthma control care and exacerbation prevention strategies may substantially improve health and reduce costs.

Keywords: Asthma, Morbidity, Health services, Medical record linkage, Hospitalization

Abbreviations

AMA: Against medical advice; BRFSS: Behavioral risk factor surveillance system; CDC: Centers for disease control and prevention; DHSS: Missouri department of health and senior services; ED: Emergency department; ICD-9-CM: International classification of diseases, ninth revision, Clinical modification; LOS: Length of stay; PAS: Patient abstract system; RSMo: Missouri revised statute; SSN: Social security number

Introduction

Asthma, a chronic inflammatory respiratory condition, may lead to disability and adversely affect quality of life when not well controlled. Nationally, approximately 26.2 million adults [1] and children [2] and more than 600,000 people in Missouri have the condition. From 2001 to 2010, the prevalence of asthma in the US increased 1.4% per year among children aged ≤ 17 and 2.1% among adults aged ≥ 18 [3]. The increase was even greater among African-Americans and Hispanics, 3.2% per year. However, a recent study has found a decline in the prevalence of childhood asthma and a lessening in the white - black disparity in 2013 [4]. Improved scientific understanding of the disease has lead to substantial improvements in care [5]. Yet, many people are not well controlled and experience exacerbations that require emergency care or hospitalization.

While all health services have a cost, Emergency Department (ED) visits and hospitalizations are among the most costly. In the US, there were approximately 1.8 million ED visits (2011) and 439,000 hospitalizations for asthma (2010) [6,7]. In Missouri, there were 29,616 asthma ED only visits and 6,525 hospitalizations in 2013 [8,9]. Encounter data such as these are useful, but do not provide the number of individuals utilizing emergency services due to asthma or accurately reflect the total burden on emergency departments since patients seen in the ED and then are admitted, are often only captured in the hospitalization data. This was the case for about 50% of the 36 states participating in the National Asthma Prevention and Control Program in 2008-2009 [10] and this method of data capture continues for many of the states including Missouri. This study was conducted to determine the number of people with asthma in Missouri provided care in emergency departments, the populations with high utilization of acute health services, the percent with such serious asthma as to require hospitalization, and expected payment sources.

Methods

Data source

The Missouri Department of Health and Senior Services (DHSS) is the custodian of acute care hospital, ED, and ambulatory surgery center data for the State of Missouri. The Patient Abstract System

Citation: Homan S, Vantuinen M, Gaddy PD and Yun S. The Burden of Asthma: Delineation of Acute Healthcare Utilization among Asthma Patients in Missouri, 2007-2009. Chronic Dis Int. 2016; 3(1): 1023.

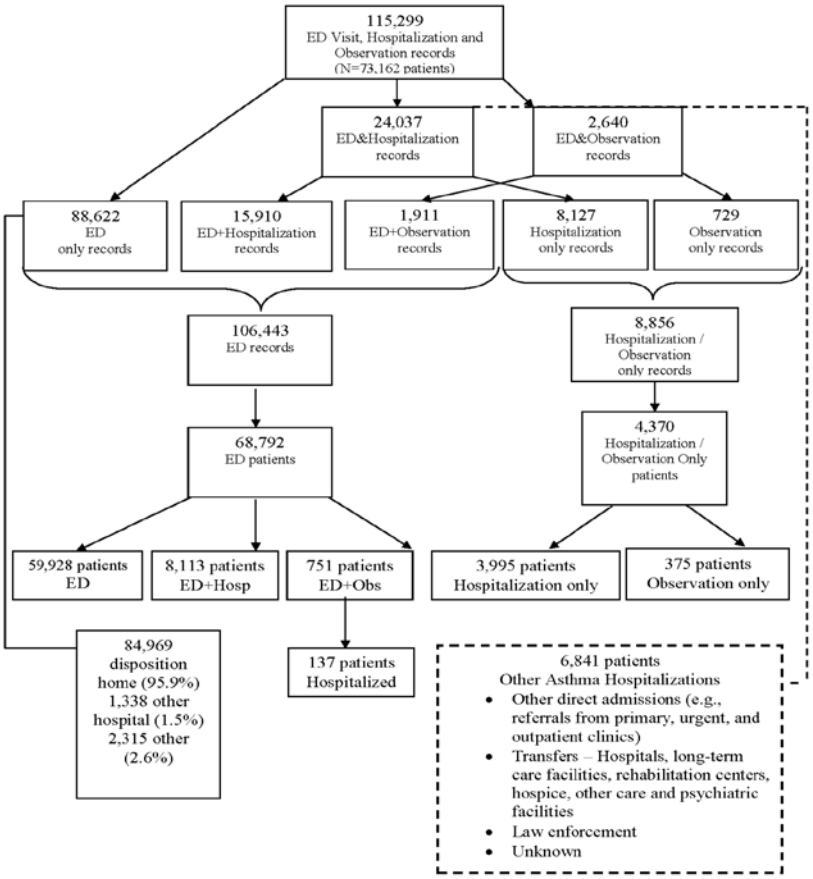

Figure 1: Study schema – Delineation of Acute Healthcare Utilization among Asthma Patients in Missouri, 2007-2009.

(PAS), established in 1993 by state statute (192.665 - 192.667RSMo), contains patient abstract records data for Missouri residents [11]. This system provides multiple elements, including demographics; ED visits; invasive and certain diagnostic procedures; admission, observation stays, and hospital discharge information; pay sources; and charges. Prior to data analysis, the DHSS Institutional Review Board reviewed the study and determined it to be exempt.

Identifying asthma patients

In the US, during the study period, the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) was the system used to classify and assign codes to health conditions. The ICD-9 code for asthma with any extension (493.xx) was used to select records [12]. Records for ED visits, observation-room discharges, and hospital discharges with the principal diagnosis of asthma for 2007-2009 were selected from the PAS. Outpatient surgery and 'Other Outpatient' records were excluded.

Data analysis

Although patients do not have identifiers that are the same within and across institutions, records were identified for each patient by using deterministic matching in multiple passes that used first and last name, date of birth, sex, race, Social Security Number (SSN), hospital identifier, and medical record number in various combinations. If SSN, first and last names matched, the records were linked; however, if SSN was missing, an iterative deterministic matching process was performed requiring an exact match on one of several passes but not on all possible identifiers. Finally, potential matches were manually reviewed and linked if matches were determined. Records for a patient were assigned the same identification number. Characteristics of patients included race, ethnicity, and assignment to age groups using the earliest patient's record. The proportion for each characteristic was compared to the 2008 Missouri population to assess disproportional use [13]. Further, in counting patients, one record for each person was selected giving priority to the ED records; if a patient had no ED record, than an admission record was selected, and if neither of these were present, then an observation record was selected. Insurance coverage compared the proportion of asthma patients that were self-pay or not charged to the Missouri population with no insurance coverage [14]. Charges for ED visits, hospitalizations, and observation visits were summed and the expected pay sources assessed. Data were analyzed using SAS 9.3 (SAS Institute, Inc. Cary, NC).

Patients with at least 1 ED visit were grouped into two categories: single exacerbation requiring 1 ED visit and multiple exacerbations requiring ≥ 2 ED visits. Rates and 95% confidence intervals were calculated to compare population groups. The rate was calculated using the total number of ED visits for the 3 years (numerator) divided by the sum of Missouri's population for the 3 year time period (denominator), then multiplied by 1,000. Hospitalization, Length Of Stay (LOS), procedures, and anoxia were included as indicators of episode severity and risk for future exacerbations or fatality. Deaths

Table 1: Characteristics of Patients with Asthma as the Principal Diagnosis for an Emergency Department Visit, Hospitalization or Outpatient Observation Status, Missouri, 2007-2009 compared to Missouri Population 2008.

Characteristic	Number	Percent	Missouri Population 2008 [13,14] Percent[a]
Overall	73,162	100.0	100.0
Race			
White	45,087	61.6	85.4
African-American	24,775	33.9	12.1
Other	2,797	3.8	2.5
Unknown	503	0.7	--
Age Group			
0-4	12,878	17.6	6.6
5-11	11,432	15.6	9.2
12-17	6,337	8.7	8.4
18-44	24,690	33.8	35.8
45-64	12,235	16.7	26.4
≥ 65	5,590	7.6	13.7
Gender			
Male	32,015	43.8	48.9
Female	41,147	56.2	51.1
Number of Health Care Visits per Patient[b]			
1	46,650	63.8	--
2-5	23,736	32.4	--
≥ 6	2,776	3.8	--
Health Care Visit Types			
ED Visit	59,928	81.9	--
ED Visit with hospitalization	8,113	11.1	--
ED Visit with observation stay	751	1.0	--
Hospitalization alone	3,995	5.5	--
Observation alone	375	0.5	--
Self Pay/No Charge v No Health Care Coverage[c]	11,930	16.3	12.6

--Not applicable

[a]May not sum to 100 due to rounding

[b]Emergency department visit, inpatient hospitalization, or outpatient observation status

[c]Study patients that were self pay or no charge compared to Missouri residents reporting no health care coverage

during the study period were also reviewed.

Identifying health care visits

Five categories of records were created: ED visit only, ED visit with hospitalization, ED visit with observation stay, Observation stay only and Hospitalization only. To obtain the number of people for each category, records were linked to create a single record per person and the single record was used in counting patients. To determine the total number of patients hospitalized, the ED visit with observation group was also linked to hospitalization records to determine the number whose status was changed to an inpatient.

Results and Discussion

Health care visits: ED visits, hospitalizations and observations

There were a total of 115,299 records with a principal diagnosis of asthma for the 3-year period (Figure 1). A total of 73,162 patients accounted for these visits (Table 1). Compared to the 2008 population, the age distribution for asthma patients suggests that the younger children were over represented, particularly children age 0 to 4 accounted for 17.6% of the asthma health care visits, but made up only 6.6% of the population. African Americans were also over represented, accounting for about 33.9% of the visits while comprising only about 12.1% of the population. Those 65 and older were under represented accounting for 7.6% of asthma health care visits but made up 13.7% of the population. Overall, children and adolescents ≤ 17 years of age accounted for 41.9% of the health care visits for asthma but comprised 24.1% of the population. There was also a slight excess of health care visits among females (56.2%) compared to their population size (51.1%). The number of health care visits for asthma was evenly distributed across the 3 years, but the number of individuals decreased substantially from 2007 to 2009 (27.9%). The majority of asthma patients (84.0%) had a visit in just one of the years, and just slightly > 3% had visits each year.

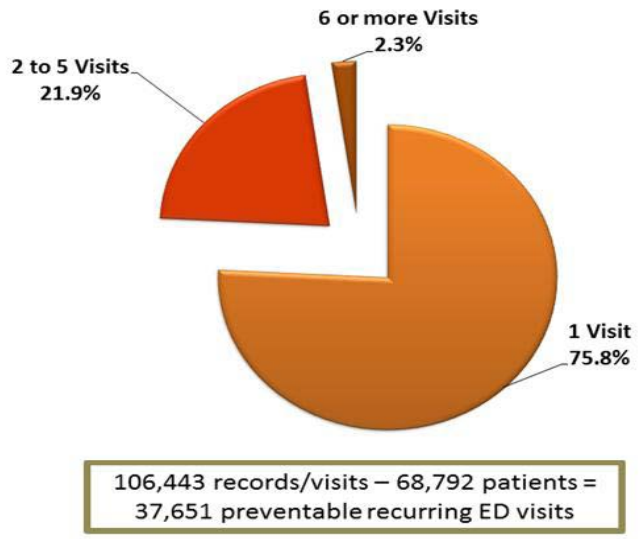

Figure 2: Percent of patients with a primary diagnosis of asthma by number of emergency department visits, Missouri, 2007-2009 (n= 68,792).

Emergency department visits, length of stay, and disposition

The number of ED visits when hospital admissions and observations through the ED were included was 106,443 records. Admissions from the ED accounted for 14.9% of the ED visit records, and observation records accounted for an additional 1.8%. A total of 68,792 patients accounted for the ED visits. Thus, it is estimated that about 94.0% of the patients with asthma in this study had ≥ 1 ED visit during the 3 years. Of these patients, 75.8% (n=52,148) had only one visit (Figure 2) and the average number of visits was 1.5 excluding one patient who had 149 visits. Of the patients with ≥ 2 ED asthma visits (n=16,644), African Americans and children age 0 to 4 had the highest rates (Table 2).

The ED visits should have only a one day LOS, but due to the practice of some hospitals of combining repeat visits for treatment into one record, or possibly some miscoding, the ED visits had a maximum LOS of 122 days. However, in reviewing these values, it was found that 99.9% of ED visits had ≤ 1 day LOS. Of the ED visits excluding hospital admissions and observations, 95.9% were discharged home, 1.5% resulted in a discharge to another hospital for further care, and the remaining 2.6% either left the ED against medical advice (AMA), were discharged to another type of facility, the discharge disposition was unknown, or the patient died.

Outpatient observation status and disposition

Observation patients should be moved out of observation status within 72 hours, but we found a maximum of 7 days. Patients given a designation of outpatient observation status with an extended stay and not admitted as an inpatient or reversed retrospectively may account for the longer LOS than expected. However, a review revealed that 99.5% of observation stays were < 72 hours. A total of 137 observation status patients became inpatients.

Hospital admissions, length of stay, and disposition

There were > 8,000 admission records for asthma each year with 19,086 patients accounting for these hospitalizations. This indicated that 26.1% of the asthma patients in this study were affected seriously enough to be admitted to a hospital. The majority of patients (37.8%) were aged ≤ 17 when admitted, followed by those aged 45 to 64 (24.3%), aged 18 to 44 (19.8%), and aged ≥ 65 (18.1%). The largest proportions of patients admitted to the hospital were Caucasian (64.2%) or African American (31.6%), and female (59.3%). Of these 19,086 patients, 15,114, or 79.2% had only 1 admission during the 3-year period, 3,730 (19.5%) had 2 to 5 admissions and 242 (1.3%) had ≥ 6 hospital admissions. The maximum number of admissions for one person was 40, or about 13 per year or once per month. There were 4,370 patients (6%) who were hospitalized or in observation status alone. Of these patients, 3,995 (91%) were directly admitted to the hospital and 375 (9%) were in observation status without going through the ED.

The mean LOS for the asthma hospital admissions was 3.1 days, with a maximum of 144 days. The majority of admitted patients were discharged home (67.2%), remained as an inpatient or transferred to another hospital (2.4%), or left AMA (1.0%). The remainder transferred to other types of facilities (e.g., rehabilitation, skilled nursing facility, hospice, etc.), died, or the disposition was unknown.

Exacerbation severity measures

Procedure: The most frequent procedure of those examined was 'insertion of endotracheal tube' recorded 201 times during the 3-year period, or about 67 times per year. The majority occurred as inpatients, but 15 (7.5%) occurred in the ED. 'Other respiratory intubation' occurred only 5 times, all with inpatients. Insertion of an endotracheal tube was most frequent among the 45-64 and 18-44 age groups, combined they accounted for 65.6% of the procedures. Children and adolescents aged ≤ 17 accounted for 11.5% of the occurrences. Medicare was the most frequent expected pay source for this procedure (37.8%).

Anoxia: There were 12 episodes of anoxia (i.e., absence of oxygen) during the 3 years. Nine patients were admitted to the hospital and 3 died who were aged ≥ 45. Charges were substantially higher when anoxia occurred. The average charge for the 12 patients was $77,376, compared to $3,447 for the other patients. Of the total charges for hypoxic patients, 99.5% were hospital charges ($923,466).

Charges and expected pay sources

The total charges for the ED, hospitalization, and observation visits for the 3 years was $394,798,859, or about $131.6 million per year (Table 3). The average charge for the combined visits was $3,455, while the median charge was $1,173. Medicaid was the most frequent expected pay source for the total asthma, acute health care visits (n=44,244, 38.3%). Medicaid was also the expected pay source for the largest proportion of asthma patients with an ED visit (35.9%), followed by commercial insurance (33.4%), Self pay/No Charge (17.0%), Medicare (11.4%) and all other sources/unknown (2.3%).

Charges for hospital stays were the highest compared to ED visits and outpatient observation stays, with an average of $12,021 and a median of $8,463 and accounted for 70.1% of the total charges. The average charges for the observation group were higher than charges for the ED group--$4,889 *vs.* $1,187. However, the ED charges ($105.2 million) totaled substantially more than the observation charges ($12.9 million) and accounted for 26.6% of the total. The average

Table 2: Characteristics of Patients with Asthma as the Principal Diagnosis and Rates for Exacerbations resulting in1 and ≥ 2 Emergency Department Visits, Missouri, 2007-2009.

	Singe Exacerbation 1 ED Visit			Multiple Exacerbations ≥ 2 ED Visits			Total		
Characteristic	Number	Percent[a]	Rate[b] (95% CI)	Number	Percent[a]	Rate[b] (95% CI)	Number	Percent[a]	Rate[b] (95% CI)
Overall	52,148	100.0	2.93 (2.91-2.96)	16,644	100.0	0.94 (0.92-0.95)	68,792	100.0	3.87 (3.84-3.90)
Age Group[y]									
0-4	8,310	15.9	7.14 (6.98-7.29)	3,553	21.3	3.05 (2.95-3.15)	11,863	17.2	10.19 (10.00-10.37)
5-11	7,896	15.1	4.84 (4.74-4.95)	3,031	18.2	1.86 (1.79-1.93)	10,927	15.9	6.70 (6.58-6.83)
12-17	4,690	9.0	3.15 (3.06-3.24)	1,520	9.1	1.02 (0.97-1.07)	6,210	9.0	4.17 (4.07-4.27)
18-44	18,416	35.3	2.89 (2.85-2.94)	5,659	34.0	0.89 (0.87-0.91)	24,075	35.0	3.78 (3.74-3.83)
45-64	8,889	17.0	1.90 (1.86-1.94)	2,240	13.5	0.48 (0.46-0.50)	11,129	16.2	2.37 (2.33-2.42)
≥ 65	3,947	7.6	1.62 (1.57-1.67)	641	3.9	0.26 (0.24-0.28)	4,588	6.7	1.88 (1.83-1.94)
Gender									
Male	22,554	43.2	2.59 (2.56-2.63)	7,744	46.5	0.89 (0.87-0.91)	30,298	44.0	3.48 (3.44-3.52)
Female	29,594	56.8	3.26 (3.22-3.30)	8,900	53.5	0.98 (0.96-1.00)	38,494	56.0	4.24 (4.20-4.28)
Race									
White	33,830	64.9	2.23 (2.21-2.25)	7,758	46.6	0.51 (0.50-0.52)	41,588	60.5	2.74 (2.71-2.77)
African-American	15,961	30.6	7.39 (7.27-7.50)	8,164	49.1	3.78 (3.70-3.86)	24,125	35.1	11.17 (11.03-11.31)
Other	1,984	3.8	4.51 (4.31-4.71)	646	3.9	1.47 (1.36-1.58)	2,630	3.8	5.98 (5.75-6.21)
Unknown	373	0.7	--	76	0.5	--	449	0.7	--
Ethnicity									
Hispanic	952	1.8	1.61 (1.51-1.71)	302	1.8	0.51 (0.45-0.57)	1,254	1.8	2.12 (2.01-2.24)
Non-Hispanic	50,741	97.3	2.95 (2.93-2.98)	16,265	97.7	0.95 (0.93-0.96)	67,006	97.4	3.90 (3.87-3.93)
Unknown	455	0.9	--	77	0.5	--	532	0.8	--

-- Not applicable.

CI: Confidence Interval

[a]May not sum to 100 due to rounding

[b]Rate per 1,000 population

and median charges were highest when Medicare was the expected pay source ($8,891 and $3,680, respectively) followed by Worker's Compensation ($3,715 and $1,514, respectively). The lowest average and median charges were for the Self pay/No Charge group ($2,096 and $1,109, respectively). The average charge per age group was highest for those aged ≥ 65 ($13,682).

Deaths

There were 51 deaths attributable to asthma over the 3-year period, or on average 17 per year in the study. The majority, 92% occurred after admission to a hospital. A large proportion (64.7%) occurred among patients age ≥ 65 and 7.8% occurred among the age group 0 to 17.

Discussion

A total of 73,162 patients accounted for the asthma acute care visits and while the majority of patients had a single ED visit (75.8%), almost 1 in 4 patients had repeat visits (24.2%). Tolomeo et al., found that a previous asthma ED visit was a significant predictor of both subsequent ED visits and subsequent hospitalizations [15] indicating a need to intervene prior to and subsequent to a first ED visit. Similar to national data [3,4], we found African Americans and children were high utilizers of ED services for uncontrolled asthma. There was also a slight excess of health care visits among females compared to their population size and may reflect the higher prevalence of asthma among adult women compared to men in Missouri [16].

The current surveillance method of capturing the asthma burden through ED only counts underestimates the toll on emergency departments. The total number of ED visits when ED visits plus hospitalization and ED visits plus observations were included was 106,010, or about 1720.1% higher than the 88,622 ED only visits. This is important as it indicates a greater usage of the ED for asthma care than previously understood and represents potential opportunities to gain control. This finding may also improve the accuracy of future evaluations of emergency services for asthma since adjustments can be made to take this into consideration. In addition, we found that a substantial proportion of the asthma patients in this study (26.1%)

Table 3: Charges for Asthma Care from Emergency Department Visits, Observations, and Hospitalizations and Expected Pay Sources, Missouri, 2007-2009.

	Number	Mean $thousands	Total $millions	Percent of Total Charges
All Records[a]	115,299	3,455	394.8	100.0
Health Care Visit				
E/D Visits	88,622	1,187	105.2	26.6
Observations	2,640	4,889	12.9	3.3
Hospitalizations	23,021	12,021	276.7	70.1
Expected Pay Source[a]				
Medicare	13,495	8,891	120.0	30.4
Medicaid	44,244	2,579	114.1	28.9
Commercial	33,928	3,280	111.3	28.2
Self/No Charge	20,205	2,096	42.3	10.7
Other Government	906	2,886	2.6	0.7
Worker's Compensation	112	3,715	0.4	0.1
Unknown	1,392	2,926	4.1	1.0
All Age Groups[b]N	73,162	5,396	394.8	100.0
00-04	12,878	3,123	40.2	10.2
05-11	11,432	3,218	36.8	9.3
12-17	6,337	2,835	17.7	4.6
18-44	24,690	4,281	105.7	26.8
45-64	12,235	9,616	117.6	29.8
≥ 65	5,590	13,682	76.5	19.4
All ED Visits[b]n	68,792	1,529	105.2	100.0
Expected Pay Source				
Medicaid	24,632	--	--	--
Commercial	22,925	--	--	--
Self/No Charge	11,788	--	--	--
Medicare	7,885	--	--	--
Other Government	605	--	--	--
Worker's Compensation	75	--	--	--
Unknown	882	--	--	--

[a]Mean cost per encounter

[b]Mean cost per person

--Data not available or proprietary information

were affected seriously enough to be admitted to a hospital and > 60 times per year the asthma exacerbations were so severe as to require intubation for respiratory support. This indicates a tremendous need to expand access to asthma preventive services.

It may be possible to avert many ED visits and reduce disparities through four key strategies: assessment and objective monitoring of asthma control, partnering for care, including self-management education, trigger reduction and management of comorbidities, and appropriate control medication [5,17,18]. Patient nonadherence to prescribed therapy may occur for a variety of reasons (e.g., lack of knowledge, poor inhalation technique, medication cost). Increasing access to self-management education may improve adherence by addressing knowledge and skills deficits. Implementing ED asthma care protocols have also improved assessment, medication therapy per national guidelines and patient education, and have shown some success at reducing hospitalizations and repeat ED visits [19]. Other repeat ED visit reduction strategies for children have included pre-printed order sheets and access to consultation with a pediatrician [20].

Consistent with Puranitee et al., [21] asthma hospitalizations had the highest average cost per person for these care services ($12,021). The average charges for the observation group were higher than charges for the ED group--$4,889 *vs.* $1,187, likely due to the 72-hour stays and associated treatment and care costs. The average and median charges for the ED group were highest when Medicare was the expected pay source ($8,891 and $3,680, respectively). This is likely due to the high charges for the elderly. The second highest average and median charges were for Worker's Compensation ($3,715 and $1,514, respectively) which may be an indication of more severe disease if work related. Although Medicaid had next to the lowest average charge per health care visit, consistent with Griswold et al., [22] it was the most frequent pay source indicating that members may benefit from a preventive services program [23].

Limitations

It may not be possible to identify every record for a patient.

Records may lack proper identifiers, or have been missing because the patient was treated at an out-of-state hospital from which Missouri does not receive records, or because a hospital inadvertently failed to submit a record. However, the number of these records is unknown but should be relatively small as in-state hospital reporting is goverened by state statute. Reviewing random samples of records suggested that these issues occurred very infrequently. Although the total number of patients in the study are reflected in the five categories reported, the number of patients who were in certain subcategories (e.g., ED visit plus hospitalization plus observation) across the 3 years were not presented, but may be included in future studies. In any case, the numbers presented are likely to be slight underestimates of patients and visits due to these reasons. Nevertheless, these data indicated that approximately 16.7% of ED visits converted to an inpatient hospitalization or observation stay and overall 26.1% of all asthma patients included in this study were admitted to the hospital for uncontrolled asthma. In the study, 51 deaths were attributed to asthma. Because the patients who died had a principal diagnosis of asthma, we can speculate that they died of asthma or its complications; however, to ascertain the exact cause of death would require a review of death records. The elderly, especially, may have been admitted with other co-morbidities that contributed to their deaths.

The prevalence of current asthma in Missouri among adults was estimated at 8.4% and 10.1% among children aged ≤ 17 indicating that there were about 517,653 people with asthma out of a population of 5,951,844 in 2008 [13,16]. The average number of ED visits in Missouri equated to .069 visits per year per persons with asthma compared to a national rate of .075 for 2005-2009 [24]. The average number of admissions per year per persons with asthma was .015 in Missouri compared to .014 nationally [24]. Since different data sources and years were used, the proportions would not be expected to be the same. However, it can be concluded that Missouri was in line with the national estimates which increase the generalizability of this study.

Conclusion

Encounter data are useful, but do not provide the number of individuals utilizing emergency services due to asthma or accurately reflect the total burden on EDs. This study revealed that uncontrolled asthma places a heavier toll on EDs than previously published and that the vast majority of asthma patients (94.0%) received ED care during the study period. Standard protocols and preprinted forms may guide ED staff to successfully initiate long-term control therapy (i.e., inhaled corticosteroid) and refer patients to primary care for management. Providing access to preventive services and linking clinical and community services may improve asthma control. Closing the gaps in care may substantially improve asthma control and quality of life, reduce costly acute care, and increase learning and productivity.

Acknowledgment

This document was supported by Cooperative Agreement Number #5U59EH000510 between the US Centers for Disease Control and Prevention (CDC) and DHSS. The content is solely the responsibility of the authors and does not necessarily represent the official views of the CDC.

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Chronic Dis Int - Volume 3 Issue 1 - 2016
ISSN 2379-7983 | www.austinpublishinggroup.com

Citation: Homan S, Vantuinen M, Gaddy PD and Yun S. The Burden of Asthma: Delineation of Acute Healthcare Utilization among Asthma Patients in Missouri, 2007-2009. Chronic Dis Int. 2016; 3(1): 1023.