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Role of ambulatory care utilization in accounting for higher inpatient acute myocardial infarction mortality among Asian Americans

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ROLE OF AMBULATORY CARE UTILIZATION IN ACCOUNTING FOR HIGHER INPATIENT ACUTE MYOCARDIAL INFARCTION MORTALITY AMONG ASIAN AMERICANS

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ABSTRACT

Introduction: To address a lack of population-level studies that examine the association between ambulatory care utilization and cardiovascular outcomes among Asian Americans, this study examined 1) ambulatory care utilization among different racial/ethnic groups and 2) the association between ambulatory care utilization and cardiovascular outcomes.

Method: This was a retrospective analysis of 2009–2012 Medicare fee-for-service data. Primary outcomes were 1) hospitalization for angina, an ambulatory care sensitive condition, and 2) inpatient AMI mortality. Intermediate outcomes of interest were ambulatory care utilization. First, a descriptive analysis of patients' predisposing and enabling factors was performed, and then bivariate association between these predisposing and enabling factors and ambulatory care utilization was examined. Lastly, using multivariate logistic regression models I estimated the association between ambulatory care utilization and cardiovascular outcomes, adjusting for socio-demographic and geographical characteristics.

Results: There were 999,999 people in the analytic sample, drawn from 21.6 million Medicare fee-for-service enrollees. In 2009, there were significant differences in racial/ethnic ambulatory care utilization. Significantly lower percentage of Asians had

frequent ambulatory care visits (>30 visits) and outpatient cardiology clinic visits (>30 visits) (both p-values<0.01), after adjusting for predisposing and enabling factors. Asians had the highest observed inpatient mortality (15.9%) and low ambulatory utilization was associated with increased odds (OR=1.85 [1.11–3.08]) of inpatient AMI mortality.

Conclusion: Among Medicare fee-for-service enrollees, Asians had fewer ambulatory clinic visits. Low ambulatory care utilization was associated with increased odds of AMI mortality. Further research is needed to understand the causal relationship between ambulatory care utilization and cardiovascular outcomes.

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LIST OF ABBREVIATIONS

AHRQ……..……..… Agency for Healthcare Research and Quality

AMI……...Acute Myocardial Infarction

ANOVA……..……. Analysis of Variance

Asian…… Asian American

CABG…….……. Coronary Artery Bypass Graft Surgery

CPT……....Current Procedural Terminology

ECHO…….…. Echocardiogram

EKG……..…… Electrocardiography

HRR……... Hospital Referral Region

ICD…….….International Classification of Diseases

NPI……..….. National Provider Identifier

NSTEMI……...……Non-ST-Segment Elevation Myocardial Infarction

OR……... Odds Ratio

PCI……..…… Percutaneous Coronary Intervention

PCP…… Primary Care Provider

PHH……...……..Potentially Preventable Hospitalization

STEMI……..……..… ST-Segment Elevation Myocardial Infarction

TIA……...……Transient Ischemic Attack

INTRODUCTION

Coronary artery disease, a common underlying cause of acute myocardial infarction (AMI), affects 15 million adults in the US and 715,000 people have AMI annually[1]. AMI mortality has significantly decreased with advancements in care, standardization of AMI management, and modifications of AMI-related risk factors [2-4]. Despite these improvements, there exist significant racial and ethnic disparities in the treatment and outcome of AMI[5-21]. Multiple prior studies of disparities have focused almost exclusively on non-Hispanic Blacks and Hispanics, particularly their lower rates of invasive cardiac interventions and worse AMI mortality. However, little is known about the inpatient AMI mortality of Asians residing in the US. It is important to study Asian Americans (including Pacific Islanders) because they make up 4.8% of the US population and this population has been growing faster than the overall national population growth rate[22].

To add to the understanding of Asian American populations, I have used State Inpatient Data from 15 states (Arizona, California, Colorado, Florida, Illinois, Massachusetts, Maryland, Nevada, New Jersey, New Mexico, New York, Oregon, Pennsylvania, Texas, and Virginia), which contained primary admission and discharge diagnosis as well as patients' socio-demographic, clinical, and administrative information. The data contained about 76% of Asian Americans and found Asian Americans to have the highest observed and age-adjusted rates of inpatient AMI mortality, compared to Whites, Blacks, and Hispanics. The inpatient AMI mortality among adults age 65 or older was 8.35%; 10.1% for Asians, 8.3% for non-Hispanic

Whites, 7.9% for non-Hispanic Blacks, and 8.3% for Hispanics. I also discovered that Asian patients who were admitted to a hospital with a primary diagnosis of AMI had higher rates of cardiac comorbidities (congestive heart failure, hypertension, diabetes, and chronic kidney disease) compared to non-Hispanic Whites, despite Asian Americans in the population having relatively low prevalence of AMI-related comorbidities, including obesity, diabetes, smoking, and hypertension[23-26]. On further examination, racial/ethnic disparity related to inpatient AMI mortality persisted even after adjusting for socio-demographic characteristics, medical comorbidities, invasive cardiac procedure use, and socioeconomic indicators. This finding indicated a need to investigate this phenomenon further.

The present study is important for several reasons. First and most importantly, there is a significant lack of health services research among Asian Americans although they comprise significant proportion of the US population and their population is increasing at a faster rate than the national population. Some contributing factors for lack of health services research among Asian Americans include a lack of national data that captures Asian Americans as a distinct group, or assumptions that Asians are healthy and the population does not have much need for improvements. For example, CDC's NHANES only started to identify and oversample Asian Americans starting in 2011, and prior to that Asian Americans were lumped into the "Other" racial category. Another explanation for the lack of literature may be due to the assumption that Asian Americans are relatively healthier. Previous epidemiologic studies found that Asian Americans have a low prevalence of cardiac comorbidities[23-25]. The limitation of these studies is that

many use self-reported medical conditions; individuals not having a medical diagnosis or being unaware that they have these diseases could have resulted in a lower reported prevalence of chronic medical conditions. In another study led by me, this hypothesis was using NHANES, which showed Asian Americans having the highest prevalence of undiagnosed hypertension and diabetes among different racial/ethnic groups.

There is a need for more healthcare utilization and outcome research among Asian Americans. In disparity research, many racial/ethnic disparity researchers have shifted from identifying areas of disparities to improving existing disparities[27-29]. However, due to the lack of population-level studies identifying health disparities among Asian Americans, there is less perceived public need and urgency to address health issues among Asian Americans. In addition, Asian Americans may have worse cardiovascular outcomes as demonstrated by high inpatient AMI mortality rates. In addition, limited literature on ambulatory care utilization has shown Asian Americans to be low ambulatory care utilizers[30-32]. Therefore, it is important to examine any association between racial/ethnic differences in ambulatory care utilization and cardiovascular outcomes. This study would help further understanding of patterns of ambulatory care utilization by Asian Americans and identify areas that are associated with their poor health outcomes with respect to AMI.

This study was conducted to fill gaps in the health services literature by examining an association between ambulatory care utilization and cardiovascular outcomes among Asian Americans. The purposes of this study included addressing 1) a scarcity of literature that examines health utilization by Asian Americans and 2) limited

number of prior research that examines an association between ambulatory care utilization and inpatient AMI outcomes. By conducting this research project, I planned to understand patterns of ambulatory care utilization by Asian Americans and identify an area that is associated with poor health outcomes among Asian Americans.

BACKGROUND

Previous epidemiologic studies found that Asian Americans have a relatively low prevalence of AMI-related comorbidities, including obesity, diabetes, smoking, and hypertension[23-26], as well as a low national-level AMI mortality rate compared to other racial/ethnic groups[33]. However, the examination of administrative inpatient data for a number of major states, which together account for a majority of the Asian American population, indicated that Asian Americans have the highest AMI inpatient mortality across all racial/ethnic groups. Furthermore, Asian Americans have a higher prevalence of cardiac comorbidities (congestive heart failure, hypertension, diabetes, and chronic kidney disease) than non-Hispanic Whites. I was puzzled by the differences in the prevalence of cardiac comorbidities between patients admitted with a diagnosis of AMI and the general population. To investigate the discrepancy in the prevalence of cardiac comorbidities, I used the CDC's NHANES[34], a nationally representative survey, to examine the prevalence of undiagnosed diabetes and hypertension. This study suggested that the national prevalence of cardiac comorbidities among Asian Americans are under-estimated, possibly due to Asian Americans having a higher rate of undiagnosed chronic conditions. Additionally, I found that, even among those with access to a routine outpatient care provider, the prevalence of undiagnosed hypertension and diabetes remained high among Asian Americans. There is evidence that this may arise from a lack of screening among Asian Americans[35]. Other possible reasons include language barriers or cultural attitudes about seeing a healthcare provider for preventive visits.

There also exist significant disparities in hospitalizations for ambulatory care

sensitive conditions. Studies have found that racial/ethnic minorities, African Americans and Hispanics having high rates of ambulatory care sensitive conditions[36-38]. Again, there is a lack of literature that examines racial/ethnic disparities in hospitalizations for ambulatory care sensitive conditions among Asian Americans.

There is evidence that ambulatory care utilization is associated with general health outcomes[39-43]. Ambulatory care utilization can be measured by examining the continuity and frequency of care. High continuity of care or frequent ambulatory care utilization is associated with improved health outcomes[39,42,44,45]. Continuous relationships with providers and frequent ambulatory clinic visits reflect sustained relationships between providers and patients, which are associated with increased trust and accumulated knowledge of the patients[46]. Subsequently, this allows for better medical management and health outcomes[40,41]. In another study, continuous ambulatory care was associated with a lower rate of emergency department utilization[47].

The review of published literature provided limited information regarding healthcare utilization among Asian Americans, mainly due to the scarcity of studies. However, the abundant literature regarding disparities in ambulatory care utilization has shown that there exist racial/ethnic disparities in ambulatory care utilization[48]. In a small number of studies, Asian Americans were identified to be low ambulatory care utilizers, including for mental health and preventive care[30-32]. Using NHANES, I found significantly lower proportions of Asians (78.9%) and Hispanics (71.6%) reported having a routine place for healthcare compared to Whites (87.2%) and Blacks (87.0%) ($p<0.01$)[49]. Also, lower percentages of Asians (67.4%) and Hispanics (60.9%) had

healthcare visits within the past year ($p<0.01$) compared to other racial/ethnic groups. The study found better healthcare access is associated with more healthcare utilization, and limited healthcare access among Asian Americans may explain why they are less likely to utilize ambulatory care. A limited number of studies showing disparities in ambulatory care utilization further underscore the importance of this proposed study, specifically in examining an association between ambulatory care utilization and cardiovascular outcomes. Currently, there is no prior study that examines an association between ambulatory care utilization and cardiovascular outcomes among Asian Americans at the population-level.

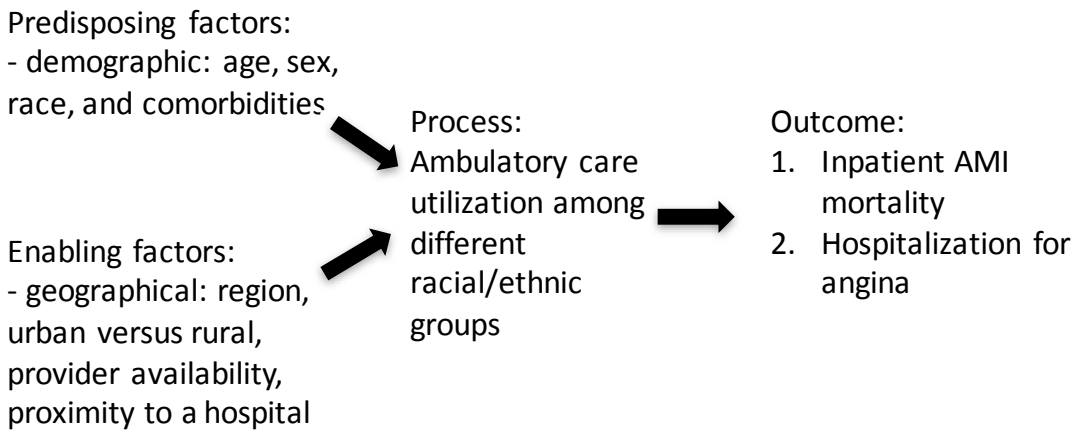
Conceptual Framework

The conceptual framework (Figure 1) for this study was derived from the Andersen and Donabedian models[44,50]. Although these frameworks were developed for different purposes, the meshed conceptual framework based on these models supports the study design. The Andersen model, a popularly used framework in health services research, was developed to demonstrate how predisposing factors, enabling factors, and needs contribute to individual health care utilization. The Donabedian model was developed to describe quality of care by examining components of structure, process, and outcomes.

For this study, which examines racial/ethnic variations in healthcare utilization and how its utilization is associated with cardiovascular outcomes, I used parts of the Andersen and Donabedian models. In the first part of the study, I examined the variations that exist in ambulatory care utilization among different racial/ethnic groups. To address

variations in ambulatory care utilization from sociodemographic and geographical characteristics, different predisposing factors (demographic characteristics) and enabling factors (geographical characteristics) from the Andersen model are identified and adjusted in describing racial/ethnic differences in ambulatory care utilization. It is important to adjust for predisposing and enabling factors in describing racial/ethnic differences in ambulatory care utilization because these factors can influence the utilization. For example, ambulatory care utilization of a Medicare enrollee living in a rural area where the closest medical clinic is located 100 miles away will be different than a Medicare enrollee living in a metro area with many healthcare providers in proximity. In the meshed conceptual framework, ambulatory care utilization is a process measure of interest in examining cardiovascular outcomes, thus subsequently I used the Donabedian model to link process to outcome. There is a conceptual link between how ambulatory care utilization affects process and the eventual outcomes of the process. Based on studies showing an association between ambulatory care utilization and better health outcomes, I believed that racial/ethnic differences in ambulatory care utilization partly explains disparities in cardiovascular outcomes. The relevant parts from the Andersen and the Donabedian frameworks can be merged to explain how factors associated with health services utilization (Andersen model) and how health services utilization is part of the process that determines healthcare outcomes (Donabedian model) such as AMI inpatient mortality.

Figure 1. Conceptual framework modified from the Donabedian and the Andersen model



The study examined predisposing factors (mainly patients' demographic and clinical characteristics) and enabling factors (based on geocoded data and geographical location) and assessed how they affect ambulatory care utilization among Asian Americans. Furthermore, I examined whether the use of ambulatory care services is associated with inpatient AMI mortality (as the connection between process and outcome suggests). The main outcomes of the study were 1) inpatient AMI mortality among those who are hospitalized with a primary diagnosis of AMI and 2) hospitalization for angina, ambulatory care sensitive condition. I also studied whether there exist any associations among predisposing factors and enabling factors in inpatient AMI mortality or hospitalization for angina. My previous research study and literature review led me to hypothesize that low ambulatory care utilization among Asian Americans would be associated with higher AMI inpatient mortality and/or hospitalization for angina.

METHODS

Design Overview

This was a secondary analysis of Medicare data from 2009–2011. The study examined variations in ambulatory care utilization among different racial/ethnic groups and how the ambulatory care utilization was associated with AMI outcomes, specifically inpatient AMI mortality and hospitalization for angina.

Specific Aims and Hypothesis

I developed the following **research questions:** 1) Do ambulatory care utilization patterns, specifically primary care and cardiology care, differ among different racial/ethnic groups? and 2) Is there an association between ambulatory care utilization and inpatient AMI mortality or hospitalization for angina among different racial/ethnic groups? The first question was designed to examine variations in ambulatory care utilization among different racial ethnic groups. I will be looking at ambulatory care visits to primary care providers and cardiologists. In addition, I examined utilization of outpatient cardiac tests. I hypothesized that Asian Americans utilize ambulatory care less than other racial/ethnic groups. The second question was aimed at establishing an association between ambulatory care utilization and AMI outcomes, specifically inpatient AMI mortality and hospitalization for angina. I hypothesized that low ambulatory care utilization will be associated with higher AMI inpatient mortality and higher rates of hospitalization of angina, ambulatory care sensitive condition.

Study Data

This was an observational study based on administrative data from a national

representative sample of the Centers for Medicare and Medicaid Services (CMS) Medicare fee-for-service data. The Medicare data was appropriate for this study because it contained nationally representative estimates of patients of age 65 + and their comprehensive healthcare information, including ambulatory care utilization, inpatient stays/readmissions, use of referral, and procedures. Among those who were enrolled in the Medicare program on 1/1/2010, I obtained a stratified random sample (N=999,999) of all Medicare fee-for-service enrollees aged 65 and older who were continuously enrolled from January 1, 2010 to December 31, 2011 with oversampling of all racial/minorities: Asians, non-Hispanic Blacks and Hispanics. The data contain additional health utilization information from January 1, 2009 to December 31, 2009. Previous studies examining ambulatory care utilization among Medicare fee-for-service enrollees showed that about 31% of enrollees had fewer than 4 ambulatory care visits and 69% had 4 or more ambulatory care visits[47]. Using the 1/1/2009–12/31/2009 data to characterize the baseline health status and healthcare utilization, I prospectively examined cardiovascular outcomes during 1/1/2010–12/31/2011. Lastly, the data contained mortality information. This information could be used to calculate inpatient mortality, 30-days mortality, 60 days mortality, and even 180-days mortality, allowing to measure short-term and long-term health outcomes.

Figure 2. Study period

Study Population

There were 47.4 million Medicare enrollees who were alive and at least 66 years old on January 1, 2010. To capture all of patients' health utilization, those Medicare enrollees with additional health insurance were excluded. Lastly, those with a missing/invalid birth date, sex, race/ethnicity, or zip code were excluded. After these inclusion and exclusion criteria were applied, there were 21.6 million Medicare fee-for-service enrollees in the available sample.

The data for this study contained a nationally representative sample of 1 million Medicare fee-for-service enrollees from the 21.6 million Medicare fee-for-service enrollee cohort. This was accomplished by obtaining an equal number of stratified random samples from each of the 306 hospital referral regions (HRR). After dividing each HRR into the top 50% income (high-income cohort) versus bottom 50% income (low-income cohort) based on median income of the zip code, an equal number of individuals from each race/ethnicity were compiled from the high-income and low-income cohorts. The data was also collected to over-sample minorities and included 300,000 non-Hispanic Whites, 300,000 Hispanics, 300,000 non-Hispanic Blacks, and

100,000 Asians. The study sample was weighted to represent the population of national fee-for-service Medicare enrollees (21.6 million people).

Race/Ethnicity

The data categorized patients into the following race/ethnicity groups based on self-reported identity: Hispanics, non-Hispanic Whites, non-Hispanic Blacks, Asians, and Others.

The data did not identify the national origin of Asian Americans. Asian Americans are comprised of diverse groups, including those who are originally from East, Southeast Asia, Indian subcontinent, and Pacific Islands. During my previous work using the Inpatient State Data, I attempted to identify national origin using geocoding, but this was not successful due to Asians living in clusters in urban and metro areas, and the lack of one group being a majority in the given geographical location.

Primary Outcomes

The primary outcome measures were 1) inpatient AMI mortality among those who were admitted with a primary diagnosis of AMI (ICD-9: 410.xx) and 2) admission for angina without a procedure, an ambulatory care sensitive condition during 1/1/2010–12/31/2011. Inpatient AMI mortality is one of the Inpatient Quality Indicators measured by the Agency for Healthcare Research and Quality (AHRQ)[51]. Among AMI patients, I further differentiated AMI cases into non-ST-segment elevation (NSTEMI) (ICD-9=410.7x) and ST-segment elevation MI (STEMI) (all ICD-9=410.xx excluding 410.7x). Hospitalization for angina without procedure is one of the 12 conditions associated with potentially preventable hospitalization (PHH) within the Agency for Healthcare Research

and Quality (AHRQ) Prevention Quality Indicators[52]. Hospitalization for this ambulatory care sensitive condition will be identified using ICD diagnosis codes and corresponding *Current Procedural Terminology (CPT)* codes to identify cardiac procedures (ICD-9 codes: 411.1, 411.8, 413 without surgical procedures [CPT codes: 01-86.99])[53].

Because of the relatively high incidence of AMI and high mortality associated with AMI among the study population, the study sample should be adequate to examine the hypothesis. In one study looking at the prevalence of AMI among the Medicare fee-for-service enrollees, the prevalence of AMI was 830 [95% confidence interval 827–833] per 100,000 person-years in 2010[54]. My previous study using the State Inpatient Data found that the inpatient AMI mortality among adults age 65 or older is 8.35%; 10.1% for Asians, 8.3% for non-Hispanic Whites, 7.9% for non-Hispanic Blacks, and 8.3% for Hispanics. There will be a subgroup of patients who will have more than one hospitalization for AMI. In 2010, the annual observed recurrent AMI hospitalization rate was 8.9% [95% Confidence interval: 8.8–9.1%][54]. In this study, if a Medicare enrollee had more than one visit for AMI, one visit was randomly selected from the study period (1/1/2010–12/31/2011) and that visit was used to measure the AMI mortality. Due to the nature of the data, it is impossible to differentiate whether an AMI event during the study period is a first AMI versus subsequent AMI prior to the study period. Therefore, it is appropriate to select one random AMI visit during the study period and use that hospitalization to measure AMI mortality. I expect about 10% of the AMI admissions during the period to be from recurrence. For the outcome of hospitalization of angina, I measured the number of visits, as more frequent admission for ambulatory care sensitive

condition implies more unnecessary hospitalizations.

Ambulatory Care Utilization

The primary covariate of interest is ambulatory care utilization. There are two components, which are ambulatory care visits and ambulatory cardiac tests. Both covariates were measured on the outpatient claims data from 1/1/2009 to 12/31/2009. For ambulatory care visits, I am interested in examining different types of ambulatory visits, including primary care visits, cardiology visits, and other specialty visits. Using the provider specialty type, I identified primary care visits as those for general practice, family practice, internal medicine, and geriatric medicine. Clinic visits for cardiology will be identified separately using the provider's national provider identifier (NPI) and the type of cardiac procedure being performed.

Previous study had identified variability in specialist availability, especially in rural areas[55]. To address such geographical variations in provider availability, I examined the distribution of specialists and examine whether there were variations in ambulatory cardiac tests based on provider availability.

I also examined outpatient cardiac tests, including electrocardiogram, echocardiogram, stress testing, and percutaneous interventions. Using CPT codes, the following cardiac tests and procedures were identified; electrocardiography (CPT: 93000, 93005, 93010), echocardiogram (CPT: 93303, 93304, 93306–93308), stress test (CPT: 93351, 93320, 93321, 93325, 93016, 93018, 93350), myocardial perfusion imaging (CPT: 78465), and angiography (CPT: 93451–93461) (Table 1). Patients were identified as either having the cardiac tests or procedures done or not in an outpatient setting during

1/1/2009–12/31/2009.

Table 1. Measures of ambulatory care utilization

Ambulatory care clinic	
Primary care provider	
cardiologist	
medical provider (includes internal medicine specialties)	
all providers	
Ambulatory cardiac tests	CPT codes
electrocardiography	93000, 93005, 93010
echocardiogram	93303, 93304, 93306–93308
stress test	93351, 93320, 93321, 93325, 93016, 93018, 93350
myocardial perfusion imaging	78465

Covariates

Based on previous literature, key demographic attributes, comorbidities, use of invasive cardiac procedures, and area-based characteristics that were associated with AMI mortality were identified. These covariates were categorized into predisposing factors and enabling factors.

Predisposing factors, which were mainly socio-demographic variables, included race, gender, age, and cardiac comorbidities[17,56-59]. Age was categorized into three groups: 65–74, 75–84, and 85+. For cardiac comorbidities, I identified presence of cardiac conditions from the Medicare data. Medicare data compiles presence of these medical conditions from previous healthcare utilization. These cardiac conditions include atrial fibrillation, chronic kidney disease, congestive heart failure, diabetes, ischemic heart disease, depression, stroke/TIA, cancer, anemia, hyperlipidemia, and hypertension.

Enabling factors (geographical characteristics) included region, urban type, provider availability, and distance to a nearest hospital[60]. Region was defined broadly as Northeast, South, West, or Midwest. Because these socioeconomic factors were not available in the Medicare Data, I will instead use zip code-level geocoded data on urban type, provider availability, and distance to a nearest hospital median from the Census Bureau's American Community Survey and the Area Healthcare Resource File[61,62]. For PCP availability, the groups were as top quartile>82.3 PCP/100k residents, second quartile=69.1–82.3 PCP/100k residents, third quartile=59.2–68.9 PCP/100k residents, lowest quartile<59.2 PCP/100k residents. For distance to a nearest hospital, the groups were defined as living less than a mile, less than 5 miles, or more than 5 miles away from a nearest hospital.

Among patients who were hospitalized with AMI, I examined additional covariates. Receipt of invasive cardiac procedure with AMI hospitalization was associated with improved outcomes. Using diagnosis and procedure codes from the *International Classification of Diseases, Ninth Revision, Clinical modification* and the corresponding *Current Procedural Terminology*, I identified receipt of the invasive cardiac procedures, specifically coronary artery bypass surgery (CABG) and percutaneous coronary intervention (PCI)[63]. To differentiate disease severity, I used the Elixhauser comorbidity index to adjust for differences in disease burden[64]. The Elixhauser comorbidity index identifies 30 medical conditions based on ICD codes. It was developed to predict hospital resource use and inpatient mortality based on comorbid conditions. For this study, the Elixhauser comorbidity index will help adjust for

differences in healthcare utilization and AMI mortality from underlying conditions among those who were hospitalized with AMI.

Statistical Analysis

There were two parts to the thesis. All statistical analyses were conducted using SAS software, version 9.3 (SAS Institute Inc., Cary, NC) and Stata 14.1 (StataCorp (2016) Stata Statistical Software: Release 14. College Station, TX, StataCorp LP).

Study 1: Do ambulatory care utilization patterns, specifically primary care and cardiology care, differ among different racial/ethnic groups?

Hypothesis: Asian Americans have a lower rate of ambulatory care utilization (physician visits) compared to other racial/ethnic groups.

This analysis was performed at the individual level and included all 999,999 Medicare enrollees in the study cohort, with aforementioned measures of ambulatory visits as the outcomes. Statistical analysis was performed to provide summary statistics of the predisposing (demographic and clinical characteristics) and enabling (geographical characteristics) factors of the overall study population and different racial/ethnic subgroups. Next, I examined an association between different racial/ethnic groups and ambulatory care utilization. Lastly, I examined the association between race/ethnicity and ambulatory care utilization adjusting for the predisposing and enabling factors using multivariate linear regressions. For linear regression, the coefficients were presented with statistical significance. For multivariate logistic regression, odds ratio with 95% confidence intervals were presented; hypothesis testing of differences was based on analysis of variance.

The secondary analyses included examination of racial/ethnic differences in health care utilization, including outpatient clinical care and outpatient cardiovascular tests (electrocardiography, echocardiogram, stress test, myocardial perfusion imaging, and angiography). Also, I also examined differences in emergency room and short-hospital stay.

Study 2: Is there an association between ambulatory care utilization and inpatient AMI mortality among different racial/ethnic groups?

Hypothesis: Patients with infrequent ambulatory care utilization have worse cardiovascular outcomes compared to patients with frequent and continuous ambulatory care utilization.

First, I calculated frequency of hospitalization for angina and AMI among the study population and by racial/ethnic groups. For AMI, I described racial/ethnic differences in AMI hospitalization by type of AMI, presence of invasive cardiac procedure, length of inpatient stay, and Elixhauser comorbidity index.

I then examined factors associated with AMI hospitalization among difference racial/ethnic groups. Among those who were hospitalized with AMI, I estimated observed inpatient mortality. Lastly, I conduced multivariate logistic regression to examine the relationship between ambulatory care utilization and AMI inpatient mortality, adjusting for predisposing, enabling factors, and AMI-related covariates. To test the above hypothesis, I estimated the relative risks using two models, the first without including ambulatory care utilization measures and the second including these measures. I hypothesized that relative odds of inpatient mortality from AMI for Asians would be

mitigated by inclusion of the ambulatory care utilization. In addition, I repeated this analysis by stratifying the enrollees based on ambulatory care utilization; I hypothesized that among enrollees with similar ambulatory care utilization, inpatient mortality from AMI would be similar between Asians and Whites.

To address the possible effects of policy changes and advancements in technology, sensitivity analyses were performed to examine the difference in ambulatory care utilization and AMI mortality between 2010 and 2011 Medicare enrollees. Also, subgroup analysis of AMI mortality among patients with multiple AMI hospitalization was be conducted to examine whether there is a stronger association between ambulatory care utilization and multiple inpatient AMI hospitalization.

RESULTS

Study population

Our study population of 999,999 Medicare enrollees represented 21.6 million Medicare enrollees, of whom 18.5 million were White, 1.5 million were Black, 0.9 million were Hispanic, 0.5 million were Asian, and 0.2 million were Others.

Socio-demographic characteristics

To understand the characteristics of the study population, I examined distribution of gender, age, and region. There were significant differences in socio-demographic characteristics among different racial groups (Table 2). Overall, there were more females (58.3%, weighted) than males in the study population. Blacks had the highest proportion of female (gender distribution: 61.7% female and 38.3% male) and Other group had the smallest proportion of female (gender distribution: 56.2% female and 43.8% male) (ANOVA; p-value<0.01). Average mean age of the study population was 76.9 years old. Whites had the highest mean average age of 77.1 years old and Other group had the youngest mean average age of 74.4%. I also examined regions, which is grouped as Northeast, Midwest, South, or West, and found significant variations in geographical locations (p-value<0.01). Of note, more than half of Asians resided in the West compared to only 17% of the total study population that resided in the West.

Table 2. Socio-demographic characteristics by race*

	All (n=999,999)	White (n=306,000)	Black (n=306,001)	Hispanic (n=306,014)	Asian (n=45,033)	Other (n=36,951)	P-value
Gender							
Male	41.7	41.9	38.3	42.8	41.0	43.8	<0.01
Female	58.3	58.1	61.7	57.2	59.0	56.2	
Mean age, years old	76.9	77.1	76.2	75.8	76.6	74.4	<0.01
Age group							
65–74	44.3	43.5	48.8	49.9	45.9	57.9	<0.01
75–84	37.4	37.6	35.4	36.6	38.0	33.4	
85+	18.3	18.9	15.8	13.5	16.0	8.7	
Region							
Northeast	19.1	19.8	15.1	15.2	16.3	15.6	<0.01
Midwest	24.2	25.8	19.7	8.9	9.1	15.8	
South	39.8	38.9	58.5	41.2	19.0	29.7	
West	16.9	15.6	6.7	34.8	55.6	38.8	

* weighted percentages

Clinical characteristics

Next, I examined prevalence of cardiac comorbidities among different racial groups (Table 3). Certain medical conditions predispose patients to a higher risk of developing coronary artery diseases. For the analysis, the comorbidities include atrial fibrillation, chronic kidney disease, congestive heart failure, diabetes, ischemic heart disease, depression, stroke/transient ischemic attack, cancer (breast cancer, colorectal cancer, prostate cancer, lung cancer, endometrial cancer), anemia, hyperlipidemia, and hypertension. There was a mixed finding in regards to prevalence of these medical conditions. Whites had significantly lower prevalence of chronic kidney disease and diabetes, but higher prevalence of atrial fibrillation and ischemic heart diseases (ANOVA; p-value<0.01). Asians had low prevalence of atrial fibrillation, chronic kidney diseases, congestive heart failure, ischemic heart diseases, depression, and cancer. However, Asians had the highest prevalence of hyperlipidemia compared to other racial groups (ANOVA; p-value<0.01). Blacks had the highest prevalence of diabetes, chronic kidney diseases, congestive heart failure, hypertension, anemia, and stroke/TIA.

Table 3. Prevalence of cardiac comorbidities by race* (as of 12/31/2009)

	All (n=999,999)	White (n=306,000)	Black (n=306,001)	Hispanic (n=306,014)	Asian (n=45,033)	Other (n=36,951)	P-value
Atrial fibrillation	9.0	9.7**	4.5	4.9	4.9	5.1	<0.01
Chronic kidney disease	12.7	12.1	19.6**	14.0	11.9	12.5	<0.01
Congestive heart failure	16.2	15.9	20.7**	17.4	12.6	13.6	<0.01
Diabetes	27.1	25.1	40.4**	39.7	35.3	34.7	<0.01
Ischemic heart disease	33.4	33.7	31.6	34.8**	29.3	29.3	<0.01
Depression	10.7	11.0	8.1	12.4**	5.4	8.6	<0.01
Stroke/TIA	4.2	4.0	6.0**	4.3	3.5	3.4	<0.01
Cancer	8.4	9.4	10.0**	6.5	5.8	7.2	<0.01
Anemia	23.9	23.0	31.7**	28.7	27.2	21.4	<0.01
Hyperlipidemia	48.8	49.1	45.1	48.1	51.9**	43.9	<0.01
Hypertension	61.2	60.2	73.0**	62.1	62.8	57.9	<0.01

* Weighted percentages

** Racial/ethnic group with the highest prevalence of given cardiac comorbidity

Geographical characteristics

There are variations in geographical characteristics among different racial groups (Table 4). I examined county-level information on urbanity, physician availability and proximity to a nearest hospital. These variables were selected as markers for access to healthcare. In terms of geographical location, highest proportions of Asians (96.1%) resided in metropolitan areas and only 0.8% of Asians resided in rural areas. Overall, the majority (77.5%) of Medicare enrollees resided in large metro. Asians also resided in areas where there are high number of physicians (224 physicians per 100k population) and Hispanics resided in areas with lowest number of physicians (198 physicians per 100k population). Consistent with physician (any type of physicians) availability, Asians resided in areas with the highest number of primary care physicians (81.0 primary care physicians/100k population) and Hispanics resided in areas with the lowest number of primary care physician (70.9 primary care physicians/100k population. Last of all, I examined proximity to a nearest hospital. The Asians had the highest percentages (38.9%) residing within 1 mile of a hospital. Higher percentages of Whites (42.3%) and Others (45.5%) of Others resided more than 5 miles from a hospital.

Table 4. Geographical characteristics*

	All (n=999,999)	White (n=306,000)	Black (n=306,001)	Hispanic (n=306,014)	Asian (n=45,033)	Other (n=36,951)	P-value
Urban type							
Metropolitan	77.5	75.9	84.9	89.7	96.1	70.3	<0.01
Urban area	12.4	13.3	7.8	6.7	3.1	15.3	
Rural	10.1	10.8	7.3	3.6	0.8	14.4	
Physician availability							
# of physicians/100k, average	208	207	216	198	224	217	<0.01**
# of primary care physician/100k, average	74.5	74.3	76.3	70.9	81	81.2	<0.01**
Proximity to a nearest hospital							
% living <1 mile from a hospital	24.2	22.6	32.8	35.6	38.9	24.1	<0.01
% living <5 mile from a hospital	35.4	35.2	38.8	33.3	41.2	30.6	
% living >5 mile from a hospital	40.4	42.3	28.4	31.1	19.8	45.4	

* weighted percentages

** Comparing Asians versus non-Asians (combined Whites, Blacks, Hispanics, and Others)

Healthcare utilization

Ambulatory clinic visits

During the period of 1/1/2009–12/31/2009, there were significant differences in racial/ethnic ambulatory care utilization among Medicare enrollees. Overall, 31.9% of the overall study population had 0 ambulatory care visits, 10.6% had 1–3 ambulatory care visits, 14.3% had 4–6 ambulatory care visits, 21.7% had 7–12 visits, 16.7% had 13–24 visits, and 4.9% had more than 24 ambulatory care visits. The average number of ambulatory care visits was 6.87, with Whites having the highest mean average of 7.35 visits and Asians having the lowest mean average of 5.56 visits. The highest percentages (48.1%) of Asians had no ambulatory care visits. Besides Asians, high percentages of Hispanics also had zero ambulatory visits.

Emergency room visits

In 2009, 30.6% of the Medicare enrollees went to emergency room. There were significant variations in emergency room visits. Highest percentage of Blacks (37.1%) went to emergency room versus smallest percentages of Asians (21.4%) went to emergency room (ANOVA; $p<0.01$).

Short-stay hospitalization

Next, I examined short-stay hospitalization. A majority (82.2%) of Medicare enrollees were not hospitalized. Overall, 11.8% had one short-stay hospitalization, 5.7% who had 2–5 short-stay hospitalizations, and 0.2% who had six or more short-stay hospitalizations. Again, smallest percentages (12.8%) of Asians had any short-stay hospitalization and largest percentages (10.3%) of Blacks had any hospitalization

(ANOVA; p-value<0.01). Asians were the group with the lowest utilization of the emergency room, and the highest prevalence of having had no hospitalizations. They were also the group with the lowest prevalence of hospital stays in any of the short-stay frequency categories.

Table 5. Healthcare utilization during 1/1/2009–12/31/2009

	All (n=999,999)	White (n=306,000)	Black (n=306,001)	Hispanic (n=306,014)	Asian (n=45,033)	Other (n=36,951)	P-value
Number of ambulatory clinic visits (weighted percentages)							
0	31.9	30.6	35.7	41.3	48.1	33.9	<0.01
1–3	10.6	10.8	10.5	8.5	8.0	10.8	
4–6	14.3	14.6	13.8	10.9	10.3	12.9	
7–12	21.7	22.1	20.6	18	16	19.8	
13–24	16.7	16.9	15.1	16.1	13.3	16.7	
25+	4.9	4.9	4.2	5.3	4.3	5.9	
Quartiles, Medians, and Means							
Q1	0	0	0	0	0	0	
Median	4	5	4	4	3	4	
Q3	11	11	10	11	9	10	
Mean	6.87	7.35	6.73	6.70	5.56	6.96	<0.01
% with any emergency room visits	30.6	30.3	37.1	31	21.4	25.9	<0.01
% with any short-stay hospitalization							
0	82.2	82.3	79.7	82.4	87.2	84.8	<0.01
1	11.8	11.9	12.3	11.3	9.0	9.9	
2–5	5.7	5.6	7.5	5.9	3.7	5.1	
6 or more	0.2	0.2	0.6	0.4	0.1	0.3	

* Weighted percentages

Coefficients of predisposing and enabling factors in ambulatory care utilization

Because ambulatory care utilization is determined by both predisposing and enabling factors, I examined linear regression with both predisposing and enabling factors (Table 6). Compared to Whites, minority groups had smaller coefficient for number of ambulatory care visits, with Asians having the fewest visits compared to Whites (Black=-1.30, Hispanic=-0.76, and Asian=-1.62 fewer visits). Interestingly, when adjusted for both predisposing and enabling factors, elders (age group 85+) had decreased ambulatory care utilization compared to age group 65–74 (coefficient=-1.59). Being a female (coefficient=0.94) and presence of any comorbidities (atrial fibrillation, chronic kidney disease, congestive heart failure, diabetes, ischemic heart disease, depression, stroke/TIA, cancer, anemia, hyperlipidemia, and hypertension) were associated with more visits. Using South as reference, those who reside in West region had increased use of ambulatory care (coefficient=0.34). Overall, those residing in metropolitan areas had higher ambulatory care utilization (coefficient=0.29) compared to rural areas. Compared to areas with lowest PCP availability, all other groups had small but increased in ambulatory care visits: top quartile (coefficient=0.43), second quartile (coefficient=0.26), and (third quartile coefficient=0.13). Proximity to a hospital was associated with increased ambulatory care utilization. Compared to those who live 5 miles or further from a nearest hospital, those who live within 1 mile of a hospital (coefficient=0.19).

Table 6. Coefficients of enabling and predisposing factors for ambulatory care utilizations during 1/1/2009–12/31/2009

Enabling and predisposing factors	Coefficient
Race	
Black	-1.30
Hispanic	-0.76
Asian	-1.62
Other	0.44
Age group	
75–84	0.10
85+	-1.59
Gender	
Female	0.94
Cardiac comorbidities	
Atrial fibrillation	4.52
Chronic kidney disease	2.17
Congestive heart failure	1.09
Diabetes	0.48
Ischemic heart disease	1.91
Depression	1.84
Stroke/TIA	0.95
Cancer	4.65
Anemia	2.62
Hyperlipidemia	1.79
Hypertension	2.18
Region	
Northeast	0.01*
Midwest	-0.04*
West	0.34
Urban type	
Metro	0.29
Suburban	0.28
PCP availability**	
Top quartile	0.43
Second quartile	0.26
Third quartile	0.13
Distance to nearest hospital	
Living <1 mile from a hospital	0.19
Living <5 mile from a hospital	0.07*

* Reference group: White, age group 65–74, and male, region-South, urban type-rural, PCP availability-lowest quartile, distance to nearest hospital-living >5 miles away from a hospital

** PCP availability: top quartile>82.3 PCP/100k residents, second quartile=69.1–82.3 PCP/100k

residents, third quartile=59.2–68.9 PCP/100k residents, lowest quartile<59.2 PCP/100k residents

Ambulatory cardiac test utilization

I examined the utilization of ambulatory cardiac tests as identified through CPT codes. For this study, ambulatory cardiac tests of interest include electrocardiogram (EKG), echocardiogram (ECHO), stress test, and myocardial perfusion imaging (Table 7). Depending on types of cardiac tests, there were different prevalence in obtaining these tests (all p-values<0.01). EKG was most commonly done, with 44.7% of study population getting at least one EKG performed in 2009. The next frequently conducted cardiac tests included stress test (11.4%) and myocardial perfusion imaging (9.4%), and then echocardiogram (2.7%). Among different racial/ethnic groups, there were significant variations in obtaining cardiac tests. Highest percentages of Blacks had electrocardiogram, but for other cardiac tests (echocardiogram, stress test, and myocardial perfusion imaging), highest percentages of Hispanics had them done. Smallest percentages of Asians had a myocardial perfusion imaging, but for other tests, their prevalence was neither the highest nor lowest.

Table 7. Percentages of patients with cardiac imaging test during 1/1/2009–12/31/2009*

	All (n=999,999)	White (n=306,000)	Black (n=306,001)	Hispanic (n=306,014)	Asian (n=45,033)	Other (n=36,951)	P-value
Electrocardiogram	44.7	44.8	45.1	43.3	41.9	37.4	<0.01
Echocardiogram	2.7	2.6	3.2	3.5	3.3	2.5	<0.01
Stress test	11.4	11.5	10.4	11.7	11.6	10.7	<0.01
Myocardial perfusion imaging	9.4	9.4	9	9.8	8.2	8.6	<0.01

* weighted percentages

Predictors of getting ambulatory cardiac tests

Adjusting for both predisposing and enabling factors, I conducted multivariate logistic regressions to identify predictors for ambulatory cardiac tests (Table 8). There were statistically significant differences in likelihood of getting ambulatory cardiac tests. Minorities (Black OR=0.86 [0.85–0.88], Hispanic OR=0.88 [0.86–0.89], Asian OR=0.90 [0.86–0.94], Other OR=0.83 [0.79–0.87]) were less likely to get ECHO compared to Whites. This finding was persistent in stress test (Black OR=0.88 [0.86–0.91], Hispanic OR=0.92 [0.89–0.94]) and myocardial perfusion imaging test (Black OR=0.93 [0.90–0.96], Hispanic OR=0.97 [0.94–1.00]). For echocardiogram, minorities (Black OR=1.16 [1.10–1.23], Hispanic OR=1.22 [1.16–1.28], and Asian OR=1.16 [1.01–1.33]) were more likely to have the test performed than Whites.

I also examined other predictors of getting ambulatory cardiac tests. Older patients were less likely to get ambulatory cardiac tests. For example, those who are 75 to 84 years old were 19% less odds (OR=0.81 [0.79–0.84]) of getting stress test and those who are 85 years or older were 0.63% less odds (OR=0.37 [0.36–0.39] compared to those ages 65–74. Cardiac comorbidities, such as presence of atrial fibrillation, congestive heart failure, history of ischemic heart disease, cancer, anemia, hyperlipidemia, and hypertension, were associated with increased odds of getting ambulatory cardiac tests. There were regional variations in obtaining cardiac tests, but there were no consistent patterns. This finding also persisted for urban type, primary care availability, and distance to the nearest hospital.

Table 8. Odds ratio of having cardiac tests during 1/1/2009–12/31/2009

	Cardiac tests			
	EKG	ECHO	Stress	Myocardial perfusion imaging
Race				
Black	0.86 [0.85–0.88]	1.16 [1.10–1.23]	0.88 [0.86–0.91]	0.93 [0.90–0.96]
Hispanic	0.88 [0.86–0.89]	1.22 [1.16–1.28]	0.92 [0.89–0.94]	0.97 [0.94–1.00]
Asian	0.90 [0.86–0.94]	1.16 [1.01–1.33]	1.02 [0.95–1.09]	0.93 [0.86–1.01]
Other	0.83 [0.79–0.87]	0.94 [0.81–1.09]	0.96 [0.90–1.09]	0.99 [0.91–1.07]
Age group				
75–84	1.03 [1.01–1.05]	0.85 [0.80–0.91]	0.81 [0.79–0.84]	0.85 [0.83–0.88]
85+	0.84 [0.82–0.87]	0.56 [0.51–0.61]	0.37 [0.36–0.39]	0.42 [0.40–0.44]
Gender				
Female	1.02 [1.00–1.04]	0.95 [0.90–1.01]	0.90 [0.87–0.93]	0.93 [0.90–0.96]
Cardiac comorbidities				
Atrial fibrillation	2.86 [2.74–2.98]	1.91 [1.77–2.06]	1.15 [1.38–1.52]	1.46 [1.39–1.54]
Chronic kidney disease	1.23 [1.19–1.27]	1.10 [1.02–1.18]	0.95[0.91–0.99]	0.96 [0.92–1.01]
Congestive heart failure	1.53 [1.48–1.58]	1.80 [1.68–1.92]	1.00 [0.97–1.05]	1.02 [0.98–1.06]
Diabetes	0.92 [0.90–0.94]	0.94 [0.88–1.00]	0.94 [0.91–0.97]	1.00 [0.96–1.03]
Ischemic heart disease	2.54 [2.49–2.60]	2.29 [2.14–2.46]	5.31 [5.13–5.50]	5.85 [5.63–6.09]
Depression	1.46 [1.42–1.51]	1.00 [0.93–1.09]	0.96 [0.91–1.00]	0.97 [0.92–1.01]
Stroke/TIA	2.18 [2.07–2.30]	1.81 [1.65–1.98]	0.97 [0.91–1.04]	0.96 [0.90–1.03]
Cancer	1.62 [1.56–1.68]	1.10 [1.00–1.20]	1.13 [1.07–1.18]	1.11 [1.05–1.17]
Anemia	1.80 [1.76–1.84]	1.41 [1.33–1.51]	1.13 [1.09–1.17]	1.12 [1.08–1.16]
Hyperlipidemia	1.58 [1.55–1.62]	1.49 [1.40–1.59]	2.03 [1.96–2.10]	2.04 [1.96–2.11]
Hypertension	2.10 [2.05–2.14]	1.56 [1.44–1.70]	1.64 [1.57–1.71]	1.72 [1.64–1.80]
Region				
Northeast	1.23 [1.19–1.26]	1.44 [1.33–1.56]	0.92 [0.88–0.97]	0.87 [0.83–0.92]

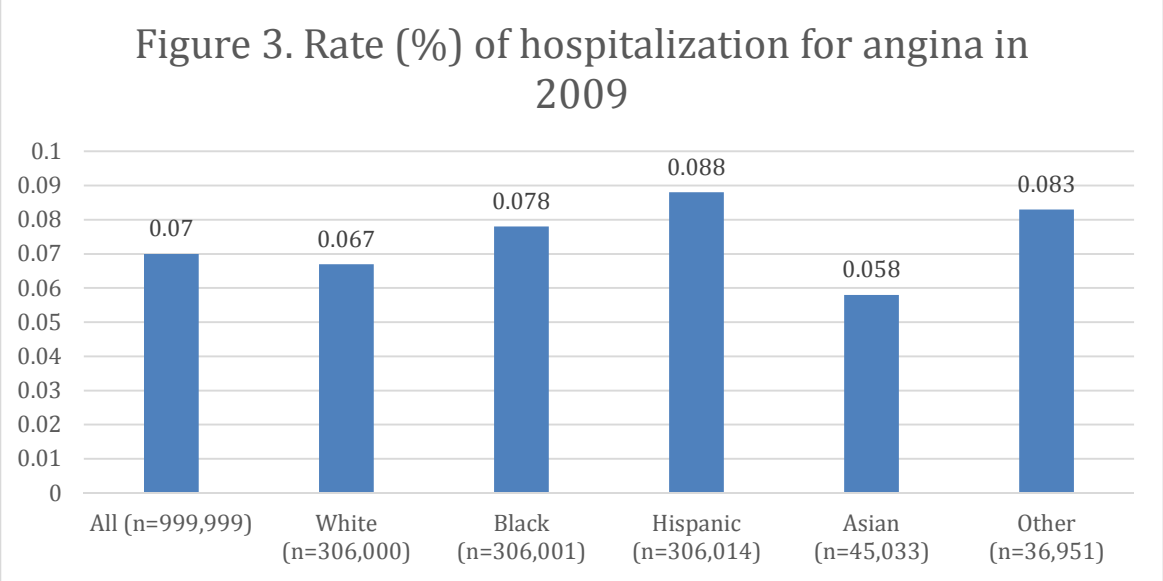
Midwest	0.79 [0.77–0.81]	1.08 [1.00–1.16]	0.94 [0.91–0.98]	0.90 [0.86–0.93]
West	0.83 [0.81–0.85]	1.56 [1.45–1.68]	1.08 [1.03–1.12]	0.87 [0.83–0.91]
Urban type				
Metro	1.31 [1.27–1.35]	0.93 [0.86–1.02]	1.26 [1.20–1.33]	1.22 [1.12–1.29]
Suburban	1.03 [0.99–1.07]	0.98 [0.88–1.09]	1.04 [0.98–1.10]	1.04 [0.97–1.11]
PCP availability**				
top quartile	1.12 [1.08–1.15]	1.15 [1.06–1.24]	0.96 [0.92–1.00]	0.91 [0.87–0.95]
second quartile	1.08 [1.05–1.11]	1.00 [0.92–1.08]	0.98 [0.94–1.02]	0.96 [0.91–1.00]
third quartile	1.05 [1.02–1.08]	1.09 [1.01–1.19]	1.00 [0.96–1.04]	0.99 [0.94–1.03]
Distance to nearest hospital				
Living <1 mile from a hospital	1.11 [1.08–1.14]	1.15 [1.08–1.24]	0.99 [0.95–1.02]	0.94 [0.90–0.98]
Living <5 mile from a hospital	1.07 [1.05–1.10]	1.06 [1.00–1.13]	0.99 [0.95–1.02]	0.97 [0.94–1.01]

* Reference group: White, age group 65–74, and male, region-South, urban type-rural, PCP availability-lowest quartile, distance to nearest hospital-living >5 miles away from a hospital

** PCP availability: top quartile>82.3 PCP/100k residents, second quartile=69.1–82.3 PCP/100k residents, third quartile=59.2–68.9 PCP/100k residents, lowest quartile<59.2 PCP/100k residents

Hospitalization for angina

Next, I examined prevalence of hospitalization for angina, an ambulatory care sensitive conditions during 1/1/2010–12/31/2011 (Figure 3). Overall and racial/ethnic specific prevalence of hospitalization for angina was about small (prevalence was less than 0.1%). Because the prevalence of hospitalization for angina was very small, further analysis in determining factors associated with hospitalization for angina was not investigated.



Hospitalization for AMI

Among the Medicare enrollee population, prevalence of AMI hospitalization was 1.5% (Table 9). Asian Americans had the lowest rate of hospitalization during the study period (hospitalization rate for AMI=1.0%). Further descriptive analysis of the AMI hospitalization showed that there were variations in types of AMI, prevalence of invasive cardiac procedures, and length of hospital stay. Highest percentages of Asians had STEMI (32.3%) compared to White (31.4%), Black (23.8%), Hispanic (26.4%), and Other (26.5%). Among those who were hospitalized for AMI, highest percentages of White (34.2%) received percutaneous coronary intervention. For coronary artery bypass graft, highest percentage of Hispanics (6.5%) had the procedure, but this was not statistically significant. Highest percentage of Asians had long hospital stay (8 days or more) and higher percentages of White had short hospital stay (1–3 days).

Table 9. Prevalence of hospitalization for AMI and their characteristics (during 1/1/2010–12/31/2011)

	All	White	Black	Hispanic	Asian	Other	P-value
% with hospitalization	1.50	1.52	1.50	1.46	1.01	1.17	<0.01
# of people with AMI hospitalization	14,466	4,622	4,535	4,334	492	483	
Type of AMI							
NSTEMI	69.4	68.6	76.2	73.6	67.7	73.5	<0.01
STEMI	30.6	31.4	23.8	26.4	32.3	26.5	
Prevalence of invasive cardiac procedures							
PCI	33.5	34.2	25.6	31.7	27.9	46.0	<0.01
CABG	5.5	5.5	4.9	6.5	5.1	3.6	0.30
Length of stay (day)							
1	12.6	12.9	10.5	10.2	10.3	12.4	<0.01
2–3	32.3	32.9	26.7	29.9	29.8	31.1	
4–7	33.7	33.3	38.1	34.6	33.6	34.0	
8+	21.5	21.0	24.7	25.3	26.3	22.5	

Presence of comorbid conditions among patients with AMI hospitalization

Next, I examined clinical characteristics of the patients with AMI hospitalization. Whites had the highest prevalence of cardiac arrhythmias, pulmonary circulation disorder, hypertension, hypothyroidism, rheumatoid arthritis/collagen vascular disease, and depression. Blacks had the highest prevalence of congestive heart failure, neurological disorder, metastatic cancer, and weight loss. Hispanics had the highest prevalence of hypertension and liver disease. Lastly, Asians had the highest prevalence of diabetes with chronic complications, renal failure, coagulopathy, and fluid and electrolyte disorder.

Table 10. Prevalence (weighted %) of Elixhauser comorbidities among patients with AMI hospitalization (during 1/1/2010–12/31/2011)

	All (n=14,466)	White (n=4,622)	Black (n=4,535)	Hispanic (n=4,334)	Asian (n=492)	Other (n=483)	P-value
Congestive heart failure	39.4	39	43.6	42.6	38.2	42.6	0.03
Cardiac arrhythmias	28.3	29.4	22	22	19.8	19.9	<0.01
Valvular disease	14.8	15.1	13.4	12.5	12.4	10.3	0.04
Pulmonary circulation disorders	5.0	4.9	7.0	4.6	2.2	6.6	<0.01
Hypertension	47.8	48.4	41.7	47.1	41.8	45.8	<0.01
Paralysis	0.7	0.6	1.2	0.6	0.3	0.2	0.02
Other neurological disorders	4.2	4.0	6.0	5.2	5.4	4.2	0.04
Diabetes, uncomplicated	27.3	26.3	33.5	37.9	28.9	30.0	<0.01
Diabetes with chronic complications	4.1	3.7	5.6	7.2	11.2	6.9	<0.01
Hypothyroidism	13.3	14	6.3	11.8	10.1	10.2	<0.01
Renal failure	3.6	2.6	9.5	8.4	17.9	8.7	<0.01
Liver disease	0.4	0.3	0.4	1.6	1.1	0.5	<0.01
Metastatic cancer	1.1	1.0	2.0	1.0	0.1	3.7	<0.01
RA/collagen vascular diseases	2.6	2.7	2.5	1.8	0.7	0.9	0.01
Coagulopathy	4.4	4.2	4.6	6.0	7.7	3.4	0.10
Weight loss	2.9	2.6	5.2	3.9	4.8	2.5	<0.01
Fluid and electrolyte disorders	21.2	20.4	26.0	26.0	28.5	31.4	<0.01
Deficiency anemias	14.2	13.8	16.1	18.0	15.0	20.4	0.03
Depression	6.5	6.9	3.6	5.1	3.6	4.3	<0.01

* Prevalence of acquired immune deficiency syndrome, lymphoma, alcohol abuse, drug use, and psychoses not shown due to low prevalence (<1%). Prevalence of peripheral vascular disease, chronic pulmonary disease, peptic ulcer disease without bleeding, solid tumor without metastasis, obesity, and blood loss anemia are not shown as there was no statistical significant difference.

Predictors of hospitalization with a primary diagnosis of AMI

To understand hospitalization for AMI, I examined clinical predictors of AMI admissions (Table 11). After adjusting for age and gender, only Asians (OR=0.68 [0.56–0.82]) were less like to be admitted for AMI compared to Whites. However, when cardiac comorbidities were adjusted, all minorities (Black OR=0.89 [0.84–0.95], Hispanic (OR=0.88 [0.83–0.94], Asian OR=0.66 [0.54–0.80], and Other OR=0.82 [0.68–0.99]) were less likely to be admitted for AMI. Lastly, I included geographical characteristics and minorities continued to have lower odds of being admitted for AMI.

Being female was associated with decreased odds of getting admitted with AMI. Older age and presence of cardiac comorbidities (chronic kidney disease, congestive heart failure, diabetes, ischemic heart disease, depression, stroke/TIA, and hypertension) were associated with increased odds of being admitted for AMI. Presence of cancer and atrial fibrillation were associated with decreased odds of being admitted for AMI. There were no significant variations in region, urban type, PCP availability, or proximity to a hospital in likelihood of AMI admission.

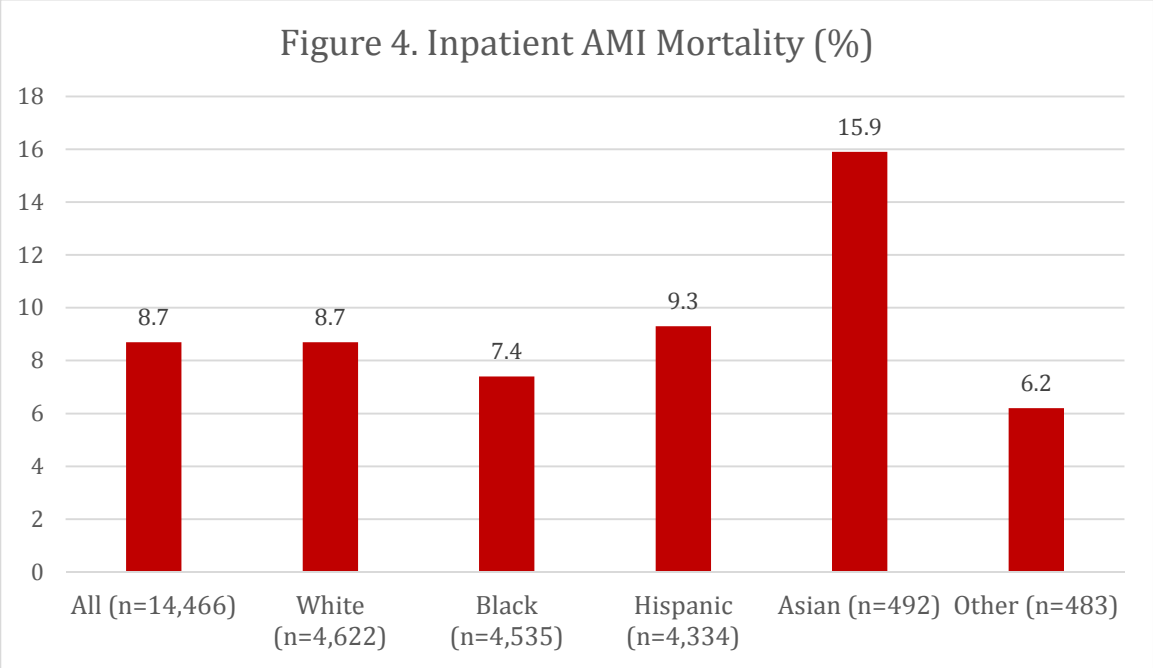
Table 11. Odds ratio of hospitalization for AMI (during 1/1/2010–12/31/2011) (N=999,999)

	Race/ ethnicity	+Gender	+ Age group	+ Cardiac comorbidities	+Geographical Characteristics
Race/ethnicity					
White	(reference)				
Black	0.99 [0.93–1.05]	1.00 [0.94–1.06]	1.05 [0.98–1.11]	0.89 [0.84–0.95]	0.91 [0.84–0.97]
Hispanic	0.96 [0.90–1.02]	0.96 [0.90–1.01]	1.02 [0.96–1.08]	0.88 [0.83–0.94]	0.92 [0.86–0.98]
Asian	0.66 [0.54–0.80]	0.66 [0.55–0.80]	0.68 [0.56–0.82]	0.66 [0.54–0.80]	0.69 [0.57–0.84]
Other	0.77 [0.63–0.93]	0.76 [0.63–0.92]	0.87 [0.71–1.05]	0.82 [0.68–0.99]	0.82 [0.68–1.00]
Gender					
Male	(reference)				
Female		0.75 [0.70–0.80]	0.69 [0.64–0.74]	0.76 [0.71–0.82]	0.76 [0.71–0.82]
Age groups					
65–74	(reference)				
75–84			1.55 [1.42–1.68]	1.33 [1.22–1.45]	1.33 [1.22–1.45]
85+			2.57 [2.35–2.82]	2.00 [1.82–2.21]	2.00 [1.82–2.21]
Cardiac comorbidities (1/0)					
Atrial fibrillation				0.73 [0.65–0.83]	0.73 [0.65–0.83]
Chronic kidney disease				1.27 [1.16–1.38]	1.27 [1.16–1.39]
Congestive heart failure				1.50 [1.38–1.64]	1.50 [1.37–1.64]
Diabetes				1.51 [1.40–1.63]	1.51 [1.40–1.63]
Ischemic heart disease				1.92 [1.77–2.09]	1.92 [1.77–2.09]
Depression				1.03 [0.93–1.15]	1.03 [0.93–1.15]
Stroke/TIA				1.25 [1.09–1.43]	1.25 [1.09–1.43]
Cancer				0.83 [0.73–0.94]	0.83 [0.73–0.94]
Anemia				1.06 [0.98–1.15]	1.06 [0.98–1.15]
Hyperlipidemia				0.94 [0.87–1.02]	0.95 [0.88–1.02]

Hypertension				1.12 [1.02–1.23]	1.12 [1.02–1.22]
Region					
South	(reference)				
Northeast					1.08 [0.97–1.21]
Midwest					1.02 [0.93–1.12]
West					0.96 [0.87–1.05]
Urban type					
Metropolitan					0.90 [0.81–1.00]
Urban area					1.08 [0.95–1.23]
Rural	(reference)				
PCP availability					
top quartile					1.05 [0.94–1.16]
second quartile					1.03 [0.93–1.14]
third quartile					1.01 [0.91–1.11]
fourth quartile	(reference)				
Distance to nearest hospital					
Living <1 mile from a hospital					0.99 [0.90–1.09]
Living <5 mile from a hospital					1.02 [0.93–1.10]
Living ≥5 miles from a hospital	(reference)				

Inpatient AMI mortality

There were 14,466 Medicare enrollees with AMI hospitalization from January 1, 2010 to December 31, 2011. Overall mortality was 8.7%. There was a significant difference in AMI mortality (p-value<0.01). Asians had the highest observed inpatient mortality (15.9%) and Other had the lowest mortality (6.2%).



Odds ratio of AMI mortality

Finally, I performed sequential multivariate logistics to examine an association between ambulatory care utilization and inpatient AMI mortality. After adjusting for predisposing and enabling factors, Asians remained to have increased odds (OR=1.90 [1.00–3.61]) of AMI mortality. This significance disappeared after adjusting for invasive cardiac procedures (coronary artery bypass graft and percutaneous coronary intervention). Lastly, ambulatory care utilization was included in the model, and Asians

remained to have increased odds of AMI mortality (OR=1.83 [0.98–3.42]) but this was not significant.

In the final model, receipt of percutaneous coronary intervention was associated with 43% decrease in AMI mortality, but receipt of coronary artery bypass graft was not associated. Compared to moderate ambulatory care utilization (4–30 ambulatory care clinic visits), low use of ambulatory clinic visits (0–3 visits) was associated with 85% decreased odds (OR=1.85 [1.11–3.08] of AMI mortality. There was no association between AMI mortality and frequent ambulatory care utilization (31 or more ambulatory clinic visits). Among different ambulatory cardiac tests, receipt of EKG was associated with decreased odds (OR=0.70 [0.53–0.92]) of AMI mortality. Receipt of any of the cardiac tests in 2009 was associated with decreased odds (0.68 [0.51–0.90] of inpatient AMI mortality.

Table 12. Odds ratio of inpatient AMI mortality (during 1/1/2010–12/31/2011) (N=14.466)

	Race/ ethnicity	+Predisposing factors	+ Enabling factors	+ Type of AMI, invasive cardiac procedures, and length of stay	+Ambulatory care utilization
Race/ethnicity					
White	(reference)				
Black	0.84 [0.68–1.05]	0.83 [0.65–1.05]	0.85 [0.67–1.10]	0.90 [0.70–1.16]	0.88 [0.68–1.14]
Hispanic	1.09 [0.88–1.35]	1.09 [0.87–1.38]	1.15 [0.90–1.47]	1.21 [0.94–1.55]	1.19 [0.92–1.53]
Asian	1.99 [1.07–3.70]*	1.84 [0.98–3.47]	1.90 [1.00–3.61]*	1.91 [1.04–3.51]*	1.91 [1.05–3.48]*
Other	0.70 [0.38–1.26]	0.76 [0.41–1.41]	0.73 [0.39–1.36]	0.85 [0.46–1.60]	0.83 [0.44–1.57]
Type of AMI					
NSTEMI				0.39 [0.29–0.52]*	0.39 [0.30–0.52]*
STEMI	(reference)				
Invasive cardiac procedures					
PCI				0.49 [0.33–0.72]*	0.50 [0.34–0.72]*
CABG				1.31 [0.69–2.48]	1.28 [0.68–2.40]
Length of stay (days)					
1	(reference)				
2–3				0.55 [0.38–0.79]*	0.55 [0.38–0.79]*
4–7				0.34 [0.23–0.50]*	0.34 [0.23–0.50]*
8+				0.45 [0.30–0.69]*	0.46 [0.30–0.70]*
Ambulatory care utilization in 2009					
0–3					1.87 [1.11–3.16]*
4–12	(reference)				
13+					1.18 [0.86–1.62]
Ambulatory cardiac tests in 2009					
Yes					0.73 [0.55–0.95]*
No	(reference)				

DISCUSSION

In a sample of 21.6 million Medicare enrollees, Asians had the fewest average number of ambulatory care visits among different racial/ethnic groups, but there was no consistent pattern in different types of ambulatory cardiac imaging or tests. In general, Asians were low healthcare utilizers; in addition to low ambulatory care clinic visits, they also had low emergency room visits and short-stay hospitalizations. This finding of low healthcare visits was also found among Asians being admitted for angina without procedures and acute myocardial infarction. For angina, there was a statistically significant difference in the hospitalization rate although the overall the rate was very small (0.2% or less among the study population).

This study examined population level differences in healthcare utilization. From the study, it is unclear which individual level reasons were behind the low healthcare utilization, whether it is due to people being healthy and not needing healthcare versus people not utilizing healthcare although they need it. In the analysis, the presence of comorbid conditions was adjusted to address possible confounding effects. Still, there is still a possibility that a group of patients with comorbidities may not be seeking medical care for different reasons.

In regards to the second objective of the study, Asian Americans had the highest observed inpatient AMI mortality, which is consistent with previous work[65]. Furthermore, I established an association between ambulatory care utilization and inpatient AMI mortality; a smaller number of ambulatory clinic visits was associated with increased odds of AMI mortality and the use of any ambulatory cardiac tests was

associated with decreased odds of AMI mortality. In multivariate logistic regression, the high odds ratio of inpatient AMI mortality among Asians was attenuated when receipt of cardiac procedures was included in the analysis. This was due to smaller percentages of Asians receiving invasive cardiac procedures compared to the overall study population.

Our study established an association between ambulatory care utilization, both in the number of ambulatory clinic visits and ambulatory cardiac imaging tests and inpatient AMI mortality. It is possible that the low ambulatory care utilization may contribute to the high inpatient AMI mortality among Asian Americans. Previous studies have established an association between ambulatory utilization and health outcomes, and our study further supported the association between low healthcare utilization and worse health outcomes, specifically among Asian Americans. One limitation of the population level measure of low ambulatory care utilization is the question of whether low ambulatory care utilization reflects low healthcare utilization associated with good health versus low utilization due to barriers to accessing health care. This was addressed to some degree by examining geographical characteristics and adjusting for these factors in the model.

Low ambulatory care utilization could potentially result in cardiovascular outcomes through several mechanisms. One possibility is that there may exist higher unobserved disease burden and severity among Asian Americans from the lack of such diagnoses. Lower ambulatory care utilization is associated with a lower rate of being aware of having medical diagnosis. Our study showed some evidence of this, by finding higher prevalence of some cardiac comorbidities contrary to epidemiologic studies[23-26].

Also, low ambulatory care utilization may indirectly reflect Asians having difficulty navigating health care, thus the lower number of healthcare visits.

Independent of healthcare utilization, another reason for poor health AMI outcomes among Asians may arise from higher cardiovascular risks than previously believed. Emerging studies have shown a subgroup of Asians having cardiovascular disease, specifically South Asians. In addition, studies have shown that the adoption of Western diet and lifestyles is association with increased cardiovascular risk. There had been waves of Asian immigration, peaking in 1970s and 1980s after the 1965 Act was passed[66]. As these groups of Asians adopt Western lifestyles and become more acculturated, their cardiovascular risks may become similar to other Americans[67,68]. This cardiovascular risk is strongly associated with the number of years they resided in the US[69-71].

In our study, the high number of ambulatory clinic visits was not associated with AMI mortality. I hypothesize that this group encompasses two groups of patients with different healthcare utilization behaviors; one group is composed of those with multiple medical conditions and another group who are healthy but high healthcare utilizers. These potentially different groups of people in the same category can negate the overall significant finding. For example, those who were making ambulatory visits may have multiple medical problems and require frequent doctor's visits. These patients would be considered to have poor prognoses. On the other hand, there are those who make frequent doctor's visits because they can afford the care and want to ensure that they are healthy.

These patients could be considered to have good prognoses. It is unclear from our data whether these frequent ambulatory care visits were from either or both of these groups.

Another contributing reason for insignificant relationship between ambulatory care utilization and AMI outcome may arise from how some cardiac comorbidities are managed. Cardiac comorbidities such as atrial fibrillation and chronic kidney disease may warrant frequent physician visits to monitor international normalized ratios (INR) associated with warfarin therapy, and to receive dialysis. In our study, I found that those with these conditions were associated with increased ambulatory care utilization. Also, diseases such as congestive heart failure and diabetes are nowadays closely monitored and being used to measure the quality of patient care. This may prompt healthcare providers to allow more frequent ambulatory clinic visits. Although these cardiac comorbidities may increase cardiovascular risks, the way these medical conditions are being managed can improve AMI outcomes from close medical management.

The most interesting finding of the study is minorities having decreased odds of being hospitalized for AMI. This observation is significant. First, if minorities are less likely to be admitted for AMI, this will result in a smaller denominator when calculating their inpatient mortality. If there is similar population-level mortality, but fewer minorities die in the community from AMI, the measured inpatient AMI mortality may appear to be higher. Second, there may be a selection bias in AMI admission, with hospitals having higher thresholds to admit minorities with cardiac symptoms. From our study, it is unclear whether this selection bias is coming from a belief that Asians are perceived to have less severe disease or whether they are less likely to have health

insurance. Thus, minorities who are admitted with AMI may be the ones with more severe diseases, and with worse health outcomes. I addressed this limitation to some degree by adjusting for comorbidities, using the Elixhauser index. Lastly, the finding may be due to cultural differences, including trust towards healthcare systems and religious beliefs. These characteristics, at the individual level, can affects patients' decisions to go to the Emergency Room and then be hospitalized for AMI.

Besides ambulatory care utilization, there are other factors that could contribute to the high inpatient AMI mortality among Asian Americans. Asians encompass a diverse population and studies have identified heterogeneity in cardiovascular disease risk factors among Asians by country of origin. For example, previous studies have identified that South Asians have more cardiovascular risk factors and worse outcomes compared to Whites[72-74]. In addition, studies have found that certain Asian and Hispanic ethnic groups have significantly lower insurance rates[75] and it is possible that these small groups of Asians with disadvantaged socioeconomic factors may have a significant impact on overall AMI mortality. Lastly, the presence of communication barriers among Asians with limited English proficiency could contribute to poor health outcomes[76-78], and possibly higher AMI mortality.

There are several limitations with the study. I do not have clinical information regarding decisions behind why patients received cardiac procedures but the high cardiac procedure rate among Asians might be due to more advanced or severe cases that require invasive interventions. The higher mortality among those receiving cardiac procedures needs further examination, as identifying contributing factors can improve future

outcomes. If the high mortality is due to a high comorbidity burden, future studies should focus on re-stratifying risk for all AMI patients. However, if the high mortality is coming from procedure-related complications common among Asians, such as high bleeding risk after anti-platelet therapy[79-81], then different medical therapies, such as lower doses of antithrombotic medications, should be used. Also, Asians with AMI may seek medical care when cardiac symptoms are severe and have been present for longer durations. Delays in receiving care have been associated with poor outcomes[82-84]. In a study that examined patients with symptoms present less than 24 hours, there was no difference in mortality between Asians and non-Hispanic Whites[85]. Our study did not differentiate patients based on their duration of symptoms, and the high mortality could have originated from higher inpatient mortality among Asians with longer duration of symptoms.

Other limitations arise from study design and the nature of the data. Given our observational data, a causal relationship cannot be established between being Asian and increased inpatient AMI mortality. Due to the nature of secondary, administrative data, information on clinical patient status is limited. For example, clinical information regarding duration or severity of symptoms, admission vitals, EKG findings, and procedure complications could have provided further insight. The data also did not include medications, which would have been helpful in understanding race/ethnicity-specific medical management of AMI, and how clinical decisions were made in obtaining invasive cardiac procedures. Previous research has shown mixed results as to whether racial differences existed in decision-making involving invasive cardiac procedures[14,86].

Another limitation of this study is the use of census data to obtain socioeconomic information and predictors of healthcare access (insurance and employment). Though commonly used, census data based on zip codes and counties have limitations in capturing micro-level information[87,88]. Lastly, there has been a significant increase in multiracial populations, especially Asians tied to other races or ethnicities[22]. For our study, I used self-reported race/ethnicity, which did not identify multiracial patients.

CONCLUSION

Among Medicare fee-for-service enrollees, Asian Americans were found to be low ambulatory care utilizers, specifically of ambulatory care clinic visits. Although there was a significant difference in hospitalization rates for angina, an ambulatory care sensitive condition, the rate was very small consistently among different racial/ethnic groups. The low ambulatory care utilization was associated with increased risk of inpatient AMI mortality. With the increasing number of Asians in the US, disparities in cardiovascular outcomes among Asian Americans warrants further investigation. Future research should focus on patient-level details to better understand the heterogeneity of the Asian population and clinical factors associated with such disparities. This can be done by conducting patient focus group or individual patient interviews via qualitative studies. In addition, it will be important to build a cohort of patient with national origin information to further understand how ethnic differences contribute to cardiovascular outcomes.

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