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Incidence of Cardiovascular Events Following Hospital Admission for Pneumonia

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Abstract

Introduction—Several studies have suggested an increased risk of cardiovascular events, primarily acute myocardial infarction, around the time of hospital admission for pneumonia. Therefore we examined cardiovascular events, including myocardial infarction, congestive heart failure, unstable angina, stroke, and serious cardiac arrhythmias, within 90 days after hospitalization for pneumonia.

Methods—Using data from the administrative databases of the Department of Veterans Affairs, we examined a cohort of subjects hospitalized with pneumonia between October 2001 and September 2007. Subjects were at least 65 years of age. We examined the incidence of myocardial infarction, congestive heart failure, cardiac arrhythmias, unstable angina, and stroke by ICD-9 codes excluding those with a diagnosis prior to the admission for pneumonia.

Results—The cohort comprised 50,119 subjects with a mean age of 77.5 years (SD 6.7 years), and 98% of the cohort was male. The 90-day incidence of cardiovascular events was 1.5% for myocardial infarction, 10.2% for congestive heart failure, 9.5% for arrhythmia, 0.8% for unstable

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angina, and 0.2% for stroke. The majority of events occurred during the hospitalization for pneumonia.

Conclusion—A clinically important number of subjects in this cohort suffered a cardiovascular event within 90 days of hospital admission, suggesting that such events may have an important role in post-pneumonia mortality. Additional research is needed to determine whether interventions may reduce the number of cardiovascular events after pneumonia.

Keywords

pneumonia; cardiovascular disease; congestive heart failure; cardiac arrhythmia; myocardial infarction

INTRODUCTION

In the United States, pneumonia affects approximately 4 million individuals per year,¹ and, in combination with influenza, is the eighth leading cause of death and the leading cause of infectious death.² Although pneumonia is one of the leading causes of death, little attention has been focused on the contributors to this mortality.³

Recently several studies have suggested that there are a clinically important number of cardiovascular events occurring during the hospital admission for pneumonia. These studies have linked respiratory infection with increased risk of cardiovascular events in the short term, with the greatest risk occurring within the first few days to one week following diagnosis of respiratory infection.^{4–7} One postulated explanation for the observed increase in cardiovascular events occurring around the time of respiratory infection is the acute increase in serum levels of inflammatory cytokines that accompanies serious infection, which may lead to instability of atherosclerotic plaques.^{8, 9} Other studies have found significant occurrence of myocardial infarction either at the time of hospital admission for pneumonia or within 15 days post-hospital admission for pneumonia.^{9–12} Additionally, the Musher study¹⁰ found significant occurrence of new or worsening congestive heart failure and cardiac arrhythmia at the time of hospital admission for pneumonia.

The majority of previous research has focused on defining the incidence of myocardial infarction, and to a lesser extent congestive heart failure, at the time of hospitalization for pneumonia. However, given the likely mechanisms at work, other cardiovascular events could also play an important role in the mortality associated with pneumonia. Further, little research has characterized the incidence of both repeat and first-time cardiovascular events following hospitalization for pneumonia. The purpose of this study is to examine the incidence of cardiovascular events, including myocardial infarction, congestive heart failure, unstable angina, cardiac arrhythmia, and stroke, within 90 days of hospitalization for pneumonia utilizing the extensive clinical databases of the Department of Veterans Affairs.

METHODS

Data and Study Population

After approval by the Institutional Review Board of the University of Texas Health Science Center at San Antonio, we obtained national VA inpatient, outpatient and pharmacy data from fiscal year 2002 (FY02; October 1, 2001 to September 30, 2002) through FY07 (October 1, 2006–September 30, 2007). Mortality was ascertained using VA Vital Status file, which identifies the date of death.¹³ Data from each database was linked by encrypted patient identifiers.

We identified all subjects who were hospitalized during fiscal years 2002–2007 with a primary discharge diagnosis of pneumonia (International Classification of Diseases, ninth revision (ICD-9) codes 480.0–483.99 or 485–487.0) or a secondary discharge diagnosis of pneumonia with a primary diagnosis of respiratory failure (ICD-9 code 518.81) or sepsis (ICD-9 code 038.xx). Subjects were included in the study if they (1) were 65 or older on the date of hospital presentation, (2) had at least 1 year of VA outpatient care prior to admission, (3) were hospitalized for at least 24 hours, and (4) had received at least 1 dose of antibiotics within 48 hours of admission. If a subject was admitted more than once during the study period, only the first hospitalization was included. A similar approach to identification of cases of pneumonia has been previously used by Meehan, et al., where the diagnosis of pneumonia by ICD-9 code was validated by clinical criteria such as chest X-ray performed within 48 hours of admission, and clinic record showing at least an initial working diagnosis of pneumonia³⁵. By including only those patients who were hospitalized for more than 24 hours, with pertinent ICD-9 code, and who received antibiotics within 48 hours, we feel that our cohort contains a high percentage of true pneumonia cases.

Measures

Demographic Characteristics—We obtained demographic information (age, sex, race, marital status) from inpatient and outpatient data. Race/ethnicity categories included white, black, Hispanic, and other/unknown.

Comorbid conditions were obtained from administrative data for the year prior to the hospitalization for pneumonia. We used ICD-9 codes to identify tobacco use and comorbid conditions that may be associated with mortality. ICD-9 codes for tobacco use (305.1, V15.82), visits to a smoking cessation clinic, and/or use of medications for the treatment of nicotine dependence (Zyban, nicotine replacement, or varenicline) were used to infer tobacco use. ICD-9 codes from previous outpatient and inpatient encounters were used to identify non-cardiac preexisting comorbid conditions prior to admission utilizing the Charlson-Deyo algorithms.^{14, 15}

Outcomes

We identified cardiovascular events in the cohort of hospitalized patients with pneumonia using ICD-9 codes indicating an inpatient diagnosis of myocardial infarction, congestive heart failure, cardiac arrhythmia, unstable angina, and stroke (Table 1). Cardiac arrhythmias included symptomatic bradycardia, atrial fibrillation, ventricular fibrillation or tachycardia, and cardiac arrest. We defined prior cardiovascular events as those that occurred at least 1 day prior to the day of admission for the pneumonia hospitalization, and examined records dating back to at least 1 year prior to that hospitalization. Due to the sources of the data (i.e. administrative data) we were unable to determine whether a given cardiac event played a major or minor role in the index admission. Therefore for each type of event we restricted our analyses to only those subjects who did not have history of that specific cardiovascular event (e.g., subject with congestive heart failure but not myocardial infarction was included in the myocardial infarction analysis but not the congestive heart failure one).

Statistical Analyses

Bivariate statistics were used to test the association of sociodemographic and clinical characteristics with cardiovascular events within 90-days of hospital admission. Categorical variables were analyzed using the chi-square test and continuous variables were analyzed using Student's t-test. To examine time-to-diagnosis for each of the cardiovascular outcomes, a graph was created using Kaplan-Meier estimated probabilities.

Next we created two generalized linear mixed-effect models to examine potential predictors of either incident congestive heart failure or cardiac arrhythmias with the patient's hospital as a random effect. Factors examined in the model included demographics, intensive care unit admission, prior comorbid conditions, and prior cardiac conditions (excluding those with prior history of the specific condition being examined.)

All analyses were performed using STATA 10 (College Station, Texas).

RESULTS

Our overall cohort was composed of 50,119 subjects who met the inclusion criteria. The mean age was 77 years (standard deviation (SD) 6.7), and 49,226 (98%) were male (Table 2). The majority of the cohort was white (78%), with black and Hispanic ethnicity making up 11% and 6%, respectively. Diabetes and malignancy were the most common comorbidities, and the mean length of hospital stay was 7.8 (SD $\pm$ 12.6) days.

To further examine the contribution of the episode of pneumonia on each of the cardiovascular diagnoses we restricted the analysis to incident cases of each type of cardiovascular event, excluding those subjects with a prior diagnosis of the specific cardiovascular condition (e.g., those with a prior history of only congestive heart failure were excluded from the congestive heart failure analysis but not from other analyses). Figure 1 demonstrates this process and the resulting sample sizes. For those subjects with no history of a particular cardiovascular event, the incidence of cardiovascular events during hospitalization, as well as 30 days and 90 days post-admission is summarized in Table 3. Overall, congestive heart failure and arrhythmia were the most common events, accounting for the majority of post-pneumonia cardiovascular events.

Table 4 shows the percentages of various demographic and other factors per each type of cardiovascular event. Prior history of cardiovascular events, other than the type suffered, was among the highest versus those with no subsequent cardiovascular event. For other factors, diabetes was substantially more prevalent in those who suffered post-pneumonia myocardial infarction, congestive heart failure, angina, and stroke compared to those who suffered no post-pneumonia cardiovascular event. In addition, uncomplicated and complicated diabetes and renal disease were much more common in those who had subsequent cardiovascular events.

We also examined the 90-day trends in the occurrence of new-onset cardiovascular events by plotting the percentage of total 90-day events versus time post-admission for pneumonia (Figure 2). The trends show that the majority of myocardial infarction, congestive heart failure, cardiac arrhythmia, and unstable angina events occur early in the 90-day period, and primarily during the hospitalization for pneumonia. Stroke has a more gradual trend with less than 20% of events occurring during the hospitalization, and roughly 40% of the events occurring after 30 days post-hospitalization for pneumonia.

To examine risk factors for the two common cardiac events within 90 days after hospitalization for pneumonia, congestive heart failure and cardiac arrhythmias, we performed two multilevel regression analyses. Factors significantly associated with an incident diagnosis of congestive heart failure included increasing age, admission to the intensive care unit, uncomplicated and complicated diabetes, renal disease and cancer (Table 5). Factors significantly associated with an incident diagnosis of cardiac arrhythmias included increasing age and admission to the intensive care unit (Table 6).

DISCUSSION

Prior work has demonstrated that a significant proportion of mortality within 90 days of admission for pneumonia is attributable to other comorbid conditions,³ and that there are a number of cardiovascular events that occur during, or soon after, hospitalization for pneumonia.^{4-6, 9-12} A 1996 meta-analysis of CAP mortality rates found an overall mortality rate of 13.6% for hospitalized patients, and 36.5% for CAP patients admitted to the ICU.³⁴ In their 2007 study, Musher, et al. reported a mortality rate of 21/170 (12.4%), with congestive heart failure or myocardial infarction either causing or contributing to the mortality in 9/21 (42.9%) of the deaths¹⁰. Our study confirms that hospitalization for pneumonia is associated with a clinically significant number of cardiovascular events occurring either during the hospital admission for pneumonia or shortly thereafter, and demonstrates some factors associated with risk of cardiovascular disease.

While we did find substantial incidence of cardiovascular events in our cohort, the incidence of myocardial infarction was considerably lower than reported in previous studies. Musher, et al., reported an incidence of myocardial infarction of 7.1% at the time of hospital admission in 170 patients hospitalized with bacterial pneumonia caused by *S. pneumoniae*.¹⁰ Additionally, Ramirez et al. reported an incidence of myocardial infarction at the time of hospital admission of 5.8% in 500 patients hospitalized with community-acquired pneumonia.⁹ Corrales-Medina et al. reported an incidence of myocardial infarction of 10.7% in 206 patients hospitalized with bacterial pneumonia caused by either *S. pneumoniae* or *H. influenzae*. This incidence was measured during the first 15 days following hospital admission.¹² All three of these incidence rates appear to include both repeat and new myocardial infarction events. When considering both repeat and new events, the incidence of myocardial infarction occurring during the reference hospitalization in our cohort was 1.4% (722/50,119). Potential explanations may include the differences in the patient populations, decreased testing (e.g., electrocardiograms and/or cardiac enzymes) in the VA, reliance by prior studies on mildly elevated levels of serum troponins as the primary way to diagnose an myocardial infarction, or that due to our age cutoff (≥ 65 years of age) congestive heart failure rather than myocardial infarction is more likely.

Musher et al. also reported on the incidence of post-pneumonia cardiovascular events other than myocardial infarction,¹⁰ describing an incidence of new onset or worsening congestive heart failure for 14% of their sample and an incidence of new onset arrhythmia (including atrial flutter, atrial fibrillation, and ventricular tachycardia with the exclusion of terminal arrhythmias) of 5.8%. These incidences were measured at the time of admission for pneumonia. During the reference hospitalization for our cohort, the incidence of new or repeat congestive heart failure was 19.2% and for cardiac arrhythmias 6.4%, which were similar to those reported by Musher, et al. However, our definition of arrhythmia was more inclusive including symptomatic bradycardias and cardiac arrest.

Both Musher and Ramirez cited a number of explanations for the significant incidence of post-pneumonia cardiovascular events observed in their studies. One possible explanation is that an acute increase in inflammatory cytokines leads to instability of previously established atherosclerotic plaques. A number of studies have shown acutely increased levels of the pro-inflammatory cytokines interleukin-6 (IL-6) and tumor necrosis factor (TNF- α), and anti-inflammatory cytokine IL-10 at the time of admission for pneumonia.^{8, 16-17} Other studies have demonstrated a relationship between elevated levels of inflammatory cytokines and cardiovascular disease,¹⁸⁻¹⁹ which many believe may be due to increased plaque rupture. This hypothesis is supported by decreased pneumonia mortality associated with the administration of corticosteroids at the time of intensive care unit admission for severe pneumonia.²⁰ In addition, patients with pre-existing cardiovascular

disease such as prior myocardial infarction, ventricular fibrillation, and unstable angina show enhanced coagulation activation and an up regulation of CD40L on platelets.²¹ The resulting pro-coagulant state may contribute to the formation of thrombosis in the coronary arteries during an episode of acute infection. Finally, both Musher and Ramirez suggest that mismatches between oxygen supply and demand may also cause increased cardiovascular events for patients with pneumonia.^{9, 10}

Another potential mechanism for pneumonia-related cardiovascular events should also be considered. The common organisms involved in community-acquired pneumonia are well known, and a recent study characterizing the etiology of community-acquired pneumonia confirmed that the major causative organisms as *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Mycoplasma pneumoniae*, *Chlamydia pneumoniae*, *Legionella pneumophila*, *Staphylococcus aureus*, and a number of viral pathogens including influenza A and B.²² Several of these pathogens have demonstrated the ability to directly infect cardiomyocytes, and cause conduction and contractility dysfunction.^{23–31} For example, the most common cause of community-acquired pneumonia, *Streptococcus pneumoniae*, has recently been implicated in causing decreased cardiac contractility through immune-mediated uptake of bacterial cell wall antigen into cardiomyocytes.³² This study showed that the uptake of pneumococcal cell wall was mediated by platelet activating factor receptor (PAFr), and that once inside cardiomyocytes, a loss in contractility occurred in vitro as well as in isolated rat hearts. These findings may provide further explanation to an earlier study that found high prevalence of pneumococcal infection in intensive care unit patients with elevated Troponin I levels.³³ Factors associated with increased risk of cardiovascular events (congestive heart failure and arrhythmias) are straightforward (e.g., intensive care unit admission and prior cardiovascular disease) and clinicians should take these factors into consideration when caring for patients with pneumonia. We hypothesize that the factors associated with decreased risk of cardiovascular events, such as hemiplegia, are due to clinicians not looking as hard in these patients for cardiovascular disease rather than actually being protective.

There were a number of limitations in our analysis. The VA patient population is less than 2% female, which makes the study results poorly generalizable to women. Another limitation was reliance on ICD-9 diagnosis of cardiovascular events rather than clinical information, which particularly may impact the diagnosis of congestive heart failure. Not infrequently there is clinical confusion about whether patients have congestive heart failure, pneumonia, or both. We are unable to determine the extent to which these conditions may have been improperly differentiated. However due to our definition of pneumonia we are confident that the treating physicians believed that pneumonia was present, and that by excluding those with pre-existing history of congestive heart failure, we were able to identify subjects that were very likely to have had a new diagnosis of congestive heart failure. Another limitation is that we did not examine the rates of CV events for other illnesses such as urinary tract infection and chronic obstructive pulmonary disease, which may have acted as confounding variables in our analysis.

In conclusion, a clinically important number of subjects have at least one cardiovascular event within 90 days following hospitalization for pneumonia. Congestive heart failure and cardiac arrhythmia, even for those with no history of these events, are the most common events, and the majority of these events occur during the initial hospitalization. Further research is needed to better determine cardiovascular risk among patients hospitalized with pneumonia, shed light on the mechanisms responsible for these cardiovascular events, and determine potential therapies to minimize the morbidity and mortality associated with cardiovascular events following serious infections such as pneumonia.

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Figure 1.
Flow Diagram Illustrating the Number of Subjects that were Excluded Due to Prior CV
Diagnosis

Figure 2.
Trends in CV Events from Hospital Admission to 90 days for those with no Prior History of the Specific CV Condition

Table 1

ICD-9 codes for Cardiovascular Outcomes

Outcome	ICD-9 Codes
Myocardial Infarction	410, 410.0–410.9, 411, 411.1, 412, 414.2, 414.8, 429.71, 429.79
Congestive Heart Failure	402, 402.1, 402.10, 402.11, 402.9, 402.90, 402.91, 404, 414.19, 425.4, 428, 428.0, 428.1, 428.2, 428.20–428.23, 428.3, 428.30–428.33, 428.4, 428.40–428.43, 428.9, 429.1, 429.4, 997.1
Cardiac Arrhythmias	427, 427.0, 427.1–427.5, 427.31, 427.32, 427.41, 427.42, 427.8, 427.81, 427.89, 427.9, 429.4, 997.1, V12.53
Unstable Angina	411.1, 413, 413.0, 413.1, 413.9
Stroke	430, 431, 432.0–432.9, 433.0–433.91, 434–434.91, 435–435.9, 436, 437–437.9, 438–438.9

¹ ICD-9 International Classification of Disease, ninth revision

Table 2

Demographics and Clinical Characteristics of Pneumonia Cohort

Variable	N (%)
Age in years, mean (SD)	77.5 (6.7)
Men	49,226 (98.2)
Race / Ethnicity	
White	39,201 (78.2)
Black	5,635 (11.2)
Hispanic	3,202 (6.4)
Other/unknown	2,081 (4.2)
Married	26,963 (53.8)
Smoker	18,708 (37.3)
Mean number of outpatient visits in year prior to hospitalization, mean (SD)	14.58 (13.0)
<i>Preexisting Comorbid Conditions</i>	
Peripheral vascular disorders	7,753 (15.5)
Hemiplegia or paraplegia	766 (1.5)
Diabetes, uncomplicated	16,364 (32.7)
Diabetes, complicated	4,968 (9.9)
Renal disease	6,323 (12.6)
Moderate or severe liver disease	188 (0.4)
Mild liver disease	408 (0.8)
Peptic ulcer disease	1,686 (3.4)
AIDS	114 (0.2)
Metastatic cancer	1,879 (3.8)
Malignancy	11,935 (23.8)
Rheumatoid arthritis\Collagen vascular diseases	1,421 (2.8)
Myocardial infarction	8,262 (16.5)
Congestive heart failure	16,989 (33.9)
Arrhythmia	17,430 (34.8)
Angina	7,774 (15.5)
Cerebrovascular disease (stroke)	9,140 (18.2)
ICU admission	6,977 (13.9)

¹ SD – Standard Deviation

Table 3

New CV Events Occurring Post-Hospital Admission for Pneumonia for Subjects With No History of the Specific CV Event

Post-Pneumonia CV Event	Number of Subjects Experiencing Event
MI	N=41,857
Hospitalization	374 (0.9%)
30 days	513 (1.2%)
90 days	646 (1.5%)
CHF	N=33,130
Hospitalization	2442 (7.4%)
30 days	3002 (9.1%)
90 days	3392 (10.2%)
Arrhythmia	N=32,689
Hospitalization	2103 (6.4%)
30 days	2732 (8.4%)
90 days	3099 (9.5%)
Angina	N=42,345
Hospitalization	184 (0.4%)
30 days	261 (0.6%)
90 days	342 (0.8%)
Stroke	N = 40,979
Hospitalization	22 (0.05%)
30 days	43 (0.10%)
90 days	70 (0.17%)

Table 4

Demographics and clinical characteristics of pneumonia cohort by diagnosis of new cardiovascular events within 90 days after hospital admission for pneumonia after excluding those with pre-existing conditions

Variable	Myocardial Infarction (N = 646)	Congestive Heart Failure (N = 3,392)	Arrhythmia (N = 3,099)	Angina (N = 342)	Stroke (N = 70)	No Cardiac Event (N = 30,932)
Age in years, mean (SD)	77.64 (6.6)	78.28 (6.8)	77.92 (6.6)	77.57 (6.5)	77.27 (6.3)	77.07 (6.75)
Men	630 (97.5)	3,331 (98.2)	3,039 (98.1)	334 (97.7)	69 (98.6)	30,342 (98.1)
Race / Ethnicity						
White	531 (82.2)	2,750 (81.1)	2,482 (80.1)	278 (81.3)	52 (74.3)	23,448 (75.8)
Black	52 (8.1)	317 (9.4)	293 (9.5)	21 (6.1)	11 (15.7)	3,885 (12.6)
Hispanic	33 (5.1)	171 (5.0)	165 (5.3)	30 (8.8)	5 (7.1)	2,227 (7.2)
Other/unknown	30 (4.6)	154 (4.5)	159 (5.1)	13 (3.8)	2 (2.9)	1,372 (4.4)
Married	327 (50.6)	1,762 (52.0)	1,636 (52.8)	181 (52.9)	40 (57.1)	16,588 (53.6)
Smoker	239 (37.0)	1,172 (34.6)	1,126 (36.3)	142 (41.5)	20 (28.6)	11,896 (38.5)
Mean number of outpatient visits in year prior to hospitalization, mean (SD)	14.27 (10.1)	12.82 (11.7)	12.45 (12.3)	15.12 (12.3)	15.41 (13.8)	13.78 (13.2)
<i>Precexisting Comorbid Conditions</i>						
Peripheral vascular disorders	107 (16.6)	527 (15.5)	463 (14.9)	51 (14.9)	7 (10.0)	4,349 (14.1)
Hemiplegia or paraplegia	5 (0.8)	33 (1.0)	28 (0.9)	5 (1.5)	1 (1.4)	535 (1.7)
Diabetes, uncomplicated	243 (37.6)	1,180 (34.8)	892 (28.8)	129 (37.7)	34 (48.6)	9,256 (29.9)
Diabetes, complicated	90 (13.9)	366 (10.8)	267 (8.6)	45 (13.2)	8 (11.4)	2,656 (8.5)
Renal disease	105 (16.3)	396 (11.7)	318 (10.3)	47 (13.7)	9 (12.9)	3,253 (10.5)
Moderate or severe liver disease	0 (0)	11 (0.3)	11 (0.3)	0 (0)	0 (0)	130 (0.4)
Mild liver disease	3 (0.5)	24 (0.7)	28 (0.9)	2 (0.6)	0 (0)	264 (0.9)
Peptic ulcer disease	20 (3.1)	113 (3.3)	86 (2.8)	14 (4.1)	4 (5.7)	1,067 (3.5)
AIDS	3 (0.5)	11 (0.3)	2 (0.1)	1 (0.3)	0 (0)	79 (0.3)
Metastatic cancer	7 (1.1)	68 (2.0)	98 (3.1)	4 (1.2)	3 (4.3)	1,412 (4.6)
Malignancy	114 (17.7)	656 (19.3)	709 (22.9)	65 (19.0)	18 (25.7)	7,889 (25.5)
Rheumatoid arthritis(Collagen vascular diseases	21 (3.3)	114 (3.4)	93 (3.0)	10 (2.9)	2 (2.9)	855 (2.8)
<i>Cardiovascular events prior to admission</i>						
Myocardial infarction	N/A	396 (11.7)	349 (11.3)	55 (16.1)	10 (14.3)	3,712 (12.0)
Congestive heart failure	294 (45.5)	N/A	777 (25.1)	133 (38.9)	28 (40.0)	6,038 (19.5)

Variable	Myocardial Infarction (N = 646)	Congestive Heart Failure (N = 3,392)	Arrhythmia (N = 3,099)	Angina (N = 342)	Stroke (N = 70)	No Cardiac Event (N = 30,932)
Arrhythmia	234 (36.2)	1,060 (31.3)	N/A	112 (32.8)	23 (32.9)	6,608 (21.4)
Angina	105 (16.3)	370 (10.9)	317 (10.2)	N/A	12 (17.1)	3,771 (12.2)
Cerebrovascular disease (stroke)	107 (16.6)	608 (17.9)	510 (16.5)	68 (19.9)	N/A	5,388 (17.4)
ICU Admission	100 (15.5)	766 (22.6)	957 (30.9)	58 (17.0)	13 (18.6)	3,378 (10.9)

/ SD – Standard Deviation

Table 5

Results of Regression Model with Outcome of CHF within 90-days of Admission

Variable	Odds Ratio	95% Confidence Interval	P value
Age	1.03	1.02–1.03	0.0001
Men	1.06	0.81–1.39	0.67
Married	0.93	0.86–1.0	0.05
Smoker	0.95	0.88–1.04	0.25
ICU admission	2.08	1.85–2.34	0.0001
Peripheral vascular disorders	1.12	1.01–1.24	0.03
Hemiplegia or paraplegia	0.54	0.37–0.77	0.001
Diabetes, uncomplicated	1.36	1.25–1.49	0.0001
Diabetes, complicated	1.29	1.12–1.47	0.0001
Renal disease	1.25	1.11–1.41	0.0001
Moderate or severe liver disease	0.98	0.50–1.92	0.95
Mild liver disease	0.97	0.61–1.53	0.88
Peptic ulcer disease	1.01	0.82–1.23	0.96
Metastatic cancer	0.57	0.44–0.74	0.0001
Malignancy	0.78	0.71–0.86	0.0001
Rheumatoid arthritis/Collagen vascular diseases	1.30	1.06–1.60	0.01
Myocardial infarction	1.25	1.09–1.42	0.001
Arrhythmia	1.48	1.36–1.61	0.0001
Angina	0.99	0.86–1.13	0.88
Cerebrovascular disease	1.04	0.94–1.15	0.42

Table 6

Results of Regression Model with Outcome of Arrhythmia within 90-days of Admission

Variable	Odds Ratio	95% Confidence Interval	P value
Age	1.03	1.02–1.03	0.0001
Men	0.99	0.75–1.31	0.96
Married	1.03	0.95–1.11	0.44
Smoker	1.0	0.92–1.09	1.00
ICU admission	3.59	3.21–4.01	0.0001
Peripheral vascular disorders	1.10	0.99–1.23	0.08
Hemiplegia or paraplegia	0.70	0.57–0.85	0.0001
Diabetes, uncomplicated	0.9	0.82–0.99	0.02
Diabetes, complicated	1.04	0.89–1.21	0.62
Renal disease	0.89	0.78–1.01	0.07
Moderate or severe liver disease	1.15	0.75–1.78	0.51
Mild liver disease	0.82	0.42–1.61	0.56
Peptic ulcer disease	0.83	0.66–1.04	0.11
Metastatic cancer	0.85	0.68–1.07	0.17
Malignancy	1.0	0.91–1.10	0.95
Rheumatoid arthritis/Collagen vascular diseases	1.08	0.87–1.35	0.49
Myocardial infarction	1.04	0.91–1.20	0.57
Angina	0.91	0.79–1.05	0.18
Cerebrovascular disease	1.04	0.94–1.16	0.42
Congestive heart failure	1.13	1.03–1.24	0.01