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# Analysis of Emergency Department Visits for Palpitations (from the National Hospital Ambulatory Medical Care Survey)

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Palpitations is a common complaint in patients who visit the emergency department (ED), with causes ranging from benign to life threatening. We analyzed the ED component of the National Hospital Ambulatory Medical Care Survey for 2001 through 2010 for visits with a chief complaint of palpitations and calculated nationally representative weighted estimates for prevalence, demographic characteristics, and admission rates. ED and hospital discharge diagnoses were tabulated and categorized, and recursive partitioning was used to identify factors associated with admission. An estimated 684,000 visits had a primary reason for visit of “palpitations” representing a national prevalence of 5.8 per 1,000 ED visits (0.58%, 95% confidence interval 0.52 to 0.64). Women and non-Hispanic whites were responsible for most visits. A cardiac diagnosis made up 34% of all ED diagnoses. The overall admission rate was 24.6% (95% confidence interval 21.2 to 28.1), with higher rates seen in the Midwest and Northeast compared with the West. Survey-weighted recursive partitioning revealed several factors associated with admission including age >50 years, male gender, cardiac ED diagnosis, tachycardia, hypertension, and Medicare insurance. In conclusion, palpitations are responsible for a significant minority of ED visits and are associated with a cardiac diagnosis roughly 1/3 of the time. This was associated with a relatively high admission rate, although significant regional variation in these rates exists. © 2014 Elsevier Inc. All rights reserved. (Am J Cardiol 2014;113:1685–1690)

Palpitations, defined as a sensation of irregular, rapid, or forceful pulsation in the chest, is a common presenting complaint in medical outpatients.<sup>1–4</sup> The cause of palpitations ranges from benign causes to life-threatening cardiac conditions.<sup>5,6</sup> The relative frequency of diagnoses associated with palpitations has been described in outpatient and inpatient populations,<sup>3,4,7–9</sup> but only 1 single-center study has focused specifically on patients who visit the emergency department (ED)—who, because of self-selection, may be different from either of these other groups.<sup>4</sup> The primary goal of this study is to describe the epidemiology of ED visits and hospitalizations for palpitations using nationally representative United States (US) data from the National Hospital Ambulatory Medical Care Survey (NHAMCS)

over a 10-year period. In addition, we sought to (1) determine diagnosis frequencies, (2) evaluate demographic and clinical factors associated with admission, and (3) investigate regional variation in admission rates.

## Methods

We performed an analysis of the ED component of the 2001 to 2010 NHAMCS. The NHAMCS data set is a nationally representative sample of US ED visits obtained by the National Center for Health Statistics (NCHS) branch of the Centers for Disease Control and Prevention.<sup>10</sup> NHAMCS uses a 4-stage sampling strategy, covering geographic primary sampling units, hospitals within primary sampling units, EDs within hospitals, and patient visits within EDs. The ED visit is the basic sampling unit and represents a larger number of samples based on the inflation factor called the ED patient weight. This weighting is based on 4 factors: the reciprocal of the probability of selection, nonresponses adjustment, population ratio adjustment, and weight smoothing.

All visit sampling and data collection were performed by hospital staff, and review of data collection was performed by a US Census Bureau field supervisor. The data abstraction forms include information pertaining to the sampled visit including demographic information, 3 patient “reason-for-visit” fields, triage acuity, initial vital signs, ED tests and procedures performed, 3 International Classification of Diseases, ninth revision (ICD-9) ED discharge diagnoses, and, starting in 2005, 1 hospital discharge diagnosis. Further data collection methods and sampling design are described in detail on the NCHS Web site (<http://www.cdc.gov/nchs>).

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See page 1689 for disclosure information.

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Table 1

Demographic characteristics of emergency department (ED) visits for palpitations in the United States, 2001 to 2010

Characteristic	All Visits			Admitted or Transferred	
	Absolute No. of Cases	Estimated No. of US Cases	Percent Total of ED Palpitations (%)	Estimated No. of Cases	Weighted Percentage (%)
Overall	1,998	684,177	100	168,400	24.6
Age (yrs)					
0–9	30	9,900	1.5	NR	NR
10–19	106	37,300	5.5	970	2.6
20–29	218	66,300	9.7	4,700	7.1
30–39	242	84,200	12.3	11,500	13.7
40–49	325	120,000	17.6	26,300	21.9
50–59	312	100,300	14.7	25,300	25.2
60–69	272	100,100	14.6	31,300	31.3
70–79	274	93,200	13.6	37,600	40.3
80+	219	72,800	10.6	29,500	40.5
Gender					
Male	795	268,000	39.2	71,400	26.6
Female	1,203	416,000	60.8	97,000	23.3
Race/ethnicity					
Non-Hispanic white	1,396	486,500	71.1	122,400	25.2
Non-Hispanic black	273	90,800	13.3	17,600	19.4
Hispanic	190	67,000	9.8	14,500	21.6
Other	139	39,800	5.8	14,000	35.1
Insurance status					
Private insurance	901	303,400	44.3	57,100	18.8
Medicare	558	199,600	29.2	77,700	38.9
Medicaid/SCHIP	227	66,300	9.7	1,500	22.5
Uninsured	173	64,700	9.5	8,400	13.0
Other	139	50,300	7.4	10,200	20.4
Region					
Northeast	530	147,400	21.5	44,000	29.9
Midwest	434	161,800	23.6	51,000	31.5
South	590	229,000	33.5	53,000	23.1
West	444	146,000	21.4	20,500	14.0
Metropolitan statistical area					
Urban area	1,710	576,100	84.2	144,600	25.1
Nonurban	288	108,100	15.8	23,800	22.0

NR = not reportable (because of unweighted sample size &lt;30); SCHIP = State Children's Health Insurance Program.

This study was exempted from review by our institutional review board.

From the 2001 to 2010 NHAMCS database, we selected all ED visits that had a primary reason for visit (RFV) of “1260.0 Abnormal pulsations and palpitations; includes rapid heartbeat, slow heartbeat, irregular heartbeat, fluttering, jumping, racing, skipped beat” coded using Reason for Visit Classification for Ambulatory Care, a standardized sourcebook used in NCHS studies.<sup>11</sup> ED visits with this RFV as secondary or tertiary complaints were not included.

We collected the demographic characteristics of the patients including age, gender, race, ethnicity, insurance status, metropolitan statistical area, and geographic region. We recorded clinical data such as vital signs, triage acuity, and mode of arrival, diagnostic testing data (i.e., laboratory tests, electrocardiograms, cardiac monitoring, and x-ray imaging), and ED therapy and procedures. Additionally, ED consultations, dispositions (i.e., admit to hospital, admit to observation unit, transferred to outside hospital, and discharged), and short-term mortality in ED or in hospital were examined. We also recorded the 3 ED discharge

diagnoses provided for every ED visit and the single hospital discharge diagnosis for admitted patients.

The NHAMCS data form varies in content from year to year. For example, cardiac enzyme ordering and hospital discharge diagnosis were recorded starting in 2005, respiratory rate and pulse oximetry starting in 2007. We included in our analyses only data that were available without using imputation other than what was already done by the NCHS. For simplicity, all ED visits were categorized into 2 classes: high acuity, comprising patients needing to be seen in ≤1 hour, and low acuity, comprising patients needing to be seen in 1 to 24 hours, as has been done in previous NHAMCS analyses.<sup>12</sup> We created new variables to examine the frequency of abnormal initial vital signs. We defined tachycardia, bradycardia, fever, hypoxia, tachypnea, hypotension, and hypertension using standard age-adjusted clinical cutoffs used in previous NHAMCS vital sign analyses (see [Appendix 1](#)).<sup>13</sup>

We also recorded whether the ED visits contained a cardiac ICD-9 discharge diagnoses including dysrhythmias (e.g., cardiac dysrhythmias, atrial flutter or fibrillation, and ventricular fibrillation or flutter), structural heart disease

Table 2

Clinical characteristics and resource utilization of emergency department visits for palpitations, 2001 to 2010 (weighted estimates)

Variable	Estimated Cases	Percentage (95% CI)
Acuity		
High triage acuity	561,400	87.8 (85.6–90.0)
Low triage acuity	77,900	12.2 (10.0–14.4)
Arrival by EMS*		
Yes	117,400	22.1 (19.5–24.8)
Abnormal pulse		
Tachycardia	276,300	42.2 (39.4–44.9)
Bradycardia	31,400	4.8 (3.4–6.1)
Abnormal SBP		
Hypotensive	17,400	2.7 (1.7–3.5)
Hypertensive	139,000	20.3 (18.1–22.5)
Oxygen saturation†		
Pulse oximetry <95%	19,500	6.0 (4.0–7.9)
Temperature (°F)		
Febrile: T >100.3	43,200	6.3 (4.8–7.9)
Tachypnea‡		
Elevated RR	35,600	12.3 (9.3–15.3)
Laboratory tests		
CBC	500,900	73.2 (70.6–75.8)
Electrolytes	265,700	48.0 (43.7–52.2)
BUN/creatinine	345,800	50.5 (46.6–54.5)
Glucose	304,800	44.6 (40.8–48.3)
Cardiac enzymes‡	224,600	54.5 (50.2–58.8)
INR	57,000	19.7 (15.0–24.4)
Telemetry/ECG		
Cardiac monitoring	305,800	44.7 (41.1–48.3)
ECG	591,500	86.5 (84.2–88.8)
Imaging		
Chest x-ray	141,200	51.9 (47.2–56.6)
Any x-ray	367,700	53.7 (50.5–56.9)
Therapy		
IV fluids	321,000	46.9 (43.5–50.3)
Medication given	425,800	62.2 (59.5–65.0)
MD consultation§		
Seen by consult MD	22,400	15.6 (10.5–20.8)
Disposition		
Admit to observation	20,900	3.1 (2.1–4.0)
Admit or transfer to OH	168,400	24.6 (20.9–28.3)

BUN = blood urea nitrogen; CBC = complete blood count; ECG = electrocardiogram; EMS = emergency medical services; F = Fahrenheit; INR = international normalized ratio; IV = intravenous; MD = medical doctor; OH = outside hospital; RR = respiratory rate; SBP = systolic blood pressure.

\* Data available from 2003 to 2010 only.

† Data available from 2006 to 2010 only.

‡ Data available from 2005 to 2010 only.

§ Data available from 2009 to 2010 only. (Defined as a physician who is called to the ED by the patient's ED provider and who may leave a consultation note.)

(e.g., congestive heart failure, aortic valve disorder, and endocarditis), ischemic heart disease (e.g., angina pectoris and acute myocardial infarction), and other cardiac diagnoses (e.g., complication of heart transplant, cardiac murmurs, and premature beats). Such classifications have been used in previous NHAMCS analyses.<sup>4</sup> We created a new variable, “cardiac diagnosis,” defined as positive for any visit in which at least 1 of the 3 possible ICD-9 ED discharge diagnoses included a cardiac diagnosis. A

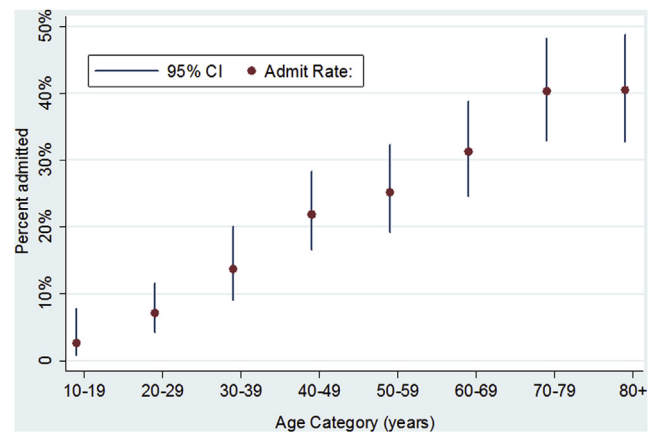


Figure 1. Survey-weighted age-stratified admission rates for patients presenting to US EDs with palpitations, 2001 to 2010.

complete list of recorded cardiac diagnoses is presented in [Appendix 2](#).

We separated all primary diagnoses into 4 categories: cardiac, psychiatric, medication or substance related, and other diagnoses or symptoms. Each diagnosis was classified independently by 2 investigators (MAP and HKK), blinded to the disposition and outcome, with a third (JRH) serving as arbitrator in cases of disagreement. Interrater agreement was assessed using a kappa statistic. We defined hospital admission as a disposition of “admit to hospital” or “transferred to outside hospital.” Admissions to the observation area and discharges were considered to be nonadmissions.

We performed all statistical analyses with Stata (version 12.1; StataCorp LP, College Station, Texas) using a standard method for analyzing survey-weighted data by way of the survey command. The survey program from Stata takes into account the multilevel sample design when producing national estimates. We determined point estimates and 95% confidence intervals (CIs) for demographic and clinical characteristics of all ED visits with a primary RfV of palpitations. We additionally tabulated frequencies summarizing resource utilization with regard to ED testing, treatment, and hospital admission. We explored regional variation in clinical management with regard to testing and admission rates. Nationally representative estimates were determined using NCHS-assigned patient weights. Estimates based on <30 sample records were excluded as they are considered to be unreliable because of high relative standard errors.<sup>14</sup>

Finally, using hospital admission as our binary outcome, we selected 29 candidate binary patient variables (see [Appendix 3](#)) based on construct validity and used survey-weighted chi-square recursive partitioning to identify factors associated with admission. Compared with logistic regression, this nonparametric technique is resistant to outliers, does not suffer from missing data, and does not rely on the independence of the explanatory variables. It involves successive univariate chi-square analyses for each of the candidate variables. The variable with the greatest discriminating power (i.e., highest chi-square value) is identified as the first criterion. Visits showing this variable are removed from further analysis, leaving a contracted database. Chi-square analyses

Table 3

Survey-weighted most common emergency department primary diagnoses for visits for palpitations, 2001 to 2010

ICD-9 Diagnosis	Weighted Count	Percentage
785.1 Palpitations	215,400	31.49
427.31 Atrial fibrillation	91,000	13.30
427.9 Cardiac dysrhythmias	75,300	11.00
785.0 Tachycardia, not otherwise specified	39,000	5.71
786.5 Chest pain	38,500	5.63
427.0 Paroxysmal supraventricular tachycardia	25,400	3.71
300.00 Anxiety state, unspecified	20,300	2.97
427.32 Atrial flutter	10,000	1.45
786.05 Shortness of breath	7,400	1.09
401.9 Hypertension, not otherwise specified	6,700	0.97
427.1 Paroxysmal ventricular tachycardia	6,000	0.88
427.69 Premature beats, other	5,000	0.73
428.0 Congestive heart failure, not otherwise specified	4,700	0.68
300.01 Panic disorder without agoraphobia	4,000	0.59
427.61 Supraventricular premature beats	3,800	0.55

were then performed on the contracted database to identify a second criterion from among the remaining variables, and so on. Within the recursive partitioning analysis, age was studied as a binary variable at 10-year cut-off intervals starting at age 20, and we excluded variables with a nonresponse rate of >30% threshold or with <30 sample records as per NHAMCS instructions.<sup>10</sup>

## Results

The complete data set contained a total of 357,681 ED visits from 2001 to 2010, representing an estimated 118 million visits. From this sample, we found 1,998 visits with a primary RFV of palpitations, representing an estimated 684,177 visits nationally. The nationally estimated prevalence of palpitations as a chief complaint in the ED was 5.8 per 1,000 patient visits (95% CI 5.2 to 6.4). Further demographic characteristics of patients who visit the ED with palpitations are provided in Table 1. Most patients were considered high acuity on triage (87.8%, 95% CI 85.6 to 90.0). Further clinical and testing information is presented in Table 2.

The overall survey-weighted admission rate, including transfers to other hospitals, was 24.6% (95% CI 21.3 to 28.1), and 3.1% of the visits resulted in an admission to the observation unit (95% CI 2.1 to 4). Admission rates increased with older age. Figure 1 shows survey-weighted, age-stratified admission rates for subjects aged >10 years. (The admission rate for 0 to 9-year age group decreased because of small sample size.) The survey-weighted admission rate varied by region, ranging from 14% (95% CI 11 to 18) in the West, 23% (95% CI 20 to 27) in the South, 30% (95% CI 25 to 36) in the Northeast, to 31% (95% CI 25 to 38) in the Midwest. Further resource utilization information is presented in Table 2. Data regarding ED and in-hospital mortality are not reported because of unweighted sample sizes being too small to be reliable, as per NHAMCS instructions.<sup>10</sup>

Table 4

Survey-weighted most common hospital discharge diagnoses for patients admitted after an emergency department visit for palpitations, 2005 to 2010 (n = 82,700)

ICD-9 Diagnosis	Weighted Count	Percentage
427.31 Atrial fibrillation	22,700	27.7
427.9 Cardiac dysrhythmias	10,800	13.1
786.5 Chest pain	6,900	8.4
785.1 Palpitations	6,400	7.8
427.1 Paroxysmal ventricular tachycardia	3,800	4.7
427.32 Atrial flutter	2,400	2.9
428.0 Congestive heart failure, not otherwise specified	2,000	2.5
276.1 Hyposmolality	1,800	2.2
486 Pneumonia, organism not otherwise specified	1,200	1.5
410.9 Acute myocardial infarction	1,000	1.2

Cardiac and psychiatric diagnoses made up approximately 34% and 6% of all ED diagnoses (up to 3 per patient), respectively. A summary of the most common ED primary diagnoses is presented in Table 3. Of all admitted patients, 18% had a primary ED diagnosis of “palpitations,” “cardiac dysrhythmia, not otherwise specified,” or “tachycardia, not otherwise specified” at the time of admission. Cardiac diagnoses made up approximately 62% of all hospital discharge diagnoses. A summary of the 10 most common hospital discharge diagnoses is presented in Table 4.

Cardiac disease (38%) was the most common diagnostic category when compiling all the primary ED diagnoses. Psychiatric diagnoses and medication- or substance-related disorders made up 4.7% and 1.8% of primary ED diagnoses, respectively. A list of diagnoses comprising these categories is available in Appendix 2. Interrater agreement was high for all 3 diagnostic categories (cardiac:  $\kappa = 0.87$ , psychiatric:  $\kappa = 0.97$ , and medication or substance:  $\kappa = 1.0$ ).

In younger adults (age 30 to 49 years), frequency of ED testing was very similar to the overall cohort with the exception of cardiac enzyme testing, which was 3% lower in the younger cohort. The 3 most common ED diagnoses for patients in this younger cohort who were hospitalized were atrial fibrillation, palpitations, and chest pain, not otherwise specified. About 45% of this cohort was given at least 1 cardiac diagnosis in the ED. In patients who present to the ED with a chief complaint of palpitations and a primary ED diagnosis of atrial fibrillation, there was some regional variability in management, with a trend toward lower testing rates in the West and higher in the Northeast (see Appendix 4). This trend is consistent with the pattern observed for the overall cohort.

Using survey-weighted data, chi-square recursive partitioning revealed 8 factors associated with admission. In decreasing order of magnitude of association, these were (1) age >50 years, (2) cardiac diagnosis in the ED, (3) tachycardic at triage, (4) Medicare as source of payment, (5) seen in the Midwest, (6) Hispanic ethnicity, (7) hypertensive at triage, and (8) male gender. All admissions had been dropped after the eighth partition.



## Discussion

This is the first nationally representative epidemiologic study of ED visits for palpitations. Palpitations are responsible for a significant minority of US ED visits, only slightly less than syncope,<sup>12</sup> which is an area of active medical research.<sup>15–19</sup> The frequency of cardiac diagnoses in our study (38%) is similar to that observed in a mixed cohort of ED, outpatient, and hospitalized patients.<sup>4</sup> However, the frequency of psychiatric diagnoses is substantially smaller in our study (4.7% vs 31%), which may be because of spectrum bias and/or the reluctance of emergency physicians to ascribe symptoms to benign psychiatric etiologies after a single encounter.

The overall admission rate of 24.6% is not surprising given the high prevalence of atrial fibrillation and other cardiac dysrhythmias in this cohort. This rate is less than, but comparable to, that found for syncope (32%) in an analogous NHAMCS analysis<sup>12</sup> and suggests that significant health-care resources are devoted to this clinical entity. The nearly twofold variation in admission rates between different regions indicates that management of this complaint remains subjective and has yet to be optimized. Our analysis does not permit speculation as to whether certain patients with palpitations are being admitted unnecessarily or whether they are being discharged inappropriately. Interestingly, nearly 8% of admitted patients had a hospital discharge diagnosis of “palpitations,” calling into question the diagnostic yield of the hospitalization. These findings justify further research to examine whether these patients are suffering adverse outcomes after ED discharge or, alternatively, are undergoing costly and invasive inpatient investigations without benefit. Other studies have found a low mortality rate for patients with palpitations.<sup>4,7,9</sup> Our study was limited to ED and in-hospital mortality but does not refute these results.

This is the first study to use survey-weighted chi-square recursive partitioning with the NHAMCS data set. Results of our recursive partitioning analysis revealed that 8 variables were associated with admission to the hospital. Increasing age and vital sign abnormalities, not surprisingly, were associated with admission, because these are generally associated with greater likelihood of serious illness. The ED visits for palpitations by patients aged <50 years, which were covered by Medicare, were more likely to result in admission because having Medicare coverage at age <65 years is due to disability or other chronic disease. The fact that cardiac diagnosis and male gender were associated with admission suggests that ED clinicians are primarily concerned with the investigation and treatment of serious cardiac disorders when encountering this chief complaint. Male gender has been shown to increase a clinician's perceived risk of cardiac disease.<sup>20</sup> Having been seen in the Midwest was associated with admission, even after controlling for other factors, suggesting that substantial regional variation exists, which cannot be explained by the factors available in our data. If we assume that the underlying acuity of patients who present to the ED with palpitations does not vary significantly, on average, across regions of the United States, the large variation in admission rates suggests either an overuse of health care resources in some areas,

underuse in other areas, or both. It is impossible, based only on our present data, to distinguish among these alternatives, or to identify the underlying basis for the variation that exists.

There are certain limitations to our study. First, NHAMCS data may suffer from lack of reliability and accuracy.<sup>21</sup> Nonetheless, NHAMCS is the largest and only nationally representative data set that can provide epidemiologic data on emergency conditions in the United States. Second, our case definition of palpitations allows the possibility that we included ED visits where the chief complaint was actually chest pain, dyspnea, or syncope. We believe this is unlikely, however, because these chief complaints are categorized with different Reason for Visit codes. It is nevertheless possible that patients presenting to the ED with a chief complaint of palpitations had associated dyspnea or chest pain, and that these other symptoms influenced management. Third, our diagnostic summary data are based on ICD-9 codes, which can lack specificity and accuracy.<sup>22</sup> Finally, NHAMCS does not include any follow-up diagnostic or short-term clinical outcome data, which limited our analysis to using “admission to hospital” as our outcome variable. ED and in-hospital mortality figures were too small to produce reliable estimates or permit statistical analysis. This lack of adverse event data precluded attempts at risk stratification for serious clinical outcomes.

## Disclosures

The authors have no conflicts of interest to disclose.

## Supplementary Data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.amjcard.2014.02.020>.

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