Predictors of Emergent Emergency Department Visits and Costs in Community-Dwelling Older Adults

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ABSTRACT

BACKGROUND: The number of yearly emergency department (ED) visits by older adults in the United States has been increasing.

PURPOSE: The objectives were to (1) describe the demographics, health-related variables, and ED visit characteristics for community-dwelling older adults using an urban, safety-net ED; (2) examine the association between demographics, health-related variables, and ED visit characteristics with emergent vs nonemergent ED visits; and (3) examine the association between demographics, health-related variables, ED visit characteristics, and ED visit costs.

METHODS: A cross-sectional, retrospective analysis of administrative electronic medical record and billing information from 2010 to 2013 ED visits (n = 7805) for community-dwelling older adults (⩾65 years old) from an academic medical center in central Virginia was conducted.

RESULTS: Most of the ED visits were by women (62%), African Americans (75%), and approximately 50% of ED visits were nonemergent (n = 3871). Men had 1.2 times the odds of an emergent ED visit (95% confidence interval [CI]: 1.02-1.37). The ED visits by white patients had 1.3 times the odds of an emergent ED visit (95% CI: 1.09-1.57) and 14% higher costs (white race: 95% CI: 1.07-1.21) compared with African American patients. Emergent ED visits were 60% more likely to have higher costs than nonemergent visits (95% CI: 1.52-1.69). White race and arrival by ambulance were associated with both emergent ED visits and higher total ED visit costs in this sample of ED visits by community-dwelling older adults.

CONCLUSIONS: Strategies to maximize opportunities for care in the primary care setting are warranted to potentially reduce nonemergent ED utilization in community-dwelling older adults.

KEYWORDS: ED use, costs, community-dwelling, low-income housing

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Introduction

There has been an increasing trend in the number of yearly emergency department (ED) visits by older adults in the United States.[1–3] Studies have shown a 25% to 34% increase in older adult ED visits over time.[1,2] From 2012 to 2013, a total of 20.7 million ED visits were made by older adults, corresponding to an ED visit rate of 36 per 100 persons for illness and 12 per 100 persons for injury.[4] Age ⩾85 years, living alone, poor to very good self-rated health compared with excellent, and deficiencies in activities of daily living were predictors of older adult ED use.[5]

Some ED visits and their associated costs may be preventable for conditions that are treatable by effective and timely primary care.[6–8] In a group of high-cost Medicare patients, 43% of 2009 and 2010 ED visits were classified as preventable and accounted for about 40% of the total ED costs.[9] Preventable and frequent ED use is a concern due to the potential for increased adverse outcomes after each visit, potential for care to be more appropriately delivered in a primary care setting vs an ED, and increased costs associated with unnecessary ED visits.

Frequent ED use (⩾4 ED visits per year) has been reported to be concentrated in a small number of older adults who may have multiple chronic conditions and social barriers that limit access and coordination of care.[10–13] Poor self-reported health, history of a recent ED visit, diabetes, depression, 9 or more medications, no help if needed, male, African American race, and Hispanic ethnicity have been identified as predictors of frequent ED use in older adults.[13–16]

However, there is a lack of information regarding frequent ED use and associated costs by older adults residing in health care hot spots. A health care hot spot is an emerging concept around the existence of geographic areas of high health care use.[17] In these areas, costs are often related to a small number

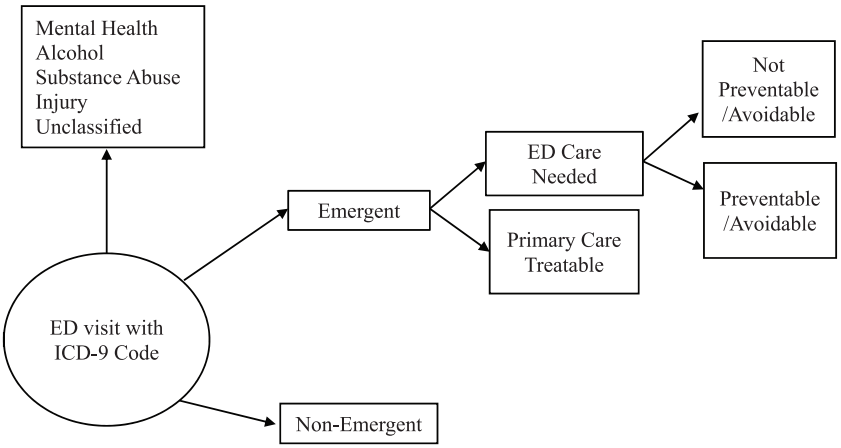

Figure 1. New York University ED Algorithm.[21,22]

of patients.[17–19] For example, in Camden, New Jersey, it was found that 30% of health care costs were associated with the care of 1% of the patients and 90% of the costs with 20% of the patients.[19] Likewise, a study in high-cost older adult Medicare beneficiaries found that 55% of the Medicare costs were associated with 10% of the beneficiaries.[20]

This study adds to the evidence around community-dwelling older adult's ED use, specifically examining if living in low-income housing, designated as a health care hot spot in this study, is a predictor of ED use. We used the validated New York University ED (NYU ED) algorithm to classify ED visits by *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) diagnosis codes into emergent and nonemergent visits.[21] The objectives and hypotheses for this study were as follows:

- Describe the demographics, health-related variables, and ED visit characteristics for community-dwelling older adults using an urban, safety-net ED.
- Examine the association between demographics, health-related variables, and ED visit characteristics with emergent vs nonemergent ED visits.
  - We hypothesized that older adults were more likely to have an emergent ED visit if they lived in a health care hot spot, had higher comorbidity scores and increasing age, and arrived to the ED by ambulance.
- Examine the association between demographics, health-related variables, ED visit characteristics, and ED visit costs.
  - We hypothesized that higher costs were more likely in older adults who lived in a health care hot spot, had higher comorbidity scores and age, arrived to the ED by ambulance, and had an emergent ED visit.

Methods

Study design and data source

A cross-sectional, retrospective analysis of administrative electronic medical record data and billing records from an urban, safety-net, level 1 trauma, academic medical center that treats more than 80 000 ED patients annually, in central Virginia, was conducted. The ED visit information from 2010 to 2013 for community-dwelling older adults (≥65 years old) was included in this study. Data were abstracted from the electronic medical and billing records by the institution's Biomedical Informatics Core.

To determine community-dwelling status, ED visits were excluded based on the following criteria: address not indicative of a community-dwelling residence (eg, skilled nursing facility or assisted living facility), address corresponded to a correctional facility, if admit source or mode was a transfer from another health care facility (eg, another hospital) or court/law enforcement, if address was not complete and community-dwelling status could not be confirmed (eg, only provided an apartment number, PO Box, trailer number, or missing), and if address indicated that the patient was under the care of another entity (eg, c/o individual or business name).

Outcome variables

ED visit type. The first dependent variable examined in this study was type of ED visit categorized by the NYU ED algorithm.[9,21] The NYU ED algorithm assigns the *ICD-9-CM* diagnosis code for the ED visit a probability (0-1) of falling into the following 4 ED visit types: nonemergent, emergent but primary care treatable, emergent ED care needed but preventable/avoidable, or emergent ED care needed not preventable/avoidable (Figure 1).[22]

These probabilities were then used to categorize ED visits into nonemergent, emergent, and intermediate ED visit types.[22] An ED visit was categorized as nonemergent if the sum of nonemergent plus emergent, primary care treatable probabilities were >0.50. The ED visit was categorized as emergent if the sum of emergent, ED care needed, preventable/avoidable plus emergent, ED care needed, not preventable/avoidable probabilities were >0.50. An ED visit was categorized as intermediate if both nonemergent and emergent probabilities were equal to 0.50.[22] The NYU ED algorithm excludes

(does not assign probabilities) mental health, alcohol, substance abuse, injury, and unclassified ED visits.[21]

Total ED visit costs. The second dependent variable examined was total ED visit cost (billing costs) adjusted to 2014 US dollars (US $). Costs were adjusted for inflation using the consumer price index for Medical Care Services and reported in 2014 dollars.[23] The method provided by the US Department of Labor, Bureau of Labor Statistics was used for adjustment.[24]

Covariates

Demographics. Demographics included in this study were age, sex, race, and ethnicity. Age was categorized by its quartile distribution (65-67, 68-71, 72-78, and 79 years and older) and sex was dichotomous (men vs women). Race categories were white, black or African American, Asian, Other, and Unknown. Due to small sample size, American Indian/Alaskan, Native Hawaiian/Other Pacific Islander, and Asian were collapsed into the Other race category. Ethnicity categories were Hispanic-Latino-Spanish Origin, Not Hispanic-Latino-Spanish Origin, and Unknown. Variables with responses of unknown were considered missing.

Payment source. Payment source was defined as Medicare, Medicaid, Medicare and Medicaid, Medicare and Other, Self-pay, Virginia Coordinated Care Program (VCC), Indigent, and Other.

Health-related variables. The Charlson Comorbidity Index (CCI) was used as a measure of comorbidity.[25] The Dartmouth-Manitoba (Romano) CCI adaptation which incorporates *ICD-9-CM* codes for identifying comorbid conditions was used.[26] Patient problems in the data were defined either as *ICD-9-CM* or Systematized Nomenclature of Medicine-Clinical Terms (SNOMED CT) code. The SNOMED CT codes were converted to a corresponding *ICD-9-CM* code using the Unified Medical Language System (UMLS) cross map.[27]

The CCI scores were categorized into 5 categories based on the variable's distribution: 0, 1, 2, 3, or ⩾4. The total disease count variable was created from the sum of the *ICD-9-CM* codes per ED visit. Total disease count was categorized into quartiles for analysis. The quartile (Q) distribution for the total disease count was 1 to 3 (Q1), 4 to 6 (Q2), 7 to 9 (Q3), and ⩾10 diseases (Q4).

ED visit characteristics. The mode of arrival to the ED was defined as ambulance (emergency medical services [EMS]), helicopter, and self-private transportation.

Discharge disposition was defined as follows: home or self-care, expired, left against medical advice (AMA), left before clinical evaluation, and other facility/nursing home.

A dichotomous variable was created to identify ED visits from the zip code including a health care hot spot (yes/no). This was the zip code that included the address of the low-income, subsidized housing apartment building identified as a health care hot spot.

A dichotomous variable was created to identify ED visits from the address of the low-income, subsidized housing apartment building in this study. It was considered a health care "hot spot" (ie, geographic area of high health care utilization) due to a history of high use of ambulance services and ED for primary care.[28] The variable was defined as yes/no.

The year of ED visit was categorical and defined as 2010, 2011, 2012, and 2013. The total number of visits per unique medical record number by year was determined. The inclusion of this variable helps examine the relationship of frequent ED use with total ED costs and helps to characterize whether frequent ED users are more likely to have emergent vs nonemergent ED visit. A frequent ED user was defined as having 4 or more ED visits[29–32] over any one year in the study (yes/no).

Data analysis. Descriptive statistics, bivariate analyses, and multivariable regression analyses were used. The small number of intermediate ED visits (n = 115) limited their inclusion in multivariable analyses. An adjusted prediction multivariable logistic regression model was used to examine the relationship between demographics (age, sex, race, ethnicity), payment source, health-related variables (CCI, total disease count), hot spot zip code, hot spot address, and ED visit characteristics (mode of arrival, frequent ED use, year of ED visit) with emergent vs nonemergent ED visits (reference group). For emergent and nonemergent ED visits, race unknown, ethnicity unknown, admit mode by helicopter, discharge disposition, left before clinical evaluation/expired/other facility/nursing home was considered missing (cell size <5 or unknown). The variable discharge disposition was collinear with total disease count and removed from the full multivariable logistic regression model. After removal of this variable, multicollinearity was not a problem (variance inflation factors <4, correlation <0.8).

Analysis of variance was used to examine differences between mean total ED visit costs by demographic and ED visit characteristic variables. Adjusted generalized linear model (GLM) regression with gamma distribution and log link was used to model the relationship with the independent variables (age, sex, race, ethnicity, payment source, CCI score, total disease count, mode of ED arrival, discharge disposition, frequent ED user, year of ED visit, hot spot zip code, hot spot address, type of ED visit) and total ED costs.

The dependent cost variable was assessed for skewness, kurtosis, normality, and heteroscedasticity in the nonemergent and emergent ED visits. The data indicated that total costs were skewed to the right (skewness: 2.71, kurtosis: 29.61, n = 5050). The assumption of normality was violated (n = 5050, Kolmogorov-Smirnov, $P < .010$). The histogram of the cost variable also showed a nonnormal distribution and the q-q plot showed 5 extreme outliers. The 5 extreme observations were deleted from the data and skewness, kurtosis, normality, and heteroscedasticity was reassessed. The skewness and kurtosis were improved (1.30 and 1.37, respectively) but the data were still not

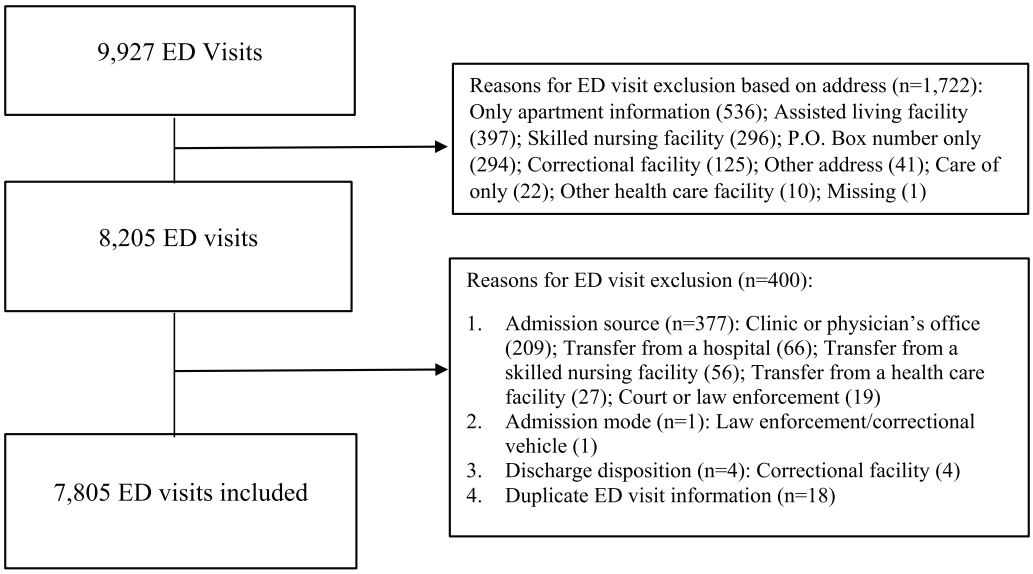

Figure 2. Flow chart for inclusion of ED visits.

normally distributed (n = 5045, Kolmogorov-Smirnov, $P < .010$, histogram appearance skewed) or homoscedastic (White test for heteroscedasticity $P = .003$). Next, log transformation of the total costs was performed. There were 253 ED encounters with zero cost (5% of study sample). The appearance of the cost histogram was improved. However, the normality and equal error variance assumptions were still violated (n = 4792, Kolmogorov-Smirnov, $P < .010$ and White test for heteroscedasticity, $P < .0001$). This was accounted for in the final GLM regression with a gamma distribution and log link. The GLM does not require normal distribution of the cost data and can correct for heteroscedasticity (unequal error variance).[33–35] The 5 extreme cost outliers, zero costs, unknown race and ethnicity category, admit mode by helicopter, and discharge disposition categories of other facility/nursing home and expired were considered missing in the final model. Multicollinearity was assessed and not a concern in this model. The a priori significance level was $P < .05$. SAS for Windows version 9.4 was used for data analysis (SAS Institute Inc., Cary, NC, USA). This study was approved by the local institutional review board.

Results

The flow chart provides the number of ED visits excluded based on address, admission source, admission mode, discharge disposition, and duplicate records (Figure 2). A total of 7805 ED visits were included in this study for descriptive statistics. Intermediate ED visits (n = 115, 1.5%) were not included in multivariable analyses due to small sample size. The remaining approximate 34% of NYU ED visits classifications not included in additional analyses were injury (n = 1274, 16.3%), mental health related (n = 124, 1.6%), alcohol or drug related (n = 26, 0.4%), and not in a special category, not classified (n = 1216, 15.6%).

Table 1 provides descriptive statistics for demographic and ED visit characteristics and compares nonemergent and emergent ED visits. The overall mean age was 73 years (SD 7.1) for all ED visits. Most of the ED visits were by women (62%), African Americans (75%), and non-Hispanic-Latino-Spanish origin patients (98%). Approximately 50% of ED visits were classified as nonemergent (n = 3871) and 15% were classified as emergent (n = 1179). Emergent ED visits had a higher proportion of men, higher CCI score, arrived by ambulance more often, more frequent ED users, and had higher total ED visit costs than nonemergent ED visits. Table 2 provides the 10 most common primary diagnosis codes for emergent and nonemergent ED visits.

Predictors of Emergent ED Visits

The results of the adjusted multivariable logistic regression analysis (adjusted OR, 95% CI) are summarized in Table 3. Sex, race, CCI score, total disease count, and mode of arrival to the ED were significant independent predictors of emergent ED visits. Men had 1.2 times the odds of an emergent ED visit compared with women (adjusted odds ratio [AOR]: 1.18, 95% CI: 1.02-1.37). The ED visits by white patients had 1.3 times the odds of an emergent visit compared with African American patients (AOR: 1.31, 95% CI: 1.09-1.57). A CCI score of ≥ 4 compared with 0 had 1.5 times the odds of being of being categorized as emergent (AOR: 1.45, 95% CI: 1.12-1.89). Use of the ambulance for arrival mode had 2.2 higher odds of emergent ED visit categorization compared with self-private transportation (AOR: 2.19, 95% CI: 1.89-2.54). There were no other significant predictors in the presence of all other variables.

Predictors of Total ED Visit Costs

The mean total ED costs per visit by demographics and ED visit characteristics are summarized in Table 4. A total of 5045 ED visits were included, of which a total of 3870 ED visits were nonemergent and 1175 were emergent ED visits. Total ED costs increased with age. Age ≥ 79 years had a higher mean

Table 1. Demographics, health-related variables, and ED visit characteristics of adults ⩾65 years old.

VARIABLES	ALL ED VISITS (N = 7805) MEAN (SD), RANGE OR NO. (%)	NONEMERGENT ED VISITS (N = 3871) MEAN (SD), RANGE OR NO. (%)	EMERGENT ED VISITS (N = 1179) MEAN (SD), RANGE OR NO. (%)	*P* VALUE[a]
Age by quartile, y	n = 7805	n = 3871	n = 1179	.4154
65-67	2005 (25.7)	1055 (27.3)	295 (25.0)	
68-71	1956 (25.1)	970 (25.1)	316 (26.8)	
72-78	2076 (26.6)	1002 (25.9)	311 (26.4)	
⩾79	1768 (22.7)	844 (21.8)	257 (21.8)	
Sex	n = 7805	n = 3871	n = 1179	.0202*
Female	4819 (61.7)	2498 (64.5)	717 (60.8)	
Male	2986 (38.3)	1373 (35.5)	462 (39.2)	
Race[b]	n = 7805	n = 3867	n = 1178	.1946
Black or African American	5840 (74.8)	3009 (77.8)	895 (76.0)	
White	1655 (21.2)	707 (18.3)	242 (20.5)	
Other	253 (3.2)	151 (3.9)	41 (3.5)	
Asian	50 (0.6)	—	—	
Unknown	7 (0.1)	—	—	
Ethnicity[b]	n = 7653	n = 3798	n = 1152	.4422
Not Hispanic-Latino-Spanish origin	7523 (98.3)	3735 (98.3)	1129 (98.0)	
Hispanic-Latino-Spanish origin	124 (1.6)	63 (1.7)	23 (2.0)	
Unknown	6 (0.1)	—	—	
Payment source[c]	n = 7803	n = 3871	n = 1179	.6949
Medicare	6625 (84.9)	3256 (84.1)	1012 (85.8)	
Other	424 (5.4)	210 (5.4)	62 (5.3)	
Virginia Coordinated Care	197 (2.5)	101 (2.6)	28 (2.4)	
Medicare, Other	172 (2.2)	91 (2.4)	23 (2.0)	
Medicaid	135 (1.7)	72 (1.9)	20 (1.7)	
Indigent	107 (1.4)	71 (1.8)	13 (1.1)	
Medicare, Medicaid	75 (1.0)	34 (0.9)	12 (1.0)	
Self-pay	68 (0.9)	36 (0.9)	9 (0.8)	
Charlson Comorbidity Index Score	n = 7420	n = 3692	n = 1135	<.0001*
0	2303 (31.0)	1166 (31.6)	288 (25.4)	
1	2194 (29.6)	1095 (29.7)	386 (34.0)	
2	1177 (15.9)	597 (16.2)	171 (15.1)	
3	819 (11.0)	432 (11.7)	118 (10.4)	
⩾4	927 (12.5)	402 (10.9)	172 (15.2)	

(Continued)

Table 1. (Continued)

VARIABLES	ALL ED VISITS (N=7805) MEAN (SD), RANGE OR NO. (%)	NONEMERGENT ED VISITS (N=3871) MEAN (SD), RANGE OR NO. (%)	EMERGENT ED VISITS (N=1179) MEAN (SD), RANGE OR NO. (%)	*P* VALUE[a]
Total disease count by quartile	n=7420	n=3692	n=1135	.0033*
1-3	2097 (28.3)	1044 (28.3)	259 (22.8)	
4-6	2169 (29.2)	1096 (29.7)	375 (33.0)	
7-9	1449 (19.5)	734 (19.9)	234 (20.6)	
⩾10	1705 (23.0)	818 (22.2)	267 (23.5)	
Mode of arrival to ED	n=7800	n=3780	n=1177	<.0001*
Self-private transportation	5597 (71.8)	2998 (77.5)	715 (60.8)	
EMS ambulance	2203 (28.2)	872 (22.5)	462 (39.3)	
Frequent ED user (yes)	1074 (13.8)	539 (13.9)	193 (16.4)	.0368*
Year of ED visit	n=7805	n=3871	n=1179	.1309
2010	1726 (22.1)	911 (23.5)	306 (26.0)	
2011	1828 (23.4)	915 (23.6)	295 (25.0)	
2012	2068 (26.5)	1016 (26.3)	281 (23.8)	
2013	2183 (28.0)	1029 (26.6)	297 (25.2)	
Hot spot zip code (yes)	484 (6.2)	244 (6.3)	77 (6.5)	.7791
Hot spot address (yes)	104 (1.3)	50 (1.3)	19 (1.6)	.4075
Total ED costs (US $)[d]	US $611 (US $674), US $0-US $29 835	US $549 (US $502), US $0-US $3341	US $947 (US $709), US $0-$11 901	<.0001*

Abbreviations: ED, emergency department; EMS, emergency medical services.
[a]*P* value for bivariate analyses: χ^2 (categorical variables) or *t* test (continuous variable) between nonemergent and emergent ED visit, *$P < .05$.
[b]For emergent and nonemergent ED visits race unknown, ethnicity unknown, admit mode by helicopter (cell size <5), for Asian (n=29 for nonemergent ED visits and n=4 for emergent ED visits—collapsed into other category).
[c]Some payment source categories were collapsed due to small sample size. There were n=5 ED visits with Medicaid, Other and n=2 ED visits with Medicaid, Tricare collapsed into the Medicaid payment source category, n=2 ED visits with Medicare, Medicaid, Other payment source collapsed into the Medicare, Medicaid category, n=9 ED visits with Medicare, Tricare collapsed into the Medicare, Other category, and n=3 ED visits with Tricare/VA only collapsed into the Other category.
[d]Costs rounded to nearest dollar.

Table 2. Top 10 primary diagnosis codes for emergent and non-emergent ED visits in adults ≥ 65 years old.

EMERGENT ED VISITS[a]			NON-EMERGENT ED VISITS[a]		
ICD-9-CM CODE	ICD-9-CM CODE DESCRIPTION	N=1,179 N (%)	ICD-9-CM CODE	ICD-9-CM CODE DESCRIPTION	N=3,871 N (%)
786.50	Chest pain, NOS	405 (34.4)	789.09	Abdominal pain, other specific site	284 (7.3)
780.2	Syncope and collapse	73 (6.2)	V64.2	No procedure/patient decision	260 (6.7)
786.05	Shortness of breath	68 (5.8)	780.4	Dizziness and giddiness	201 (5.2)
250.80	Diabetes with other specified manifestations, type II	56 (4.8)	786.09	Respiratory abnormality, NEC	179 (4.6)
785.1	Palpitations	53 (4.5)	599.0	Urinary tract infection, NOS	173 (4.5)
493.92	Asthma, unspecified acute	44 (3.7)	784.0	Headache	158 (4.1)

Table 2. (Continued)

EMERGENT ED VISITS[a]			NON-EMERGENT ED VISITS[a]		
ICD-9-CM CODE	ICD-9-CM CODE DESCRIPTION	N = 1,179 N (%)	ICD-9-CM CODE	ICD-9-CM CODE DESCRIPTION	N = 3,871 N (%)
486.	Pneumonia, organism unspecified	40 (3.4)	786.59	Chest pain, NEC	141 (3.6)
428.0	Congestive heart failure	37 (3.1)	780.79	Other malaise and fatigue	135 (3.5)
493.90	Asthma, without status	32 (2.7)	724.2	Lumbago	131 (3.4)
780.39	Other convulsions	32 (2.7)	729.5	Pain in limb	119 (3.1)

[a]NEC = not elsewhere classifiable, NOS = not otherwise specified.

Table 3. Association between demographics, health-related variables, and ED visit characteristics with emergent ED visits in adults ⩾65 years old.

VARIABLES	ADJUSTED OR (95% CI)[a,b] (N = 4739)	*P* VALUE
Age by quartile, y		.2515
65-67	1.0	
68-71	1.15 (0.95-1.40)	.1465
72-78	1.10 (0.91-1.34)	.3369
⩾79	1.01 (0.82-1.24)	.9120
Sex		.0230*
Female	1.0	
Male	1.18 (1.02-1.37)	.0230
Race		.0134*
Black or African American	1.0	
White	1.31 (1.09-1.57)	.0034
Other	1.04 (0.66-1.64)	.8572
Ethnicity		.3036
Not Hispanic-Latino-Spanish origin	1.0	
Hispanic-Latino-Spanish origin	1.34 (0.77-2.36)	.3036
Payment source		.8183
Medicare	1.0	
Other	0.83 (0.59-1.15)	.2506
Self-pay	1.15 (0.51-2.59)	.7361
Virginia Coordinated Care	1.05 (0.63-1.73)	.8639
Medicare, Other	0.78 (0.47-1.30)	.3466
Medicaid	0.81 (0.48-1.38)	.4440
Indigent	0.75 (0.40-1.38)	.3509
Medicare, Medicaid	1.03 (0.49-2.14)	.9431
Charlson Comorbidity Index Score		.0007*
0	1.0	
1	1.32 (1.09-1.59)	.0038
2	1.02 (0.81-1.28)	.8870
3	0.95 (0.73-1.24)	.7180
⩾4	1.45 (1.12-1.89)	.0055
Total disease count by quartile		.0466*
1-3	1.0	
4-6	1.31 (1.08-1.59)	.0072
7-9	1.23 (0.99-1.54)	.0666
⩾10	1.13 (0.90-1.43)	.2967
Mode of arrival to ED		<.0001*
Self-private transportation	1.0	
Ambulance	2.19 (1.89-2.54)	<.0001
Frequent ED user		.0814
No	1.0	
Yes	1.19 (0.98-1.44)	.0814
Year of ED visit		.0650
2013	1.0	
2012	0.99 (0.82-1.20)	.9143
2011	1.19 (0.98-1.44)	.0852
2010	1.22 (1.00-1.48)	.0482

Table 3. (Continued)

(Continued)

Table 3. (Continued)

VARIABLES	ADJUSTED OR (95% CI)[a,b] (N = 4739)	*P* VALUE
Hot spot zip code		.8831
No	1.0	
Yes	0.98 (0.71-1.34)	.8831
Hot spot address		.7317
No	1.0	
Yes	1.12 (0.58-2.16)	.7317

Abbreviations: CI, confidence interval; ED, emergency department; OR, odds ratio.
[a]n = 4379 due to missing responses, exclusion of unknown race and ethnicity category, admit mode by helicopter.
[b]Likelihood ratio for probability of emergent ED visit $\chi^2 = 173.06$, $df = 28$, $P < .0001$.
*$P < .05$ statistically significant.

Table 4. Average total ED costs per visit by demographics, health-related variables, and ED visit characteristics in adults ⩾65 years old.

VARIABLES	TOTAL ED COSTS (US $)[A] MEAN (SD), RANGE	*P* VALUE
Age by quartile, y		.0004*
65-67	607 (577), 0-2903	
68-71	614 (546), 0-3236	
72-78	645 (543), 0-2854	
⩾79	694 (535), 0-3341	
Sex		.8377
Female	639 (543), 0-3342	
Male	636 (568), 0-2903	
Race		.0114*
Black or African American	625 (543), 0-3326	
White	685 (578), 0-3341	
Other	641 (596), 0-2973	
Ethnicity		.6952
Not Hispanic-Latino-Spanish origin	639 (553), 0-3341	
Hispanic-Latino-Spanish origin	615 (543), 0-2243	
Payment source		.1131
Medicare	640 (548), 0-3341	
Other	609 (563), 0-2860	
Virginia Coordinated Care	633 (622), 0-2243	

Table 4. (Continued)

VARIABLES	TOTAL ED COSTS (US $)[A] MEAN (SD), RANGE	*P* VALUE
Medicare, Other	751 (617), 0-2756	
Medicaid	579 (508), 0-2266	
Indigent	513 (517), 0-2215	
Medicare, Medicaid	694 (559), 0-2095	
Self-pay	599 (613), 0-2379	
Charlson Comorbidity Index Score		.0775
0	609 (562), 0-3341	
1	658 (559), 0-2973	
2	669 (579), 0-2903	
3	639 (525), 0-2661	
⩾4	636 (509), 0-3236	
Total disease count by quartile		.7303
1-3	635 (570), 0-3341	
4-6	633 (557), 0-2973	
7-9	657 (549), 0-3236	
⩾10	642 (534), 0-2821	
Mode of arrival to ED		<.0001*
Self-private transportation	577 (535), 0-3341	
Ambulance	807 (562), 0-3236	
Discharge disposition		<.0001*
Home or self-care	666 (544), 0-3341	
Left against medical advice	210 (452), 0-2244	
Left before clinical evaluation	58 (207), 0-1161	
Frequent ED user		.0383*
No	644 (556), 0-3341	
Yes	599 (525), 0-2553	
Year of ED visit		<.0001*
2013	730 (593), 0-2903	
2012	656 (562), 0-3341	
2011	589 (526), 0-2787	
2010	566 (504), 0-3236	
Hot spot zip code		.5246
No	636 (551), 0-3341	

Table 4. (Continued)

VARIABLES	TOTAL ED COSTS (US $)[A] MEAN (SD), RANGE	*P* VALUE
Yes	657 (568), 0-2973	
Hot spot address		.3451
No	638 (554), 0-3341	
Yes	575 (426), 0-2237	
Type of ED visit		<.0001*
Nonemergent	549 (502), 0-3341	
Emergent	928 (607), 0-2903	

Abbreviation: ED, emergency department.
[a]Costs rounded to nearest dollar.
*$P < .05$.

Table 5. Relationship between demographics, health-related variables, and ED visit characteristics with total ED visit costs in adults ⩾65 years old.

PARAMETER	ADJUSTED GENERALIZED LINEAR MODEL REGRESSION[a]	
	EXP(B) (95% CI)	*P* VALUE
Age by quartile, y		.2523
65-67	1.0	—
68-71	1.00 (0.94-1.06)	.8999
72-78	1.01 (0.95-1.08)	.7054
⩾79	1.06 (0.99-1.13)	.0892
Sex		.2847
Female	1.0	—
Male	0.97 (0.93-1.02)	.2847
Race		<.0001*
Black or African American	1.0	—
White	1.14 (1.07-1.21)	<.0001
Other	1.16 (1.01-1.33)	.0409
Ethnicity		.4211
Not Hispanic-Latino-Spanish origin	1.0	—
Hispanic-Latino-Spanish origin	0.92 (0.76-1.12)	.4211
Payment source		.0759
Medicare	1.0	—
Other	0.92 (0.83-1.02)	.1102
Self-pay	1.02 (0.78-1.32)	.8855

Table 5. (Continued)

PARAMETER	ADJUSTED GENERALIZED LINEAR MODEL REGRESSION[a]	
	EXP(B) (95% CI)	*P* VALUE
Virginia Coordinated Care	1.00 (0.86-1.17)	.9729
Medicare, Other	1.09 (0.94-1.27)	.2659
Medicaid	0.85 (0.73-1.01)	.0609
Indigent	0.83 (0.69-0.99)	.0376
Medicare, Medicaid	1.14 (0.90-1.45)	.2704
CCI score		.3828
0	1.0	—
1	1.03 (0.97-1.09)	.3641
2	1.07 (0.99-1.15)	.0776
3	1.03 (0.95-1.12)	.5155
⩾4	0.99 (0.91-1.08)	.8942
Total disease count by quartile		.5833
1-3	1.0	—
4-6	0.97 (0.91-1.03)	.3259
7-9	1.01 (0.94-1.08)	.7641
⩾10	0.99 (0.92-1.07)	.8848
Mode of arrival to ED		<.0001*
Self-private transportation	1.0	—
Ambulance	1.26 (1.20-1.32)	<.0001
Discharge disposition		.2538
Home or self-care	1.0	—
Left against medical advice	0.97 (0.81-1.15)	.7057
Left before clinical evaluation	0.69 (0.45-1.08)	.1061
Frequent ED user		.2484
No	1.0	—
Yes	0.96 (0.90-1.03)	.2484
Year of ED visit		<.0001*
2013	1.0	—
2012	0.89 (0.83-0.94)	.0001
2011	0.76 (0.71-0.81)	<.0001
2010	0.72 (0.68-0.77)	<.0001

(Continued)

Table 5. (Continued)

PARAMETER	ADJUSTED GENERALIZED LINEAR MODEL REGRESSION[a]	
	EXP(B) (95% CI)	*P* VALUE
Hot spot zip code		.4452
No	1.0	—
Yes	1.04 (0.94-1.15)	.4452
Hot spot address		.2109
No	1.0	—
Yes	0.88 (0.71-1.08)	.2109
Type of ED visit		<.0001*
Nonemergent	1.0	—
Emergent	1.60 (1.52-1.69)	<.0001

Abbreviations: CCI, Charlson Comorbidity Index; CI, confidence interval; ED, emergency department.
[a]n = 4464 were included in the final model after exclusion of missing responses, zero costs, 5 extreme cost outliers, unknown race and ethnicity category, admit mode by helicopter, and discharge disposition categories of other facility/nursing home and expired variables. Scaled Pearson $\chi^2 = 5077.32$, $df = 4432$, $P < .001$.
*$P < .05$.

total ED cost (US $694) than ED visits by 65 to 67, 68 to 71, or 72 to 78 years (US $607, US $614, US $645, respectively). White race had a higher mean total ED cost (US $685) than African American (US $625) or other (US $641) race categories. Likewise, ambulance arrival to the ED vs self-private transportation (US $807 vs US $577) and ED visits with a discharge disposition to home or self-care had a higher mean total ED cost (US $666) than those ED visits with a discharge disposition of left AMA (US $210) or left before clinical evaluation (US $58). Not a frequent ED user vs frequent user (US $644 vs US $599) and the year 2013 had the highest mean total ED costs (US $730) compared with years 2010 to 2012 (US $566-US $656). The ED visits categorized as emergent vs nonemergent visit type (US $928 vs US $549) had higher mean total ED costs.

Results from the full adjusted GLM regression to evaluate predictors of total ED visit costs for nonemergent and emergent ED visits are provided in Table 5. Race, mode of arrival to the ED, year of ED visit, and visit type were significant predictors of total ED visit costs. The ED visits by white patients had 14% higher total ED visit costs and those in the other race category had 16% higher total ED visit costs than ED visits by African American patients (white race: 95% CI: 1.07-1.21; Other race: 95% CI: 1.01-1.33). Arriving to the ED via ambulance was associated with 26% higher total ED visit costs than arrival by self/private transportation (95% CI: 1.20-1.32). An ED visit in 2010, 2011, or 2012 was associated with lower total ED visit costs than an ED visit in 2013. Emergent ED visits were 60% more likely to have higher total ED visit costs than nonemergent visits (95% CI: 1.52-1.69). There were no other significant predictors while controlling for all other variables.

Discussion

Overall, this study indicated that community-dwelling older adults had more nonemergent ED visits than emergent ED visits. Many of the top nonemergent discharge diagnoses in this group of older adults were pain related (eg, abdominal pain, headache, back pain). Although our study did not indicate the length of the patient's problem, it is feasible that chronic pain conditions are suitable for treatment in the primary care setting. In a sample of health care hot spot residents who used the ED, themes identified from interviews indicated that pain was a common reason for ED use and many residents did not contact a health care provider prior to their ED visit.[36] Likewise, a study by Johnson and colleagues revealed that older adults had almost 3 times the risk of an ED visit and 7 times the risk of a subsequent hospitalization for an ambulatory care sensitive condition compared with adults aged 18 to 29 years.[37] An opportunity for patient education at ED discharge about using other sources of care, including primary care services for nonemergent conditions, may be warranted.[38] In addition, assessing whether the patient has a primary care provider at time of discharge, coordinating follow-up care when needed, and asking whether any problems exist with accessing care (eg, transportation, office hours) may help to decrease preventable ED use.

Although a lower proportion of ED visits in this study, emergent ED visits remain a concern in older adults due to their associated poor outcomes. This study identified men, white, higher number of comorbidities (CCI score, total disease count), and arrival by ambulance as significant predictors of an emergent ED visit in this group of community-dwelling older adults. For Medicare patients, emergent ED visits were 3.5 times more likely to result in hospitalization within 1 day, 3.0 times more likely to result in hospitalization within 7 days, and 2.2 times more likely to result in death with 30 days of the ED visit compared with visits categorized as nonemergent.[21] As diabetes and asthma were in the top emergent ED visit discharge diagnoses, future research is warranted around chronic disease management of these conditions and avenues for improvement.

Not surprisingly, total ED visit costs were higher for emergent ED visits and ED visits where the mode of arrival was via ambulance. Total ED visit costs were also higher for white and other race compared with African American ED visits. This study did not support a relationship of higher costs between health care hot spot residence and frequent ED use. In contrast, past studies have shown that costs are often related to a small number of patients residing in a hotspot.[17–19] However, the small number of ED visits from this health care hot spot may play a role in the nonsignificant finding.

Limitations

This study is limited by the accuracy of the data in the electronic medical record or billing data. However, if misclassification bias occurred, it is likely to be nondifferential misclassification (ie, the probability of a variable being misclassified is the same for all ED visits in the electronic medical record).

Another limitation is that this study includes data from one academic medical center and not all of the local EDs. It is unknown whether the patient selected this ED or whether care was directed to this ED by EMS, by the patient's health insurance coverage, or because of overcrowding at other local EDs. The generalizability of this study's results is limited to other urban, academic medical centers with similar patient populations (eg, predominantly African American and women).

Another potential concern is that the ED visit problem list was a mixture of SNOMED CT and *ICD-9-CM* codes. A cross map was used to convert SNOMED CT codes to *ICD-9-CM* codes for calculating the CCI score. It is possible that not all of the SNOMED CT codes converted into *ICD-9-CM* codes used in the CCI calculation. Thus, the study CCI may be lower than the actual CCI. In addition, there is a possibility that all patient problems were not coded with *ICD-9-CM* or SNOMED CT codes in the original data set (ie, some problems are missing).

The payment source was categorized from several primary health plan names. To limit misclassification bias, any primary health plan name with Medicare or Medicaid in the title was categorized as Medicare or Medicaid, respectively. It is possible that a primary health plan categorized as other may be a form of Medicare or Medicaid insurance. Another limitation is the exclusion of mental health, alcohol, substance abuse, injury, and unclassified ED visits by the NYU ED categorization. This exclusion may underestimate or overestimate our results.

Conclusions

Nonemergent ED visits were more common than emergent ED visits in this sample of ED visits by community-dwelling older adults in an urban, academic medical center. White race and arrival by ambulance were associated with both emergent ED visits and higher total ED visit costs, whereas sex (ie, men) and higher number of comorbidities were only associated with emergent ED visits. Residence in a health care hot spot was not associated with higher total ED visit costs or type of ED visit. Strategies to maximize opportunities for care in the primary care setting are warranted to potentially reduce nonemergent ED utilization in community-dwelling older adults.

Author Contributions

ABC was the principal investigator for the study and responsible for study design, data collection, data analysis and interpretation, and manuscript preparation. ABC is also the corresponding author for the manuscript. LRM was responsible for assisting with study design, data analysis and interpretation, and manuscript preparation. KCO, PLP, PWS, and PEM were responsible for assisting with study design, data interpretation, and manuscript preparation.

Ethical Approval

This study is approved by Virginia Commonwealth University IRB HM20002191.

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