EXAMINATION OF CARDIOVASCULAR OUTCOMES IN PATIENTS ADMITTED FOR ACUTE MYOCARDIAL INFARCTION WITHIN UNITED STATES COMMUNITY HOSPITALS

By

KIMBERLY BETH WOODRUFF, PharmD, MS

A Dissertation submitted to the

School of Public Health

and the

Graduate School – New Brunswick

Rutgers, The State University of New Jersey

in partial fulfillment of the requirements

for the degree of

Doctor of Philosophy

written under the direction of

Professor George G. Rhoads, MD, MPH

and approved by

____

____

____

____

New Brunswick, New Jersey

January, 2014

ABSTRACT OF THE DISSERTATION

EXAMINATION OF CARDIOVASCULAR OUTCOMES IN PATIENTS ADMITTED FOR ACUTE MYOCARDIAL INFARCTION WITHIN UNITED STATES COMMUNITY HOSPITALS

by

KIMBERLY BETH WOODRUFF, PharmD, MS

Dissertation Director:

Professor George G. Rhoads, MD, MPH

Objective: The objective of this dissertation was to examine cardiovascular (CV) outcomes in patients admitted for acute myocardial infarction (AMI) within United States (U.S.) community hospitals, focusing on three areas: impact of primary payer type among patients admitted for ST-segment elevation myocardial infarction (STEMI); effect of weekday vs. weekend admissions among STEMI hospitalizations; examination of trends in AMI type over a 10-year timeframe.

Methods: We conducted retrospective cohort studies using hospital discharge data from the Nationwide Inpatient Sample (NIS), Healthcare Cost and Utilization Project (HCUP), Agency for Healthcare Research and Quality. Chapters 1 and 2 included the years 2005, 2008, and 2010, while Chapter 3 included the years 2000, 2005, and 2010.

Results: Chapter 1 results indicated that among patients <65, those with private insurance as the primary payer type were significantly less likely to experience in-hospital mortality vs. patients with other primary forms of payment. In Chapter 2, results suggested that odds of in-hospital mortality in the overall cohort for weekday vs. weekend admissions depended on patient's race in 2005 and 2008, with no significant difference observed in 2010; however those with comorbid diabetes had more favorable outcomes when admitted on a weekday across all years studied. In Chapter 3, we observed an approximately 54% decrease in STEMI, and 10% decrease in NSTEMI hospitalizations over the timeframe studied; however the odds of in-hospital mortality remained significantly higher for STEMI vs. NSTEMI admissions over the decade.

Conclusions: Results of this research suggest the following: 1) Patients <65 who have private health insurance experience lower odds of in-hospital mortality vs. those with other primary forms of payment; 2) In recent years, admission day does not appear to impact in-hospital mortality, except in those with comorbid diabetes; and 3) The clinical presentation of AMI within U.S. community hospitals has changed over the past decade; however STEMI admissions are still associated with increased odds of in-hospital mortality vs. NSTEMI admissions.

ACKNOWLEDGEMENTS

I would like to express my sincere thanks to my committee members, Drs. George Rhoads, Stephen Marcella, Pamela Ohman-Strickland, and Jianwei Xuan, all of whom spent considerable time and energy helping me through this process. I am very grateful to all of you!

Throughout my dissertation experience, Dr. Rhoads provided helpful insights, constructive feedback, and excellent guidance. I am tremendously thankful that I was able to benefit from his expertise. Dr. Marcella has been a trusted advisor for the past six years, helping me navigate my path to the PhD, while balancing work and family life at the same time. I especially appreciate the time he has spent working with me on my dissertation. Despite his own career demands, he always made time to provide helpful and constructive feedback on my progress.

Dr. Ohman-Strickland was one of the most effective statistics professors I have had the benefit of learning from. She provided great insight and guidance regarding how to analyze the data and "tell the story" in a meaningful way. Dr. Xuan provided tremendous guidance in helping me to best articulate the impact and meaning of my research findings. Once again, I would like to say thank you to you all.

I would also like to thank my various managers at both Pfizer and Janssen, for their consistent support and encouragement throughout this journey. Their support helped make this achievement a reality.

Finally, I would like to extend a very special thank you to my family for their love, encouragement, support, and patience throughout this experience. My children

were kind enough to choose birthdays at the end of various Spring semesters, and their grandparents were more than willing to babysit while I attended class. My husband was, and continues to be, a consistently strong source of love and strength. I am not sure how I would have achieved this milestone without them!

DEDICATION

This dissertation is dedicated to my husband Michael, and my children, Mia and Zachary.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

Chapter 1:

INTRODUCTION

Acute myocardial infarction (AMI) remains a leading cause of death in the developed world, with ST-segment elevation myocardial infarction (STEMI) considered the most severe form. (1; 2) The management of STEMI is both time-sensitive and costly to the healthcare system, and as such, the most recent ACC/AHA treatment guidelines for patients presenting with signs and symptoms consistent with STEMI are as follows: (3; 4)

- *Percutaneous coronary intervention (PCI) within 90 minutes of FMC*
- *Fibrinolytic therapy within 120 minutes of first medical contact (FMC), if it is anticipated that primary percutaneous intervention (PCI) cannot be performed within 120 minutes of FMC*
- *Coronary artery bypass graft (CABG) in patients deemed not suitable for PCI*

Primary PCI is the preferred method of reperfusion therapy whenever possible, as it has consistently demonstrated improved cardiovascular outcomes relative to fibrinolytic therapy. (5; 6; 7; 8; 9) Stent placement has also been recommended in PCI patients, either as drug-eluting, or bare metal, with bare metal stents being recommended for patients with high bleeding risk, an inability to comply with anti-platelet drug regimen, or anticipated surgery within the next year. (4; 10) While PCI is generally considered to be the preferred reperfusion method, there is increasing evidence in the medical literature which supports the use of CABG over PCI in patients with diabetes and advanced coronary disease, in reducing the rates of mortality and myocardial infarction. (11; 12; 13; 14)

Because management of STEMI is time-critical and expensive, it is important to examine quality of care as it relates to a patient's hospital experience. It has been well-established in the medical literature that health disparities exist among Americans with or without health insurance. Ng, et al evaluated risk of death associated with insurance status after hospital admission for an acute cardiovascular event, and found that being underinsured was associated with an increased risk of death after myocardial infarction, coronary atherosclerosis, or stroke. (15)

Hasan, et al. evaluated the impact of insurance status on hospital care for myocardial infarction, stroke, and pneumonia among working age Americans. Investigators determined that in-hospital mortality was significantly lower for privately insured patients vs. uninsured or Medicaid patients across the three conditions studied. Authors suggested that interventions aimed at reducing insurance-related gaps in inpatient quality of care should be investigated. (16)

A separate study conducted by Smolderen, et al. examined how health insurance status affects the decision-making process regarding when to seek care during emergency medical conditions. Investigators found that patients with financial concerns, regardless of insurance status, were more likely to delay seeking care during an acute myocardial infarction. Over 40% of such patients experienced pre-hospital delays of greater than 6 hours. Authors concluded that both the lack of health insurance, as well as financial concerns among insured patients contribute to the delays in seeking emergency care for AMI. (17)

A study conducted by Hiestand, et al. examined the impact of insurance status on the treatment of myocardial infarction at academic centers in the United States. Investigators examined 178 patients with STEMI, and determined that self-pay patients were more likely to receive less expensive therapies (i.e. fibrinolytics), while insured patients were more likely to receive invasive treatments (i.e. PCI/CABG). (18) While this study provides insightful information regarding health disparities related to insurance status, it is small in size, and focused only on academic centers.

Aside from health insurance status, another aspect to consider in the evaluation of STEMI outcomes is whether or not STEMI outcomes differ among patients hospitalized on a weekday vs. a weekend. The published literature in this area has left room for further investigation of this issue. Gonzalez, et al. conducted a study to determine whether "on" vs. "off"-hours hospital presentation impacted in-hospital outcomes for STEMI admissions. Investigators evaluated 786 patients with STEMI referred for primary PCI to a cardiac catheterization team within a tertiary care center, and compared outcomes for patients admitted during "on" hours (weekdays from 8am-5pm) vs. "off" hours (all other times, including holidays). The authors concluded that there were no differences in in-hospital outcomes between patients admitted during "on" vs. "off"-hours. (19)

In a separate study conducted by Casella, et al. investigators evaluated whether results of "off-hours" and "regular-hours" primary PCI were comparable in patients admitted for STEMI. Authors evaluated in-hospital and 1-year cardiac mortality among 3,072 STEMI patients treated with primary PCI during "regular" hours (weekdays 8am-8pm) and "off" hours (weekdays 8:01pm-7:59am, weekends, and holidays) within the STEMI Network of the Italian Region Emilia-Romagna. The results of this study indicated comparable outcomes between patients who received procedures during "regular" or "off" hours, despite the finding that door-to-procedure time was longer for "off"-hours patients. (20)

In contrast, Kruth, et al. evaluated the MITRA-PLUS registry, a German registry of current treatment of acute coronary syndromes. They examined records of 11,516 patients with STEMI admitted to hospitals with catheterization facilities to examine potential differences in in-hospital mortality among patients admitted during regular working hours (weekdays from 8am-6pm), at night (weekdays 6pm-8am), or on weekends. Investigators found that both pre-hospital delay, as well as door-to-balloon time were significantly longer on weekends and nights vs. regular working hours. In-hospital mortality was significantly higher on weekends, and a trend in higher mortality was noted at night, vs. regular working hours. (21)

In a separate study conducted by Magid,et al., investigators evaluated whether or not time of day and/or day of week influenced door-to-drug time, or door-to-balloon time, and subsequent cardiovascular outcomes among patients admitted for STEMI. Authors conducted a retrospective cohort study including over 100,000 patients within the National Registry of Myocardial Infarction (NRMI), a nation-wide U.S. database of patients admitted with AMI. Regular hours were defined as weekdays (7am-5pm) and "off"-hours were defined as weekdays 5pm-7am and weekends. Results indicated that patients presenting during "off"-hours had significantly higher in-hospital mortality vs. those presenting during regular hours. (22)

Additional evidence to support this argument was developed by Kostis, et al., who evaluated differences in mortality between patients admitted for a first AMI on weekdays vs. weekends, using the Myocardial Infarction Data Acquisition System (MIDAS), a database containing discharges for AMI among all non-federal acute care hospitals in New Jersey. Investigators evaluated 231,164 admissions between 1987-2002, and determined that patients admitted on weekends were less likely to undergo invasive cardiac procedures, and in the 1999-2002 cohort, had significantly higher 30-day mortality rates vs. patients admitted on weekdays (12.9% vs. 12.0%, $p=0.006$). Authors concluded that weekend admissions for AMI was associated with higher mortality, mediated by the lower use of invasive cardiac procedures among such patients. (23)

While STEMIs are considered to be the most severe type of AMIs, recent studies have shown that non-STEMI (NSTEMI) hospitalizations can result in similar cardiovascular outcomes as STEMI hospitalizations. A study conducted by Montalescot, et al., evaluated 2151 patients admitted with AMI at 56 centers in France. Results indicated that STEMI patients were more likely to receive fibrinolytic therapy (28.9% vs. 0.7%, $p<0.0001$), or undergo PCI vs. NSTEMI patients (71.0 vs. 51.6%, $p<0.0001$); however, in-hospital mortality, 1-year mortality, and re-hospitalization rates were all similar among both STEMI and NSTEMI patients ($p\geq0.05$). (24)

In a separate study, Rogers, et al. evaluated 1,950,561 patients admitted for AMI in the National Registry of Myocardial Infarction, and found that the proportion of NSTEMI patients increased from 14.2% in 1990 to 59.1% in 2006, while the proportion of STEMI patients decreased. Despite the fact that the prevalence of NSTEMI has been increasing over this timeframe, in-hospital mortality rates have declined by 22.6% for NSTEMI, and 24.3% for STEMI patients over that same time period. (25)

In contrast, Polonski, et al. evaluated 13,441 patients enrolled in the Polish Registry of Acute Coronary Syndromes to compare 2-year outcomes for STEMI vs. NSTEMI patients. After adjusting for baseline characteristics, and treatment strategy (invasive vs. non-invasive), investigators found that the 2-year mortality rate was significantly worse for STEMI vs. NSTEMI patients (HR for NSTEMI was 0.76 (95% CI 0.71-0.83, $p<0.0001$). (26)

In order to more fully examine these quality of care issues, this dissertation addresses three key topics:

1) Impact of payer type on STEMI outcomes
2) Association between admission time and STEMI outcomes (weekend vs. weekday)
3) Analysis of STEMI vs. NSTEMI outcomes over time

CHAPTER 1: EXAMINATION OF THE IMPACT OF PAYER TYPE ON CARDIOVASCULAR OUTCOMES AMONG PATIENTS ADMITTED FOR ST-SEGMENT ELEVATION ACUTE MYOCARDIAL INFARCTION WITHIN UNITED STATES COMMUNITY HOSPITALS

Study Objective:

The objective of this study was to evaluate the potential impact of payer type on STEMI outcomes, among patients admitted to U.S community hospitals over the years 2005, 2008, and 2010. The key research questions addressed were: 1) Does in-hospital mortality differ by payer type? 2) Do the types of procedures for STEMI management differ by payer type? 3) Is the potential relationship between payer type and in-hospital mortality mediated by the type of revascularization procedure conducted?

Methods:

Data Source:

We conducted a retrospective cohort study using data from the Nationwide Inpatient Sample 2005, 2008, and 2010 datasets, from the Healthcare Cost and Utilization Project (HCUP-NIS), Agency for Healthcare Research and Quality. (27) The HCUP-NIS contains hospitalization data from approximately 8 million hospital stays from about 1000 hospitals, sampled to approximate a 20% stratified sample of U.S. community hospitals. Samples are typically drawn annually, with minimal overlap among hospitals from one year to another. In the datasets used for our analyses, approximately 4% of hospitals were the same over all years studied. Hospitals are divided into strata using the following characteristics: ownership/control, bed size, teaching status, urban/rural location, and U.S. region. The dataset contains information from patients regardless of payer type, with variables illustrating the clinical and resource utilization during the hospital stay.

Study Population:

Patients were included if they had a primary diagnosis of STEMI, identified using ICD-9-CM code 410.xx (excluding 410.7x), and were age 40 or older. This age cutoff was implemented in order to exclude most non-atherosclerotic causes of STEMIs, consistent with previous literature (28). Patients were excluded if they had a primary diagnosis of NSTEMI (ICD-9-CM code 410.7x), and were age <40.

Study Variables:

The primary outcome of interest was in-hospital mortality. The types of procedures used for STEMI (i.e. fibrinolytic therapy, PCI, CABG), as well as length of stay and total cost of hospitalization were also examined. Total cost of hospitalization for the years 2005 and 2008 were inflated to 2010 dollars using the United States Bureau of Labor Statistics Consumer Price Index. (29)

The primary independent variable was payer type, defined as Medicare, Medicaid, Private, or Self-Pay. Patient–level covariates included age, gender, race, Charlson Comorbidity Index, median household income of patient's zip code, and length of stay. Race was categorized as White, Black, Hispanic, Other (Asian or Pacific Islander, Native American, "Other), and Unknown (Missing). Length of stay was excluded as a covariate in the CABG analyses, since CABG procedures would be expected to result in longer length of stay vs. other procedure types. Analyses were stratified by age (≥65, or <65, to account for Medicare coverage among those age 65 and older), as well as the following comorbidities: diabetes (DM), hypertension (HTN), and congestive heart failure (CHF), since these comorbid conditions have been shown to be independent predictors of cardiovascular mortality in patients with STEMI (though given the nature of this data, it was not possible to determine if these were true baseline comorbidities, or if they may have developed during the hospitalization, particularly CHF). (30; 31; 32; 33) Hospital-level covariates included hospital region, bed size, and teaching status.

Statistical Analysis:

Sample discharge weights were used to determine national estimates across all analyses. Univariate analyses were conducted on patient and hospital demographic data, and bivariate analyses were conducted to describe the unadjusted associations between admission day and outcomes of interest. Potential differences over the years 2005, 2008, and 2010 were analyzed using SAS PROC SURVEYREG for continuous variables, and the Cochran-Armitage Trend test for categorical variables. The continuous variables length of stay and Charlson Comorbidity index were log-transformed prior to including in the models. Hospital charges were converted to costs using the group average all-payer inpatient cost/charge ratio (GAPICC) provided with each year of HCUP-NIS data. P-values of <0.05 were considered statistically significant.

Logistic regression analyses were used to determine the odds of: 1) in-hospital mortality, 2) receiving PCI, or 3) receiving CABG, among patients admitted to community hospitals in the U.S. on a weekday vs. a weekend in 2005, 2008 and 2010. Use of fibrinolytic therapy in this population was also assessed; however, very few patients were coded as having received such therapy in this dataset (number of patients with codes for fibrinolytic therapy ranged from 262-405, depending on the year analyzed); therefore such results are not reported in this study. Possible interactions between in-hospital mortality and payer type, by race and median household income, were also assessed.

To account for the expected differences in payer types among those age 65 and older vs. those <65, results were stratified into two separate age groups. In the <65 age group, analyses were conducted for Medicare, Medicaid, and Self-Pay vs. Private pay as the reference category. In the ≥65 age group, analyses were conducted for Medicaid and Private pay vs. Medicare as the reference category. The number of Self-Pay patients in this age group was too small to include in the analyses (sample size ranged from 98-166, depending on year studied).

Because patients within the same hospital were more likely to be treated similarly vs. patients treated in different hospitals, analyses were adjusted for clustering effects within hospitals using SAS PROC SURVEYLOGISTIC. Covariates were analyzed based on their impact on the main effect (i.e. ≥10% change), and their Type III p-value. Variables with a Type III p-value of <0.05 were considered statistically significant, and therefore retained in the final models. This p-value was selected for two reasons: it is the conventional threshold for statistical significance widely published in the scientific literature, and the AIC values were lower using this method vs. assessing the impact on the main effect.

In the event that payer type was significantly associated with in-hospital mortality, analyses of the potential mediating effects of procedure type were conducted in Mplus, using a program developed by Andrew F. Hayes, PhD. This program estimates path coefficients, and utilizes bootstrapping techniques to establish confidence intervals for indirect effects of payer type on in-hospital mortality, mediated by procedure type. (34) (35) Point estimates of the direct and indirect effects were converted to probabilities using the equation: Probability of in-hospital mortality|payer type=f(-threshold+probit estimate(direct effect)+probit estimate(indirect effect), as advised from the MPlus website. (36)

Models were initially constructed by including all potential covariates mentioned previously. Variables were eliminated if they had a Type III p-value of ≥0.05. Once final covariates were identified, the main effect of payer type was added, as well as the interaction variables of payer type by race, and payer type by median household income. In the event the interactions were not significant, they were removed from the final models before the Odds Ratios and 95% confidence intervals were calculated.

Statistical analyses were conducted using SAS v9.2 (SAS Institute, Cary, NC) and Mplus v7.11 (Muthen and Muthen, Los Angeles, CA). The study was approved by the Institutional Review Board of The University of Medicine and Dentistry of New Jersey. Because the study only evaluated de-identified data acquired during routine care, patient informed consent was not required.

<u>Results:</u>

<u>Patient Characteristics:</u>

The mean age of patients in the <65 cohort was 54, and consistent across all years. The predominant payer type in this cohort was Private payer, though shifts in payer types were observed over time. The percentage of Private pay patients decreased over time, from 67.60% in 2005, to 61.50% in 2010 ($p<0.0001$), while the percentages of both Medicaid and Self-Pay patients increased over time (9.27% in 2005 to 11.50% in 2010, $p<0.0001$; 12.53% in 2005 to 16.32% in 2010, $p<0.0001$, respectively) (Table 1a).

The mean age of patients in the ≥65 cohort was approximately 77 in 2005 and 2008, and 76 in 2010 ($p<0.0001$). As would be expected in this cohort, the predominant payer type was Medicare, though the number of Medicare patients decreased over time (88.61% in 2005 to 85.02% in 2010, $p<0.0001$). Private pay was the second largest payer category, and this category increased over time (8.65% in 2005, 11.69% in 2010, $p<0.0001$). Slight increases in Medicaid were observed over time as well (1.28% in 2005 to 1.82% in 2010, $p<0.0001$).

In both age cohorts, the prevalence of both diabetes and hypertension increased, while the prevalence of congestive heart failure either remained stable (<65 age group), or decreased over time (≥65 age group). The percentage of White and Black patients increased over time, though that may partially be explained by the decreased number of patients whose race was unknown over time. Minor fluctuations were noted among the four categories of median household income over time, with statistical significance likely driven by the large sample sizes. Regional variation was also minimal over time, while growth was observed among the number of teaching hospitals included, as well as the number of hospitals with small bed sizes over time (Tables 1a, 1b).

In-hospital Mortality:

In the unadjusted analyses, no significant changes in in-hospital mortality were observed over the years 2005, 2008 and 2010 in the <65 overall cohort across payer types; however, significant decreases in in-hospital mortality were observed in the DM, CHF and HTN cohorts, with some variation by payer type noted. Significant decreases were more commonly noted for Private and Medicaid patients, while no significant differences were observed among Medicare and Self-Pay patients (Table 2a). In the ≥65 cohort, significant decreases in mortality were observed among the Overall cohort across all payer types, as well as the DM, CHF, and HTN cohorts (Table 2b).

In the <65 cohort overall, compared to Private patients, Medicare, Medicaid, and Self-Pay patients all had significantly higher odds of in-hospital mortality across all years. These results were fairly consistent among the DM, CHF and HTN cohorts, with Medicare patients consistently demonstrating higher odds of in-hospital mortality vs. Private patients (Table 3a). In contrast, in the ≥65 cohort, Private patients had significantly lower odds of in-hospital mortality vs. Medicare patients across all years in the overall and HTN cohorts, as well as in 2008 and 2010 in the DM cohort. No significant differences were observed for Medicaid vs. Medicare patients in the ≥65 cohort (Table 3b).

After adjusting for the confounders mentioned previously, in the <65 cohort overall, the odds of in-hospital mortality were significantly higher for Medicare, Medicaid and Self-Pay patients vs. Private patients across all years. An interaction was noted in the overall cohort in 2008, where the impact of payer type on in-hospital mortality depended on patient race. In these cases, odds of in-hospital mortality were significantly higher for Medicare or Medicaid vs. Private patients, when race was either White or Unknown. For Self-Pay patients, odds of in-hospital mortality were significantly higher when race was Hispanic, White, or Unknown.

Among the DM, CHF and HTN cohorts in this age group, some variability in outcomes were observed among payer types over time. In the DM cohort, Medicare patients had significantly higher odds of in-patient mortality vs. Private patients across all years studied. Similar trends were observed among CHF patients; however, results were only statistically significant in 2008. Within the HTN cohort, Medicare patients had significantly higher odds of in-hospital mortality in 2005 and 2008, but not in 2010, while Medicaid patients had significantly higher odds of in-hospital mortality across all years (Table 4a).

In the ≥65 age group, there were only two significant differences observed in the odds of in-hospital mortality by payer type. One was in the Overall cohort in 2005, where odds of in-hospital mortality depended on median household income level. In this group, odds of in-hospital mortality for Medicaid vs. Medicare patients were highest for patients in the two highest income levels (Tables 4b, 4d). The second occasion was in the DM cohort in 2008, where Medicaid patients had significantly higher odds of in-hospital mortality vs. Medicare patients (Table 4b).

PCI and CABG Use:

PCI use significantly increased over time, across both age cohorts, and across most payer types (p-value ranged from 0.2576 to <0.0001, depending on payer type and age cohort), while CABG procedures significantly decreased over time, across both age cohorts, and across most payer types (p-values ranged from 0.9068-<0.0001, depending on payer type and age cohort) (Tables 2a, 2b). Within the <65 age group, unadjusted analyses demonstrated lower odds of PCI use among Medicare, Medicaid, and Self-Pay patients vs. Private patients in both the overall population, as well as the DM, CHF, and HTN cohorts, across years. For the most part, odds of receiving CABG did not significantly differ by payer type in this age group; however, in some instances Medicare patients were less likely to receive CABG vs. Private patients (i.e. among DM patients in 2010, and among CHF patients across all years studied) (Table 3a).

Within the ≥65 age group, in the overall, CHF, and HTN cohorts, Private patients were significantly more likely to receive PCI vs. Medicare patients across years. Results were similar for the DM cohort, with the exception of 2008, were no statistically significant difference was observed (Table 3b). The use of CABG in the overall cohort was significantly higher for Private vs. Medicare in 2008, and Medicaid vs. Medicare in 2005, with no significant differences observed in 2010. Among DM patients, CABG use was significantly higher among Private vs. Medicare patients in 2005 and 2008, and numerically higher in 2010. Similar findings were observed for Medicaid vs. Medicare patients in this cohort. In the CHF and HTN cohorts, odds of receiving CABG were typically higher for Private and Medicaid patients, though statistical significance differed among years (Table 3b).

After adjusting for potential confounders, in the <65 overall cohort, odds of receiving PCI were lower across all years and payer types, with statistical significance varying by year. In 2010, an interaction was noted between payer type and race, where odds of receiving PCI for Medicare vs. Private were higher when race was Hispanic, and lower when race was White. Among Medicaid vs. Private patients, odds of receiving PCI were significantly lower for the Unknown race category (Tables 4a, 4c). Odds of PCI use tended to be lower for Medicare, Medicaid, and Self-Pay patients vs. Private patients in the DM, CHF, and HTN cohorts as well, with statistical significance varying by year and payer type (Table 4a). Within the ≥65 age group, the only significant difference observed in PCI use was in the overall cohort in 2010, where Private patients had a higher likelihood of receiving PCI vs. Medicare patients (Table 4b).

In contrast to PCI use, after adjusting for potential confounders, in the <65 age group, odds of receiving CABG were significantly lower in the overall cohort for Medicare patients vs. Private patients in 2005, but not in other years. In contrast, Medicare patients in the DM, CHF, and HTN cohorts were significantly less likely to receive CABG vs. Private patients across most years studied (Table 4a). In the ≥65 age group, no significant differences were observed among cohorts across all years studied (Table 4b).

<u>Length of Stay and Total Cost of Care:</u>

Mean length of stay was longer for the ≥65 cohort vs. <65 cohort; however, both cohorts demonstrated decreased length of stay over time (5.70 days in 2005 to 5.08 days in 2010 vs. 4.30 days in 2005 to 4.10 days in 2010, in the overall cohorts respectively). In both age cohorts, Medicaid patients tended to have the highest length of stay among the various payer types across all years studied, and Private patients had the lowest (Tables 2a, 2b). Medicaid patients also tended to have the highest mean total cost of care across age groups, cohorts, and all years studied (Tables 2a, 2b).

Evaluation of the Potential Mediating Effect of Intervention on Outcome:

In the instances where payer type was significantly associated with in-hospital mortality, we used Mplus described previously, to evaluate the potential mediating effect of procedure type on in-hospital mortality. Across these analyses, the indirect effect of payer type on in-hospital mortality, mediated by procedure type was limited, though at times, statistically significant for PCI use (effect ranged from 0-25% of the probability of in-hospital mortality being mediated by PCI use).. The mediating effect of CABG use was not statistically significant. The direct impact of payer type on in-hospital mortality remained significant independent of any mediating effect of procedure type (Table 5, Figure 1).

Discussion:

The results of this study indicate that the vast majority of patients <65 have private insurance as the primary payer type, while not surprisingly, the majority of patients ≥65 have Medicare as their primary payer type. Only a small percentage of the ≥ 65 cohort relied upon Medicaid (<2%) their primary method of payment. Both age cohorts had a higher male population, which was more pronounced in the <65 cohort. Among both cohorts, the prevalence of DM and HTN increased over time, while the prevalence of CHF either remained stable, or decreased over time.

After adjusting for covariates in the <65 age cohort overall, Medicare, Medicaid, and Self-Pay patients experienced higher odds of in-hospital mortality vs. Private patients across all years analyzed. In contrast, in the ≥65 age cohort, after adjusting for covariates, payer type was not commonly associated with in-hospital mortality, with the exception of Medicaid patients having higher in-hospital mortality vs. Medicare patients in the DM cohort 2008. Regarding procedure types, in the <65 cohort, Medicare, Medicaid and Self-Pay patients tended to have a lower likelihood of receiving PCI or CABG vs. Private patients; in contrast minimal differences were observed in the ≥65 cohort.

An important consideration in this study relates to the differences in Medicare populations in the <65 vs. ≥65 age groups. Generally, a U.S. citizen or permanent resident < 65 years of age is eligible for Medicare if: 1) they have a disability, and have been receiving Social Security Disability Insurance (SSDI) for more than 24 months, or 2) have end stage renal disease, and receive dialysis or received a kidney transplant, or 3) have amyotrophic lateral sclerosis. In contrast, U.S. citizens age 65 or older are typically eligible for Medicare if they are a U.S. citizen or permanent resident (37); hence, the Medicare patients in the<65 age group may have more concomitant disabling conditions vs. traditional Medicare patients.

One of the hypotheses tested in this study was whether or not any interactions existed between payer type and either race or median household income level, with the hypothesis being that minorities and/or patients from areas with lower median household income levels may be more likely to experience worse outcomes vs. White patients, or those from higher household income areas. While interactions were occasionally observed in this study, no consistent trend was observed in either race or household income level to support this hypothesis. The clinical relevance of these findings is therefore questionable.

The results of this study are consistent with findings in the published literature. (15; 16; 18) Ng, et al (15), examined the risk of death associated with insurance status after admission for an acute cardiovascular event, among patients hospitalized in Maryland between 1993-2007. In that study, investigators concluded that being under-insured was strongly associated with death among those admitted with a myocardial infarction, vs. patients with private insurance. Hasan, et al. examined the relationship between insurance status and in-hospital care, and found in-hospital mortality rates to be significantly higher for uninsured vs. privately insured. One key difference to note between these published studies, and the findings in our research relates to the different categories of payer types included. The Ng, et al, paper focused on private-pay vs. under-insured (which combined Medicaid and Self-Pay patients), while Medicare patients were excluded from that analysis. The Hasan, et al., study excluded patients ≥65, and only reported results of privately insured, uninsured, and Medicaid patients. Our findings support the conclusions from both of these studies that private-pay patients have lower risk of mortality vs. Self-Pay patients among those age < 65.

Our results were somewhat consistent with findings from Hiestand (18), et al. in their evaluation of the impact of insurance status on quality of care, though some differences should be noted. In that study, investigators determined that Medicare patients had lower odds of receiving fibrinolytics or PCI, while the odds of privately insured patients receiving either PCI or CABG was higher than other payer types. While our study was not able to determine degree of fibrinolytic use among various payer types, our results also found higher use of CABG among privately insured vs. Self-Pay patients. One difference in our findings relative to Hiestand, et al. related to PCI use. Our results did not indicate a consistent association between payer status and odds of receiving PCI in the ≥65 age group.

An area of focus in our study that, to our knowledge, has not been previously published on, relates to the potential mediating effect of procedure type on in-hospital mortality. Our analyses found that a portion of the effect of payer type on in-hospital mortality was mediated by procedure type, specifically PCI use. Additional research may be warranted evaluating other potential mediating factors (i.e. time from onset of chest pain to hospital presentation), which might further describe this association.

There are several limitations to our study which should be noted. The source of data for these analyses comes from retrospective hospitalization data in the United States, with only approximately 4% of hospitals being the same across all years studied. Changes that were observed over time could partly be explained by the changing hospital participation over the years studied. Our findings are also limited to outcomes within the hospitalization. Longer term outcomes data were not able to be captured in this dataset.

Additional limitations include the fact that the information regarding DM, HTN, and CHF status, as well as readmissions for AMI, is limited to their corresponding ICD-9 codes, with no reference to time since diagnosis of these conditions. It is possible that some of these comorbidities may have been initially diagnosed within the hospitalizations analyzed in this study (i.e. STEMI leading to CHF), vs. having been pre-existing conditions. It is also possible that some co-morbidities existed within patients, but were not coded for in the dataset, and therefore may have been excluded from some analyses. Results of these subgroups should therefore be interpreted with caution.

Another consideration is that the information on time from onset of chest pain to hospitalization is not available within this dataset, which could impact type of procedures used, as well as in-hospital mortality rates. The inability to control for smoking status, alcohol use, drug use, potential re-admissions, or time from onset of chest pain to hospitalization, may result in an overestimation of the impact of payer type on cardiovascular outcomes in this study. These limitations should be carefully considered when interpreting the results of our study.

Conclusions:

Despite the limitations noted above, the results of this study suggest that among patients aged <65, those with private insurance as the primary payer type experience lower odds of in-hospital mortality, and higher use of invasive procedures vs. patients with other forms of primary insurance (including Self-Pay patients). The effect of payer type on in-hospital mortality is somewhat mediated by the use of PCI, as well. Further work is needed to provide improved quality of care for patients without Private insurance coverage who require hospitalization for STEMI.

Table 1a: National Estimates of Patient Demographics and Hospital Characteristics (<65 cohort)*

	2005 N=99,229	2008 N=92,326	2010 N=84,702	p-value
Primary Payer Type (n,%)				
Medicare	10,507 (10.59)	9314 (10.09)	9020 (10.65)	0.7907
Medicaid	9198 (9.27)	8914 (9.65)	9740 (11.50)	<0.0001
Private	67,081 (67.60)	60,608 (65.65)	52,094 (61.50)	<0.0001
Self-Pay	12,438 (12.53)	13,485 (14.61)	13820 (16.32)	<0.0001
Mean Age (SE)	53.95 (0.05)	54.03 (0.05)	54.22 (0.06)	0.0021
Comorbidities (n,%)				
DM	23,454 (23.64)	23,198 (25.13)	22,313 (26.34)	<0.0001
HTN	49,855 (50.24)	49,129 (53.21)	47,134 (55.65)	<0.0001
CHF	12,485 (12.55)	10,215 (11.06)	9450 (11.16)	<0.0001
Gender (n, %Female)	23,849 (24.04)	21,699 (23.51)	19,437 (22.95)	<0.0001
Race (n,%)**				
White	55,416 (79.51)	56,114 (77.67)	54,944 (75.67)	<0.0001
Black	4661 (6.69)	5749 (7.96)	6737 (9.28)	<0.0001
Hispanic	5588 (8.02)	4667 (6.46)	5835 (8.04)	<0.0001
Other	4032 (5.79)	5719 (7.92)	5092 (7.01)	<0.0001
Median HH income (n,%)				
Lowest Quartile	25,262 (25.46)	24,138 (26.14)	23,028 (27.19)	<0.0001
Second Lowest	25,205 (25.40)	28,983 (28.14)	21,541 (25.43)	0.0092
Second Highest	24,422 (24.61)	21,522 (23.31)	20,106 (23.74)	<0.0001
Highest Quartile	21,455 (21.62)	18,428 (19.96)	17,628 (20.81)	<0.0001
Hospital Region (n,%)				
Northeast	17,454 (17.59)	14,626 (15.84)	16,068 (18.97)	<0.0001
Midwest	23,831 (24.02)	23,776 (25.75)	21,998 (25.97)	<0.0001
South	40,657 (40.97)	38,763 (41.98)	30,490 (36.00)	<0.0001
West	17,288 (17.42)	15,161 (16.42)	16,146 (19.06)	<0.0001
Hospital Bed Size (n,%)				
Small	4257 (4.29)	6975 (7.55)	6381 (7.53)	<0.0001
Medium	23,701 (23.88)	19,634 (21.27)	15,855 (18.72)	<0.0001
Large	71,271 (71.82)	65,708 (71.17)	61,079 (72.11)	0.5190
Hospital Teaching Status (n,%)				
Teaching	43,309 (45.66)	44,975 (48.72)	42,234 (50.69)	<0.0001
Non-Teaching	53,920 (54.34)	47,341 (51.28)	41,080 (49.31)	<0.0001

*P-values represent differences over the years 2005, 2008 and 2010 for each variable, and were determined using PROC SURVEYREG for continuous variables (2010 as referent year) and Cochran-Armitage Trend test for categorical variables. Two-sided p-values used, where applicable. Sample discharge weights were used to calculate national estimates. Numbers may not add to 100% of total sample due to missing data.

**Percentages calculated excluding "Unknown Race each year (Number of "Unknown in 2005: 29,532, 2008: 20,077, 2010: 12,094)

Table 1b: National Estimates of Patient Demographics and Hospital Characteristics (≥65 cohort)*

	2005 N=103,603	2008 N=82,277	2010 N=69,434	p-value
Primary Payer Type (n, %)				
Medicare	93,312 (90.07)	72,072 (87.60)	60,048 (86.48)	<0.0001
Medicaid	1327 (1.28)	1211 (1.47)	1267 (1.82)	<0.0001
Private	8964 (8.65)	8994 (10.93)	8119 (11.69)	<0.0001
Mean Age (SE)	77.06 (0.10)	76.62 (0.09)	76.29 (0.10)	<0.0001
Comorbidities (n,%)				
DM	24,924 (24.06)	21,039 (25.57)	17,989 (25.91)	<0.0001
HTN	60,410 (58.31)	49,451 (60.10)	42,494 (61.20)	<0.0001
CHF	33,538 (32.37)	21,976 (26.71)	17,268 (24.87)	<0.0001
Gender (n, %Female)	49,485 (47.77)	37,790 (45.93)	30,480 (43.90)	<0.0001
Race (n,%)**				
White	63,047 (84.98)	55,056 (82.77)	49,333 (82.51)	<0.0001
Black	3269 (4.41)	3716 (5.59)	3770 (6.31)	<0.0001
Hispanic	4675 (6.30)	3555 (5.34)	3445 (5.76)	0.0009
Other	3198 (4.31)	4191 (6.30)	3243 (5.42)	<0.0001
Median HH income (n,%)				
Lowest Quartile	26,337 (25.42)	21,249 (25.83)	17,497 (25.20)	0.6838
Second Lowest	27,871 (26.90)	23,922 (29.07)	18,242 (26.27)	0.9393
Second Highest	25,520 (24.63)	18,557 (22.55)	16,867 (24.29)	<0.0001
Highest Quartile	21,671 (20.92)	17,052 (20.92)	15,170 (21.85)	0.0001
Hospital Region (n,%)				
Northeast	21,193 (20.46)	15,711 (19.10)	13,807 (19.89)	<0.0001
Midwest	24,613 (23.16)	19,113 (23.23)	17,513 (25.22)	<0.0001
South	37,680 (36.37)	32,115 (39.03)	23,659 (34.07)	<0.0001
West	20,117 (19.42)	15,337 (18.64)	14,455 (20.82)	<0.0001
Hospital Bed Size (n,%)				
Small	8550 (8.25)	8072 (9.81)	6693 (9.78)	<0.0001
Medium	23,987 (23.15)	18,524 (22.52)	13,710 (20.03)	<0.0001
Large	71,065 (68.59)	55,666 (67.67)	48,034 (70.19)	0.24
Hospital Teaching Status (n,%)				
Teaching	40,563 (39.15)	36,228 (44.04)	32,614 (47.65)	<0.0001
Non-Teaching	63,040 (60.85)	46,034 (55.96)	35,824 (52.35)	<0.0001

*P-values represent differences over the years 2005, 2008 and 2010 for each variable, and were determined using PROC SURVEYREG for continuous variables (2010 as referent year) and Cochran-Armitage Trend test for categorical variables. Two-sided p-values used, where applicable. Sample discharge weights were used to calculate national estimates. Numbers may not add to 100% of total sample due to missing data.

**Percentages calculated excluding "Unknown Race each year (Number of "Unknown in 2005: 29,414, 2008: 15,759, 2010: 9643)

Table 2a: Unadjusted National Estimates for Outcome Variables (<65 cohort)*

	2005	2008	2010	p-Value
Overall Cohort	N=99,229	N=92,326	N=84,702	
In-hospital mortality (n,%)				
Overall	3231 (3.26)	3318 (3.59)	2850 (3.37)	0.0591
Medicare	683 (5.99)	690 (7.41)	553 (6.13)	0.2791
Medicaid	465 (5.06)	459 (5.15)	493 (5.07)	0.9451
Self-Pay	477 (3.84)	612 (4.54)	549 (3.97)	0.4194
Private	1661 (2.48)	1557 (2.57)	1255 (2.41)	0.6679
PCI (n,%)				
Overall	68,416 (68.95)	73,395 (79.50)	70,470 (83.20)	<0.0001
Medicare	6174 (58.76)	6637 (71.25)	6852 (75.97)	<0.0001
Medicaid	5527 (60.10)	6537 (73.34)	7679 (78.84)	<0.0001
Self-Pay	8525 (68.54)	10,644 (78.93)	11,627 (84.13)	<0.0001
Private	48,190 (71.84)	49,572 (81.79)	44,294 (85.03)	<0.0001
CABG (n,%)				
Overall	9719 (9.79)	7295 (7.90)	5552 (6.55)	<0.0001
Medicare	1033 (9.83)	691 (7.42)	577 (6.40)	<0.0001
Medicaid	968 (10.53)	790 (8.87)	615 (6.31)	<0.0001
Self-Pay	1109 (8.92)	1140 (8.46)	894 (6.47)	<0.0001
Private	6609 (9.98)	4673 (7.71)	3465 (6.65)	<0.0001
Mean Length of stay (SE)				
Overall	4.30 (0.08)	4.25 (0.07)	4.10 (0.06)	0.1198
Medicare	5.29 (0.17)	5.33 (0.21)	5.07 (0.24)	0.6744
Medicaid	5.39 (0.20)	5.60 (0.26)	5.49 (0.21)	0.8137
Self-Pay	4.15 (0.11)	4.11 (0.11)	3.92 (0.11)	0.2582
Private	4.02 (0.07)	3.92 (0.06)	3.72 (0.05)	0.0024
Mean Total Cost of Care (SE)				
Overall	24,138 (628)	25,534 (535)	25,238 (547)	0.1059
Medicare	23,974 (816)	27,150 (977)	27,034 (1110)	0.0067
Medicaid	26,795 (1179)	28,489 (994)	28,564 (869)	0.2765
Self-Pay	22,609 (867)	23,401 (571)	23,068 (626)	0.6300
Private	24,054 (630)	25,357 (558)	24,930 (552)	0.0832
DM Cohort	N=23,448	N=23,193	N=22,308	
In-hospital mortality (n,%)				
Overall	805 (3.43)	739 (3.19)	603 (2.70)	<0.0001
Medicare	238 (6.45)	204 (6.62)	159 (5.17)	0.0534
Medicaid	88 (3.30)	82 (3.26)	113 (3.79)	0.3420
Self-Pay	92 (3.16)	97 (2.81)	106 (2.81)	0.3944
Private	387 (2.73)	356 (2.52)	225. (1.81)	<0.0001
PCI (n,%)				
Overall	14,720 (62.76)	17,762 (76.57)	17,988 (80.61)	<0.0001
Medicare	1997 (54.06)	2112 (68.60)	2387 (77.50)	<0.0001
Medicaid	1480 (55.63)	1822 (72.27)	2227 (74.84)	<0.0001
Self-Pay	1773 (60.91)	2590 (74.83)	3098 (82.86)	<0.0001
Private	9470 (66.74)	11,238 (79.49)	10,271 (82.41)	<0.0001
CABG (n,%)				
Overall	2824 (12.04)	2254 (9.72)	1916 (8.59)	<0.0001
Medicare	414 (11.21)	225 (7.30)	186 (6.02)	<0.0001

Medicaid	305 (11.45)	229 (9.10)	219 (7.36)	<0.0001
Self-Pay	336 (11.53)	380 (10.98)	310 (8.21)	<0.0001
Private	1770 (12.47)	1420 (10.01)	1201 (9.63)	<0.0001
Mean Length of stay (SE)				
Overall	4.57 (0.10)	4.02 (0.08)	3.92 (0.06)	<0.0001
Medicare	5.07 (0.23)	4.40 (0.19)	4.11 (0.14)	0.0021
Medicaid	4.99 (0.21)	4.76 (0.31)	4.67 (0.18)	0.5243
Self-Pay	4.62 (0.22)	4.15 (0.13)	3.78 (0.11)	0.0009
Private	4.35 (0.11)	3.77 (0.08)	3.74 (0.07)	<0.0001
Mean Total Cost of Care (SE)				
Overall	24,307 (739)	24,503 (555)	24,721 (610)	0.6468
Medicare	22,408 (955)	23,229 (938)	23,891 (888)	0.3032
Medicaid	24,324 (1127)	26,495 (1249)	25,777 (926)	0.1650
Self-Pay	24,763 (1386)	22,833 (695)	22,571 (734)	0.6249
Private	24,721 (835)	24,867 (577)	25,830 (698)	0.6180
CHF Cohort	N=12,453	N=10,211	N=9445	
In-hospital mortality (n,%)				
Overall	1094 (8.79)	772 (7.56)	623 (6.59)	<0.0001
Medicare	256 (11.74)	214 (11.86)	132 (9.35)	0.0595
Medicaid	183 (10.59)	128 (8.44)	66 (4.31)	<0.0001
Self-Pay	112 (7.05)	118 (7.85)	116 (7.84)	0.3785
Private	543 (7.81)	312 (5.78)	308 (6.16)	<0.0001
PCI (n,%)				
Overall	6447 (51.75)	6613 (64.73)	6605 (69.89)	<0.0001
Medicare	903 (41.36)	963 (53.19)	856 (60.67)	<0.0001
Medicaid	770 (44.52)	939 (61.93)	1015 (65.60)	<0.0001
Self-Pay	830 (52.21)	924 (61.45)	1074 (72.47)	<0.0001
Private	3944 (56.70)	3787 (70.32)	3655 (73.02)	<0.0001
CABG (n,%)				
Overall	2158 (17.32)	1518 (14.86)	1155 (12.22)	<0.0001
Medicare	264 (12.09)	200 (11.07)	93 (6.62)	<0.0001
Medicaid	277 (16.03)	218 (14.37)	165 (10.65)	<0.0001
Self-Pay	267 (16.77)	223 (14.85)	150 (10.13)	<0.0001
Private	1350 (19.41)	877 (16.28)	747 (14.91)	<0.0001
Mean Length of stay (SE)				
Overall	8.07 (0.19)	7.25 (0.22)	7.55 (0.27)	0.0249
Medicare	8.61 (0.48)	7.61 (0.54)	8.01 (0.81)	0.3818
Medicaid	9.44 (0.54)	8.98 (0.80)	9.36 (0.67)	0.8885
Self-Pay	7.70 (0.39)	6.92 (0.33)	6.61 (0.34)	0.1186
Private	7.64 (0.21)	6.74 (0.26)	7.15 (0.27)	0.0336
Mean Total Cost of Care ($) (SE)				
Overall	36,394 (1221)	35,735 (1100)	36,632 (1356)	0.9667
Medicare	29,522 (1542)	33,460 (2171)	32,475 (3749)	0.2617
Medicaid	40,991 (2927)	40,156 (2200)	40,229 (2720)	0.9734
Self-Pay	37,064 (2418)	31,633 (1535)	30,524 (1676)	0.3834
Private	37,236 (1321)	36,470 (1334)	38,619 (1553)	0.7660
HTN Cohort	N=49,839	N=49,129	N=47,114	
In-hospital mortality (n,%)				

Overall	1060 (2.13)	1053 (2.14)	856 (1.82)	0.0019
Medicare	222 (3.65)	303 (5.45)	204 (3.62)	0.5054
Medicaid	163 (3.33)	123 (2.54)	128 (2.42)	0.0040
Self-Pay	132 (2.34)	173 (2.53)	166 (2.23)	0.7132
Private	543 (1.63)	454 (1.42)	358 (1.24)	<0.0001
PCI (n,%)				
Overall	33,648 (67.49)	39,000 (79.38)	39,413 (83.62)	<0.0001
Medicare	3674 (60.24)	4050 (72.97)	4350 (77.22)	<0.0001
Medicaid	2827 (57.85)	3550 (73.28)	4239 (79.92)	<0.0001
Self-Pay	3725 (65.91)	5365 (78.30)	6245 (84.06)	<0.0001
Private	23,422 (70.52)	26,030 (81.66)	24,569 (85.47)	<0.0001
CABG (n,%)				
Overall	5207 (10.44)	3780 (7.69)	3076 (6.53)	<0.0001
Medicare	636 (10.42)	361 (6.50)	322 (5.71)	<0.0001
Medicaid	532 (10.89)	417 (8.60)	297 (5.61)	<0.0001
Self-Pay	544 (9.63)	606 (8.84)	476 (6.41)	<0.0001
Private	3495 (10.52)	2397 (7.52)	1982 (6.89)	<0.0001
Mean Length of stay (SE)				
Overall	4.03 (0.07)	3.72 (0.06)	3.59 (0.05)	<0.0001
Medicare	4.89 (0.20)	4.28 (0.19)	4.24 (0.23)	0.0419
Medicaid	4.55 (0.16)	4.33 (0.18)	4.16 (0.14)	0.2088
Self-Pay	4.00 (0.14)	3.73 (0.09)	3.48 (0.09)	0.0022
Private	3.80 (0.06)	3.53 (0.06)	3.39 (0.05)	<0.0001
Mean Total Cost of Care (SE)				
Overall	23,018 (643)	23,418 (480)	23,353 (512)	0.5308
Medicare	22,756 (850)	23,258 (857)	23,740 (854)	0.2907
Medicaid	23,747 (1015)	24,998 (844)	24,174 (770)	0.3665
Self-Pay	21,523 (965)	21,559 (541)	21,574 (638)	0.8405
Private	23,198 (656)	23,627 (504)	23,624 (525)	0.5637

*P-values represent differences over the years 2005, 2008 and 2010 for each variable, and were determined using PROC SURVEYREG for continuous variables (2010 as referent year) and Cochran-Armitage Trend test for categorical variables. Two-sided p-values used, where applicable. Sample discharge weights were used to calculate national estimates. Numbers may not add to 100% of total sample due to missing data.

Table 2b: Unadjusted National Estimates for Outcome Variables (≥65 cohort)*

	2005	2008	2010	p-Value
Overall Cohort	N=103,568	N=82,264	N= 69,418	
In-hospital mortality (n,%)				
Overall	13,185 (12.73)	9611 (11.68)	7457 (10.74)	<0.0001
Medicare	12074 (12.94)	8635 (11.98)	6697 (11.10)	<0.0001
Medicaid	217 (16.34)	152 (12.53)	103 (8.18)	<0.0001
Private	894 (9.97)	824 (9.16)	657 (8.09)	<0.0001
PCI (n,%)				
Overall	47697 (46.04)	48,986 (59.54)	46,521 (67.00)	<0.0001
Medicare	42,105 (45.12)	42,338 (58.74)	39,544 (65.85)	<0.0001
Medicaid	645 (48.63)	726 (59.93)	789 (62.26)	<0.0001
Private	4947 (55.19)	5922 (65.85)	6188 (76.22)	<0.0001
CABG (n,%)				
Overall	9371 (9.05)	6829 (8.30)	4756 (6.85)	<0.0001
Medicare	8278 (8.87)	5816 (8.07)	4060 (6.76)	<0.0001
Medicaid	185 (13.95)	118 (9.76)	81 (6.41)	<0.0001
Private	908 (10.13)	895 (9.95)	615 (7.57)	<0.0001
Mean Length of stay (SE)				
Overall	5.70 (0.07)	5.42 (0.08)	5.08 (0.07)	<0.0001
Medicare	5.74 (0.08)	5.44 (0.08)	5.08 (0.07)	<0.0001
Medicaid	7.12 (0.44)	6.68 (0.43)	7.05 (0.70)	0.7236
Private	5.12 (0.13)	5.01 (0.17)	4.81 (0.15)	0.3034
Mean Total Cost of Care (SE)				
Overall	24,176 (641)	25,690 (616)	26,118 (644)	<0.0001
Medicare	23,825 (626)	25,201 (604)	25,745 (639)	<0.0001
Medicaid	35,078 (2802)	39,900 (3345)	35,113 (3594)	0.7046
Private	26,172 (1016)	27,608 (994)	27,369 (1059)	0.2234
DM Cohort	N=24,909	N=21,039	N=17,978	
In-hospital mortality (n,%)				
Overall	2804 (11.26)	2003 (9.52)	1537 (8.55)	<0.0001
Medicare	200 (9.41)	163 (7.08)	96 (4.60)	<0.0001
Medicaid	64 (14.27)	48 (11.75)	35 (7.53)	0.0016
Private	2540 (11.37)	1792 (9.78)	1406 (9.11)	<0.0001
PCI (n,%)				
Overall	10,513 (42.18)	12,193 (57.95)	11,805 (65.63)	<0.0001
Medicare	1031 (48.58)	1424 (61.75)	1572 (74.88)	<0.0001
Medicaid	218 (48.56)	230 (56.61)	267 (57.63)	0.0044
Private	9264 (41.44)	10,539 (57.50)	9967 (64.61)	<0.0001
CABG (n,%)				
Overall	2053 (8.24)	1678 (7.97)	1242 (6.90)	<0.0001
Medicare	251 (11.81)	248 (10.74)	159 (7.59)	<0.0001
Medicaid	43 (9.62)	56 (13.77)	41 (8.86)	0.9068
Private	1760 (7.87)	1374 (7.50)	1041 (6.75)	<0.0001
Mean Length of stay (SE)				
Overall	5.20 (0.09)	4.74 (0.09)	4.51 (0.08)	<0.0001
Medicare	5.39 (0.23)	4.53 (0.16)	4.44 (0.20)	0.0044
Medicaid	6.03 (0.43)	6.09 (0.56)	6.09 (1.07)	0.9962

Private	5.16 (0.09)	4.74 (0.09)	4.47 (0.08)	<0.0001
Mean Total Cost of Care (SE)				
Overall	21,574 (651)	23,427 (683)	24,020 (670)	0.0123
Medicare	26,236 (1573)	24,497 (1086)	23,464 (623)	0.0106
Medicaid	29,901 (2850)	36,156 (3731)	31,194 (5377)	0.2325
Private	20,958 (630)	22,990 (692)	26,410 (1472)	0.4393
CHF Cohort	N=33,524	N=21,963	N=17,263	
In-hospital mortality (n,%)				
Overall	6370 (19.00)	3488 (15.88)	2454 (14.21)	<0.0001
Medicare	418 (18.00)	264 (14.50)	225 (12.63)	<0.0001
Medicaid	102 (22.24)	60 (16.54)	42 (10.61)	<0.0001
Private	5850 (19.03)	3164 (16.00)	2187 (14.50)	<0.0001
PCI (n,%)				
Overall	10,216 (30.46)	9180 (41.77)	8763 (50.75)	<0.0001
Medicare	902 (38.80)	895 (49.15)	1089 (61.04)	<0.0001
Medicaid	197 (43.04)	171 (47.23)	183 (46.54)	0.2576
Private	9117 (29.64)	8115 (40.99)	7492 (49.64)	<0.0001
CABG (n,%)				
Overall	3051 (9.10)	1751 (7.97)	1242 (7.19)	<0.0001
Medicare	294 (12.64)	140 (7.68)	201 (11.27)	0.0211
Medicaid	68 (14.90)	40 (11.01)	26 (6.56)	0.0001
Private	2689 (8.74)	1571 (7.94)	1015 (6.72)	<0.0001
Mean Length of stay (SE)				
Overall	7.86 (0.13)	6.94 (0.12)	6.95 (0.12)	<0.0001
Medicare	8.02 (0.31)	6.64 (0.45)	7.40 (0.36)	0.0486
Medicaid	8.97 (0.97)	9.29 (0.73)	7.72 (0.81)	0.4244
Private	7.83 (0.14)	6.93 (0.12)	6.88 (0.12)	<0.0001
Mean Total Cost of Care (SE)				
Overall	27,700 (901)	27,405 (820)	29,267 (937)	0.0531
Medicare	33,083 (2155)	26,854 (1394)	28,549 (950)	0.0891
Medicaid	43,587 (5675)	52,615 (5440)	34,257 (3149)	0.1146
Private	27,049 (870)	26,966 (817)	34,119 (1780)	0.0019
HTN Cohort	N=60,395	N=49,451	N=42,489	
In-hospital mortality (n,%)				
Overall	6178 (10.23)	4190 (8.47)	3383 (7.96)	<0.0001
Medicare	416 (8.14)	343 (6.37)	274 (5.49)	<0.0001
Medicaid	114 (13.55)	50 (6.74)	58 (7.66)	<0.0001
Private	5648 (10.37)	3798 (8.76)	3051 (8.30)	<0.0001
PCI (n,%)				
Overall	28,046 (46.43)	30,195 (61.06)	28,943 (68.11)	<0.0001
Medicare	2725 (53.27)	3680 (68.46)	3829 (76.79)	<0.0001
Medicaid	375 (44.72)	441 (59.84)	504 (66.33)	<0.0001
Private	24,946 (45.81)	26,074 (60.16)	24,610 (66.97)	<0.0001
CABG (n,%)				
Overall	5082 (8.41)	3428 (6.93)	2636 (6.20)	<0.0001
Medicare	493 (9.63)	455 (8.47)	400 (8.02)	0.0033
Medicaid	107 (12.43)	59 (8.03)	31 (4.02)	<0.0001
Private	4483 (8.23)	2913 (6.72)	2206 (6.00)	<0.0001
Mean Length of				

stay (SE)				
Overall	5.08 (0.08)	4.59 (0.06)	4.31 (0.06)	<0.0001
Medicare	4.52 (0.14)	4.30 (0.12)	4.15 (0.11)	0.1052
Medicaid	6.79 (0.50)	5.15 (0.44)	5.01 (0.52)	0.0202
Private	5.11 (0.08)	4.62 (0.07)	4.32 (0.07)	<0.0001
Mean Total Cost of Care (SE)				
Overall	21,680 (599)	22,683 (575)	22,872 (538)	0.2758
Medicare	23,579 (1058)	24,769 (769)	22,483 (531)	0.3200
Medicaid	31,578 (2564)	30,365 (2206)	27,882 (3583)	0.8717
Private	21,345 (584)	22,292 (590)	24,912 (1019)	0.7655

*P-values represent differences over the years 2005, 2008 and 2010 for each variable, and were determined using PROC SURVEYREG for continuous variables (2010 as referent year) and Cochran-Armitage Trend test for categorical variables. Two-sided p-values used, where applicable. Sample discharge weights were used to calculate national estimates. Numbers may not add to 100% of total sample due to missing data.

Table 3a: Unadjusted National Estimates of Odds Ratios and 95% Confidence Intervals (CI) for Dichotomous Outcome Variables within Each Year (<65 cohort). Private Pay is Reference Group.*

	2005	2008	2010
Overall Cohort	N=20,333	N=18,811	N=16,921
In-hospital mortality (OR, 95% CI)			
Medicare	2.51 (1.98-3.17)	3.03 (2.49-3.69)	2.65 (2.08-3.38)
Medicaid	2.10 (1.64-2.68)	2.06 (1.62-2.62)	2.16 (1.71-2.74)
Self-Pay	1.57 (1.24-1.99)	1.80 (1.45-2.24)	1.68 (1.32-2.12)
PCI (OR, 95% CI)			
Medicare	0.56 (0.50-0.62)	0.55 (0.49-0.62)	0.56 (0.49-0.64)
Medicaid	0.59 (0.52-0.67)	0.61 (0.54-0.70)	0.66 (0.57-0.76)
Self-Pay	0.85 (0.75-0.97)	0.83 (0.75-0.93)	0.93 (0.82-1.07)
CABG (OR, 95% CI)			
Medicare	1.00 (0.85-1.17)	0.96 (0.78-1.18)	0.96 (0.77-1.19)
Medicaid	1.08 (0.84-1.38)	1.17 (0.97-1.40)	0.95 (0.75-1.19)
Self-Pay	0.90 (0.75-1.06)	1.11 (0.93-1.31)	0.97 (0.81-1.16)
DM Cohort	N=4658	N=4599	N=4235
In-hospital mortality (OR, 95% CI)			
Medicare	2.44 (1.63-3.66)	2.73 (1.87-4.00)	3.04 (1.91-4.83)
Medicaid	1.18 (0.72-1.95)	1.38 (0.81-2.36)	2.17 (1.28-3.68)
Self-Pay	1.13 (0.66-1.92)	1.06 (0.63-1.76)	1.51 (0.90-2.51)
PCI (OR, 95% CI)			
Medicare	0.57 (0.49-0.68)	0.56 (0.46-0.68)	0.73 (0.60-0.89)
Medicaid	0.61 (0.50-0.75)	0.67 (0.54-0.82)	0.67 (0.53-0.84)
Self-Pay	0.76 (0.62-0.93)	0.78 (0.62-0.96)	0.99 (0.79-1.25)
CABG (OR, 95% CI)			
Medicare	0.93 (0.73-1.19)	0.75 (0.54-1.05)	0.63 (0.43-0.93)
Medicaid	0.92 (0.67-1.25)	0.95 (0.68-1.31)	0.79 (0.54-1.15)
Self-Pay	0.94 (0.69-1.27)	1.13 (0.88-1.46)	0.84 (0.61-1.15)
CHF Cohort	N=2458	N=2034	N=1799
In-hospital mortality (OR, 95% CI)			
Medicare	1.54 (1.03-2.31)	2.21 (1.47-3.31)	1.53 (0.91-2.58)
Medicaid	1.26 (0.83-1.91)	1.55 (0.89-2.69)	0.71 (0.40-1.25)
Self-Pay	0.80 (0.48-1.32)	1.42 (0.85-2.37)	1.18 (0.70-1.97)
PCI (OR, 95% CI)			
Medicare	0.52 (0.42-0.64)	0.48 (0.38-0.62)	0.58 (0.42-0.79)
Medicaid	0.60 (0.46-0.78)	0.71 (0.52-0.95)	0.74 (0.56-0.97)
Self-Pay	0.81 (0.64-1.02)	0.67 (0.52-0.87)	1.01 (0.75-1.37)
CABG (OR, 95% CI)			
Medicare	0.59 (0.41-0.85)	0.64 (0.44-0.92)	0.42 (0.26-0.66)
Medicaid	0.83 (0.61-1.13)	0.83 (0.59-1.19)	0.65 (0.42-1.01)
Self-Pay	0.90 (0.63-1.27)	0.89 (0.59-1.33)	0.66 (0.42-1.04)
HTN Cohort	N=9913	N=9767	N=8982
In-hospital mortality (OR, 95% CI)			
Medicare	2.34 (1.56-3.50)	3.99 (2.85-5.58)	3.04 (1.96-4.71)
Medicaid	2.06 (1.41-3.01)	1.88 (1.21-2.92)	1.90 (1.17-3.09)
Self-Pay	1.39 (0.87-2.23)	1.78 (1.22-2.60)	1.79 (1.16-2.76)
PCI (OR, 95% CI)			

Medicare	0.63 (0.55-0.72)	0.61 (0.53-0.71)	0.58 (0.49-0.69)
Medicaid	0.57 (0.49-0.67)	0.62 (0.52-0.74)	0.72 (0.59-0.87)
Self-Pay	0.79 (0.67-0.94)	0.80 (0.69-0.94)	0.93 (0.77-1.12)
CABG (OR, 95% CI)			
Medicare	0.99 (0.83-1.18)	0.88 (0.65-1.20)	0.82 (0.62-1.08)
Medicaid	1.02 (0.77-1.36)	1.18 (0.92-1.51)	0.86 (0.64-1.14)
Self-Pay	0.94 (0.74-1.19)	1.20 (0.99-1.46)	0.93 (0.73-1.19)

*Sample discharge weights were used to determine nationally representative estimates.

Table 3b: Unadjusted National Estimates of Odds Ratios and 95% Confidence Intervals (CI) for Dichotomous Outcome Variables within Each Year (≥65 cohort). Medicare is Reference Group.*

	2005	2008	2010
Overall	N=21,201	N=16,735	N=13,922
In-hospital mortality (OR, 95% CI)			
Private	0.75 (0.62-0.89)	0.74 (0.62-0.89)	0.70 (0.58-0.85)
Medicaid	1.31 (0.93-1.86)	1.05 (0.76-1.46)	0.71 (0.45-1.13)
PCI (OR, 95% CI)			
Private	1.50 (1.24-1.81)	1.35 (1.20-1.53)	1.66 (1.48-1.86)
Medicaid	1.15 (0.89-1.49)	1.05 (0.77-1.43)	0.86 (0.61-1.20)
CABG (OR, 95% CI)			
Private	1.16 (0.97-1.38)	1.26 (1.05-1.51)	1.13 (0.92-1.39)
Medicaid	1.67 (1.18-2.35)	1.23 (0.72-2.10)	0.94 (0.58-1.55)
DM Cohort	N=5103	N=4285	N=3605
In-hospital mortality (OR, 95% CI)			
Private	0.81 (0.56-1.17)	0.70 (0.50-0.99)	0.48 (0.29-0.79)
Medicaid	1.30 (0.70-2.40)	1.23 (0.65-2.34)	0.81 (0.39-1.68)
PCI (OR, 95% CI)			
Private	1.34 (1.03-1.74)	1.19 (0.95-1.50)	1.63 (1.29-2.07)
Medicaid	1.33 (0.89-2.00)	0.96 (0.63-1.47)	0.75 (0.45-1.23)
CABG (OR, 95% CI)			
Private	1.57 (1.16-2.11)	1.48 (1.02-2.15)	1.14 (0.75-1.72)
Medicaid	1.25 (0.63-2.46)	1.97 (1.07-3.65)	1.34 (0.59-3.04)
CHF Cohort	N=6854	N=4458	N=3464
In-hospital mortality (OR, 95% CI)			
Private	0.93 (0.72-1.21)	0.89 (0.65-1.22)	0.85 (0.63-1.16)
Medicaid	1.22 (0.73-2.04)	1.04 (0.58-1.88)	0.70 (0.33-1.48)
PCI (OR, 95% CI)			
Private	1.51 (1.16-1.95)	1.39 (1.11-1.74)	1.59 (1.27-1.99)
Medicaid	1.79 (1.19-2.72)	1.29 (0.80-2.07)	0.88 (0.52-1.50)
CABG (OR, 95% CI)			
Private	1.51 (1.12-2.04)	0.96 (0.63-1.49)	1.76 (1.22-2.53)
Medicaid	1.83 (1.03-3.24)	1.44 (0.69-2.98)	0.97 (0.40-2.36)
HTN Cohort	N=12,366	N=10,046	N=8508
In-hospital mortality (OR, 95% CI)			
Private	0.77 (0.60-0.97)	0.71 (0.54-0.93)	0.64 (0.48-0.86)
Medicaid	1.36 (0.80-2.28)	0.75 (0.41-1.37)	0.92 (0.52-1.61)
PCI (OR, 95% CI)			
Private	1.35 (1.08-1.68)	1.44 (1.24-1.67)	1.63 (1.41-1.89)
Medicaid	0.96 (0.69-1.32)	0.99 (0.69-1.41)	0.97 (0.67-1.40)
CABG (OR, 95% CI)			
Private	1.19 (0.95-1.49)	1.29 (1.03-1.60)	1.37 (1.08-1.73)
Medicaid	1.63 (1.06-2.50)	1.21 (0.61-2.41)	0.66 (0.31-1.39)

*Sample discharge weights were used to determine nationally representative estimates.

Table 4a: Adjusted National Estimates of Odds Ratios and 95% Confidence Intervals (CI) for Dichotomous Outcome Variables within Each Year (<65 cohort). Private Pay is Reference Group.*

	2005	2008	2010
Overall	N=18,935	N=17,826	N=15,713
In-hospital mortality (OR, 95% CI)			
Medicare	1.73 (1.35-2.21)	1.37-3.19 (0.38-6.73)†	1.66 (1.25-2.20)
Medicaid	1.69 (1.30-2.19)	0.55-3.34 (0.19-5.17)†	1.90 (1.43-2.51)
Self-Pay	1.53 (1.18-1.98)	0.40-3.06 (0.10-5.81)†	1.44 (1.08-1.91)
PCI (OR, 95% CI)			
Medicare	0.79 (0.91-0.89)	0.77 (0.68-0.87)	0.70-2.02 (0.42-3.41)†
Medicaid	0.77 (0.67-0.88)	0.80 (0.70-0.92)	0.67-1.50 (0.46-2.41)†
Self-Pay	0.90 (0.78-1.04)	0.82 (0.73-0.93)	0.96-1.30 (0.62-1.98)†
CABG (OR, 95% CI)			
Medicare	0.78 (0.66-0.90)	096 (0.79-1.18)	0.92 (0.74-1.16)
Medicaid	0.99 (0.79-1.25)	1.16 (0.96-1.40)	0.98 (0.78-1.24)
Self-Pay	0.90 (0.75-1.09)	1.08 (0.91-1.28)	0.88 (0.73-1.06)
DM Cohort	N=4514	N=4504	N=4148
In-hospital mortality (OR, 95% CI)			
Medicare	1.71 (1.03-2.83)	2.21 (1.37-3.56)	2.22 (1.31-3.76)
Medicaid	1.13 (0.63-2.02)	1.46 (0.78-2.73)	1.72 (0.97-3.05)
Self-Pay	1.37 (0.75-2.51)	1.35 (0.77-2.36)	1.47 (0.88-2.45)
PCI (OR, 95% CI)			
Medicare	0.86 (0.72-1.03)	0.77 (0.62-0.95)	1.06 (0.84-1.33)
Medicaid	0.74 (0.59-0.94)	0.85 (0.68-1.05)	0.84 (0.66-1.08)
Self-Pay	0.82 (0.65-1.02)	0.79 (0.63-0.99)	1.05 (0.82-1.35)
CABG (OR, 95% CI)			
Medicare	0.77 (0.58-1.03)	0.63 (0.46-0.88)	0.58 (0.39-0.86)
Medicaid	0.91 (0.67-1.24)	0.94 (0.68-1.32)	0.80 (0.54-1.18)
Self-Pay	0.93 (0.68-1.28)	1.14 (0.88-1.48)	0.86 (0.63-1.18)
CHF Cohort	N=2386	N=1988	N=1768
In-hospital mortality (OR, 95% CI)			
Medicare	1.27 (0.81-2.00)	2.20 (1.43-3.38)	1.43 (0.83-2.46)
Medicaid	1.32 (0.83-2.09)	1.59 (0.90-2.83)	0.63 (0.35-1.14)
Self-Pay	0.77 (0.45-1.30)	1.56 (0.89-2.72)	1.09 (0.64-1.87)
PCI (OR, 95% CI)			
Medicare	0.69 (0.55-0.87)	0.64 (0.49-0.83)	0.67 (0.49-0.93)
Medicaid	0.65 (0.50-0.84)	0.85 (0.61-1.17)	0.80 (0.60-1.06)
Self-Pay	0.84 (0.65-1.07)	0.67 (0.51-0.88)	1.03 (0.75-1.42)
CABG (OR, 95% CI)			
Medicare	0.56 (0.39-0.80)	0.64 (0.45-0.91)	0.45 (0.29-0.72)
Medicaid	0.90 (0.64-1.26)	0.82 (0.57-1.17)	0.69 (0.44-1.07)
Self-Pay	0.85 (0.59-1.24)	0.82 (0.55-1.23)	0.66 (0.42-1.05)
HTN Cohort	N=9560	N=9515	N=8779
In-hospital mortality (OR, 95% CI)			
Medicare	1.64 (1.02-2.66)	2.98 (2.07-4.30)	1.42 (0.83-2.42)
Medicaid	1.64 (1.06-2.55)	1.65 (1.04-2.63)	1.82 (1.07-3.07)
Self-Pay	1.29 (0.73-2.30)	1.73 (1.17-2.56)	1.36 (0.83-2.23)

PCI (OR, 95% CI)			
Medicare	0.87 (0.75-1.00)	0.81 (0.70-0.95)	0.82 (0.68-0.99)
Medicaid	0.74 (0.62-0.88)	0.77 (0.64-0.93)	0.89 (0.73-1.08)
Self-Pay	0.82 (0.68-0.99)	0.80 (0.69-0.94)	1.01 (0.82-1.23)
CABG (OR, 95% CI)			
Medicare	0.79 (0.66-0.96)	0.70 (0.52-0.94)	0.64 (0.48-0.86)
Medicaid	0.95 (0.73-1.23)	1.11 (0.86-1.43)	0.81 (0.60-1.09)
Self-Pay	0.95 (0.75-1.21)	1.19 (0.97-1.46)	0.91 (0.70-1.18)

*Odds ratios adjusted for age, gender, race, length of stay (except in CABG analyses), median household income, Charlson comorbidity index, hospital region, hospital bedsize, hospital teaching status. Sample discharge weights were used to calculate national estimates.
†Interactions between payer type and race observed (refer to Table 4c for details)

Table 4b: Adjusted Odds Ratios and 95% Confidence Intervals (CI) for Dichotomous Outcome Variables within Each Year (≥65 cohort). Medicare is Reference Group.*

	2005	2008	2010
Overall	N= 19,871	N=15,791	N=12,930
In-hospital mortality (OR, 95% CI)			
Private	0.76-1.20 (0.51-1.64)†	0.94 (0.79-1.20)	0.97 (0.78-1.20)
Medicaid	1.08-3.09 (0.44-5.83)†	1.41 (0.95-2.09)	0.84 (0.49-1.45)
PCI (OR, 95% CI)			
Private	0.99 (0.84-1.17)	0.93 (0.81-1.06)	1.18 (1.04-1.33)
Medicaid	0.90 (0.68-1.20)	0.90 (0.64-1.26)	0.73 (0.51-1.04)
CABG			
Private	0.87 (0.72-1.06)	0.95 (0.79-1.16)	0.92 (0.74-1.13)
Medicaid	1.37 (0.97-1.95)	1.05 (0.61-1.81)	0.77 (0.46-1.29)
DM Cohort	N=4774	N=4044	N=3348
In-hospital mortality (OR, 95% CI)			
Private	1.00 (0.64-1.57)	1.11 (0.74-1.67)	0.86 (0.48-1.55)
Medicaid	1.84 (0.94-3.60)	2.42 (1.20-4.89)	1.36 (0.59-3.15)
PCI (OR, 95% CI)			
Private	0.93 (0.73-1.18)	0.87 (0.67-1.12)	1.13 (0.85-1.49)
Medicaid	1.27 (0.83-1.96)	0.70 (0.43-1.14)	0.63 (0.34-1.16)
CABG (OR, 95% CI)			
Private	1.19 (0.86-1.66)	1.10 (0.75-1.62)	0.90 (0.57-1.41)
Medicaid	0.99 (0.50-1.97)	1.73 (0.88-3.40)	1.11 (0.49-2.49)
CHF Cohort	N=6485	N=4247	N=3246
In-hospital mortality (OR, 95% CI)			
Private	1.04 (0.78-1.40)	0.81 (0.56-1.19)	0.91 (0.63-1.31)
Medicaid	1.37 (0.79-2.38)	1.48 (0.70-3.15)	0.95 (0.42-2.18)
PCI (OR, 95% CI)			
Private	1.09 (0.85-1.41)	1.14 (0.89-1.45)	1.09 (0.85-1.39)
Medicaid	1.19 (0.78-1.82)	0.90 (0.51-1.60)	0.60 (0.32-1.12)
CABG (OR, 95% CI)			
Private	1.03 (0.74-1.44)	0.64 (0.40-1.00)	1.24 (0.85-1.82)
Medicaid	1.07 (0.56-2.04)	0.87 (0.40-1.91)	0.56 (0.22-1.82)
HTN Cohort	N=11,629	N=9521	N=7930
In-hospital mortality (OR, 95% CI)			
Private	0.97 (0.73-1.29)	1.01 (0.74-1.39)	1.06 (0.75-1.49)
Medicaid	1.87 (0.99-3.52)	0.94 (0.51-1.74)	1.09 (0.56-2.14)
PCI (OR, 95% CI)			
Private	0.83 (0.69-1.01)	1.00 (0.85-1.19)	1.17 (1.00-1.77)
Medicaid	0.80 (0.57-1.12)	0.87 (0.59-1.30)	0.95 (0.63-1.42)
CABG (OR, 95% CI)			
Private	0.88 (0.70-1.12)	0.94 (0.74-1.19)	1.10 (0.86-1.40)
Medicaid	1.29 (0.84-1.98)	1.09 (0.54-2.19)	0.59 (0.28-1.28)

*Odds ratios adjusted for age, gender, race, length of stay (except in CABG analyses), median household income, Charlson comorbidity index, hospital region, hospital bedsize, hospital teaching status. Sample discharge weights were used to calculate national estimates.

†Interactions between payer type and median household income were observed (refer to Table 4d for details)

Table 4c: Interaction Results for Payer Type*Race or Payer Type*Median HH Income in Patients <65: Adjusted Odds Ratios and 95% Confidence Intervals*

	2008	Main Effect of Race (White=Reference)	2010	Main Effect of Race (White=Reference)
Overall	N=18,900		N=15,718	
In-Hospital				
Mortality				
(OR, 95% CI)			See Table 4a	See Table 4a
Medicare vs.				
Private when				
Race=	1.61 (0.77-3.35)			
Black	2.53 (0.95-6.73)	1.19 (0.86-1.64)		
Hispanic	2.34 (1.70-3.21)	1.31 (0.90-1.90)		
White	1.37 (0.38-5.07)			
Other	3.19 (1.91-5.34)	1.13 (0.78-1.62)		
Unknown		1.23 (0.99-1.53)		
Medicaid vs.				
Private when	0.92 (0.38-2.23)			
Race=	0.55 (0.19-1.62)			
Black	1.80 (1.19-2.72)			
Hispanic	2.23 (0.96-5.17)			
White	3.34 (2.23-5.02)			
Other				
Unknown				
Self-Pay vs.	1.83 (0.75-4.49)			
Private when	2.62 (1.18-5.81)			
Race=	1.78 (1.26-2.52)			
Black	0.40 (0.10-1.60)			
Hispanic	3.06 (1.89-4.96)			
White				
Other				
Unknown				
PCI (OR, 95%				
CI)	See Table 4a	See Table 4a		
Medicare vs.				
Private when				
Race=				
Black			0.93 (0.65-1.34)	
Hispanic			2.02 (1.19-3.41)	0.94 (0.66-1.35)
White			0.70 (0.58-0.83)	1.36 (0.99-1.87)
Other			0.73 (0.42-1.29)	
Unknown			0.86 (0.61-1.21)	1.19 (0.82-1.73)
Medicaid vs.				0.92 (0.64-1.32)
Private when				
Race=			0.85 (0.58-1.23)	
Black			1.50 (0.93-2.41)	
Hispanic			0.96 (0.77-1.19)	
White			0.81 (0.46-1.45)	
Other			0.67 (0.48-0.93)	
Unknown				
Self-Pay vs.				
Private when			0.96 (0.62-1.47)	
Race=			1.30 (0.86-1.98)	
Black			1.04 (0.88-1.24)	

Hispanic White Other Unknown			1.05 (0.63-1.74) 1.10 (0.83-1.47)	

*Odds ratios adjusted for age, gender, race, length of stay, median household income, Charlson comorbidity index, hospital region, hospital bedsize, hospital teaching status. Sample discharge weights were used to calculate national estimates.

Table 4d: Interaction Results for Payer Type*Race in Patients ≥65: Adjusted Odds Ratios and 95% Confidence Intervals, Medicare is Referent Group*

	2005	Main Effect of Median HH Income (Lowest Quartile=Ref)
Overall Cohort	N=19,864	
In-Hospital Mortality (OR, 95% CI)		
Medicaid vs. Medicare when Median Household Income=		
Lowest Quartile	1.08 (0.44-2.64)	
Second Lowest	1.09 (0.44-2.68)	0.95 (0.83-1.09)
Second Highest	2.36 (1.32-4.23)	0.98 (0.86-1.12)
Highest Quartile	3.09 (1.64-5.83)	1.07 (0.93-1.24)
Private vs. Medicare when Median Household Income=		
Lowest Quartile	1.04 (0.68-1.60)	
Second Lowest	1.20 (0.88-1.64)	
Second Highest	0.76 (0.51-1.14)	
Highest Quartile	0.84 (0.60-1.18)	

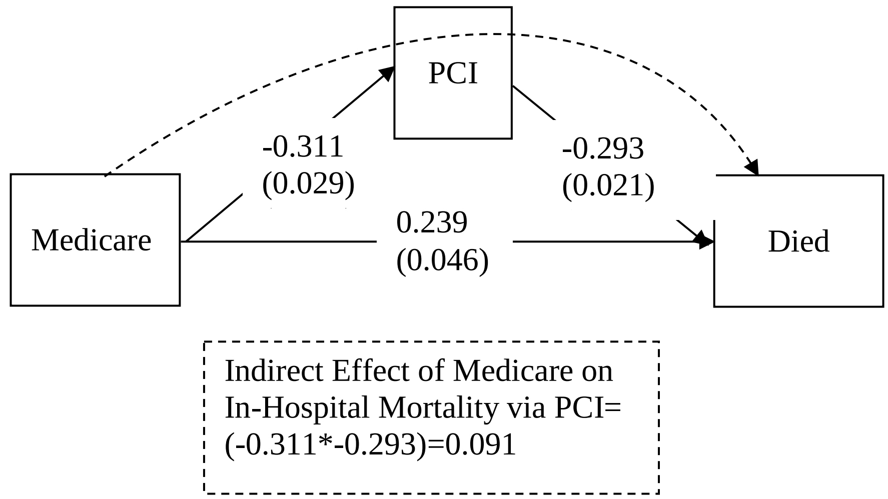
*Odds ratios adjusted for age, gender, race, length of stay, median household income, Charlson comorbidity index, hospital region, hospital bedsize, hospital teaching status. Sample discharge weights were used to calculate national estimates.

Table 5. Analyses of Mediating Effects of Procedure Type on In-Hospital Mortality*

	Direct Effect of Payer Type on In-Hospital Mortality				Indirect Effect of Payer Type on In-Hospital Mortality, Mediated by Procedure Type			
Cohort	Probability	Estimate	SE	95%CI, p-value	Probability	Estimate	SE	95%CI
<65 Overall Cohort								
Medicare (2005)								
• PCI	0.05	0.24	0.05	0.16-0.32, p<0.0001	0.01	0.09	0.01	0.08-0.12, p<0.0001
• CABG	0.06	0.33	0.05	0.25-0.41, p<0.0001	0.00	0.00	0.00	-0.00-0.00, p=0.917
Medicare (2010)								
• PCI	0.05	0.23	0.05	0.11-0.29, p<0.0001	0.01	0.10	0.01	0.07-0.12, p<0.0001
• CABG	0.06	0.33	0.05	0.21-0.39, p<0.0001	0.00	0.00	0.00	-0.00-0.01, p=0.77
Medicaid (2005)								
• PCI	0.04	0.16	0.05	0.08-0.26, p=0.001	0.01	0.08	0.01	0.06-0.09, p<0.0001
• CABG	0.05	0.24	0.05	0.16-0.34, p<0.0001	0.00	0.00	0.00	-0.00-0.01, p=0.567
Medicaid (2010)								
• PCI	0.04	0.16	0.06	0.08-0.24, p=0.004	0.01	0.06	0.01	0.04-0.09, p<0.0001
• CABG	0.05	0.22	0.05	0.14-0.30, p<0.0001	0.00	0.00	0.00	-0.00-0.01, p=0.617
Self-Pay (2005)								
• PCI	0.04	0.07	0.05	0.00-0.15, p=0.100	0.00	0.01	0.01	-0.01-0.01, p=0.525
• CABG	0.04	0.08	0.04	0.01-0.14, p=0.067	0.00	-0.00	0.00	-0.01-0.00, p=0.590
Self-Pay (2010)								
• PCI	0.04	0.12	0.05	0.06-0.20, p=0.013	0.00	-0.02	0.01	-0.04-0.00, p=0.212
• CABG	0.04	0.10	0.05	0.04-0.19, p=0.035	0.00	0.00	0.00	-0.00-0.01, p=0.804
<65 DM								
Medicare (2005)								
• PCI	0.06	0.31	0.08	0.19-0.45, p<0.0001	0.01	0.08	0.02	0.05-0.10, p<0.0001
• CABG	0.06	0.38	0.08	0.27-0.55, p<0.0001	0.00	0.00	0.00	-0.00-0.01, p=0.797
Medicare (2008)								
• PCI	0.06	0.34	0.10	0.12-0.45, p<0.0001	0.01	0.08	0.02	0.05-0.12, p<0.0001
• CABG	0.07	0.42	0.09	0.20-0.53, p<0.0001	0.00	-0.00	0.01	-0.02-0.01, p=0.809
Medicare (2010)								
• PCI	0.05	0.32	0.09	0.20-0.48, p=0.001	0.01	0.05	0.02	0.02-0.09, p=0.037
• CABG	0.05	0.37	0.10	0.22-0.53, p<0.0001	0.00	0.01	0.02	0.02-0.04, p=0.754
<65 CHF								
Medicare (2008)								
• PCI	0.11	0.28	0.09	0.13-0.40, p=0.001	0.01	0.04	0.02	0.01-0.08, p=0.044
• CABG	0.12	0.31	0.09	0.14-0.42, p<0.0001	0.00	0.02	0.02	-0.00-0.05, p=0.301
<65 HTN								
Medicare (2005)								
• PCI	0.03	0.21	0.08	0.08-0.31, p=0.005	0.01	0.07	0.01	0.05-0.09, p<0.0001
• CABG	0.04	0.28	0.07	0.62-0.38, p<0.0001	0.00	0.00	0.00	-0.00-0.00, p=0.980
Medicaid (2005)								
• PCI	0.03	0.14	0.08	-0.03-0.23, p=0.086	0.01	0.08	0.02	0.06-0.12, p<0.0001
• CABG	0.03	0.22	0.08	0.07-0.32, p=0.004	0.00	0.00	0.00	-0.00-0.01, p=0.924
Medicaid (2010)								
• PCI	0.02	0.09	0.08	-0.04-0.22, p=0.268	0.003	0.05	0.02	0.03-0.08, p=0.001
• CABG	0.02	0.13	0.09	0.001-0.27, p=0.114	0.00	0.01	0.01	-0.00-0.03, p=0.430
≥65 DM								
Medicaid (2008)								
• PCI	0.12	0.12	0.20	-0.21-0.43, p=0.548	0.00	0.01	0.05	-0.07-0.08, p=0.868
• CABG	0.13	0.20	0.21	-0.07-0.64, p=0.341	0.00	-0.07	0.06	-0.23- -0.02, p=0.189

*Payer comparisons were dichotomous in these analyses (i.e. Medicare vs. not Medicare, Medicaid vs. not Medicaid)

Figure 1. Example Diagram of Mediating Effect of Procedure Type on In-Hospital Mortality



CHAPTER 2: EXAMINATION OF CARDIOVASCULAR OUTCOMES AMONG WEEKDAY VERSUS WEEKEND ADMISSIONS IN PATIENTS ADMITTED FOR ST-SEGMENT ELEVATION ACUTE MYOCARDIAL INFARCTION WITHIN UNITED STATES COMMUNITY HOSPITALS

Study Objective:

The objective of this study was to determine whether or not STEMI outcomes differ among patients admitted to U.S. community hospitals on weekdays vs. weekends, and whether or not such differences changed over the years 2005, 2008, and 2010.

Methods:

Data Source

We conducted a retrospective cohort study using the same data sources as described in Chapter 1, which included the years 2005, 2008, and 2010 from the Nationwide Inpatient Sample (NIS), Healthcare Cost and Utilization Project (HCUP), Agency for Healthcare Research and Quality. (27)

Study Population:

Patients were included if they had a primary diagnosis of STEMI, identified using ICD-9-CM code 410.xx (excluding 410.7), and were age 40 or older. This age cutoff was implemented in order to exclude most non-atherosclerotic causes of

STEMIs, consistent with previous literature (28). Patients were excluded if they had a primary diagnosis of NSTEMI (ICD-9-CM code 410.7x), and were age <40.

Study Variables:

Similar to Chapter 1, the primary outcome of interest was in-hospital mortality. The types of procedures used for STEMI (i.e. PCI, CABG), as well as length of stay and total cost of hospitalization were also examined. Total cost of hospitalization for the years 2005 and 2008 were inflated to 2010 dollars using the United States Bureau of Labor Statistics Consumer Price Index. (29)

The primary independent variable was admission on weekends vs. weekdays. As noted in Chapter 1, patient–level covariates included age, gender, race, Charlson Comorbidity Index, median household income of patient's zip code, and length of stay. Analyses were stratified by the following comorbidities: diabetes (DM), hypertension (HTN), and congestive heart failure (CHF), since these comorbid conditions have been shown to be independent predictors of cardiovascular mortality in patients with STEMI. (30; 31; 32; 33) Hospital-level covariates included hospital region, bed size, and teaching status.

Statistical Analysis:

Statistical analyses were conducted in a similar fashion as was previously described in Chapter 1. Univariate analyses were conducted on patient and hospital demographic data, and bivariate analyses were conducted to describe the unadjusted associations between admission day and outcomes of interest. Potential differences over the years 2005, 2008, and 2010 were analyzed using SAS PROC SURVEYREG for continuous variables, and the Cochran-Armitage Trend test for categorical variables. Sample discharge weights were used in all analyses to enable the calculation of national estimates. Hospital charges were converted to costs using the group average all-payer inpatient cost/charge ratio (GAPICC) provided with each year of HCUP-NIS data. P-values of <0.05 were considered statistically significant.

Logistic regression analyses were used to determine the odds of: 1) in-hospital mortality, 2) receiving PCI, or 3) receiving CABG, among patients admitted to the sampled community hospitals in the U.S. on a weekday vs. a weekend in 2005, 2008 and 2010. Possible interactions between odds of in-hospital mortality and admission day, by race and median household income, were also assessed.

As noted in Chapter 1, because patients within the same hospital were more likely to be treated similarly vs. patients treated in different hospitals, analyses were adjusted for clustering effects within hospitals using SAS PROC SURVEYLOGISTIC. Variables with a p-value of <0.05 were considered statistically significant, and therefore retained in the final models. This p-value was selected because it is the conventional threshold for statistical significance widely published in the scientific literature. Final models were constructed in the same manner as described in Chapter 1.

Statistical analyses were conducted using SAS v9.2 (SAS Institute, Cary, NC). The study was approved by the Institutional Review Board of The University of

Medicine and Dentistry of New Jersey. Because the study only evaluated de-identified data acquired during routine care, patient informed consent was not required.

Results:

Patient Characteristics:

The mean age of patients across all years ranged from approximately 64-65, and decreased over time. Weekday admissions decreased over time as well. The prevalence of both DM and HTN increased, while the prevalence of CHF decreased over time. The percentage of White and Black patients increased over time, though that may partially be explained by the decreased number of patients whose race was unknown over time. Minor fluctuations were noted among the four categories of median household income over time, with statistical significance likely driven by the large sample sizes. Regional variation was also minimal over time, while growth was observed among the number of teaching hospitals included, as well as the number of hospitals with small bed sizes over time (Table 1).

In-hospital Mortality:

Across all cohorts studied, in-hospital mortality rates decreased over time for both weekday and weekend admissions. In the overall cohort the decline was approximately 17% from 2005 to 2010, with greater decline noted for weekend admissions (20% decrease) vs. weekdays (16% decrease). In the DM, HTN, and CHF cohorts, the decline was approximately 28% from 2005 to 2010, also with greater decline noted for weekend admissions (31-37% decrease) vs. weekday admissions (24-28% decrease) (Table 2). In the unadjusted analyses, no statistically significant differences were observed in odds of in-hospital mortality in the overall cohort over the years 2005, 2008, and 2010, though the odds were numerically lower for weekday vs. weekend admissions in 2005 and 2008. Among patients with DM, CHF or HTN, there was a significant decrease in the odds of in-hospital mortality among those admitted on a weekday vs. a weekend in 2005, but not in later years (Table 3).

In the overall cohort, after adjusting for the confounders mentioned previously, in the years 2005 and 2008 the odds of in-hospital mortality for weekday vs. weekend admissions depended on race. In 2005, odds of in-hospital mortality were significantly lower for weekday admissions vs. weekend admissions for White patients, numerically lowest for weekday admissions vs. weekend admissions for patients in the "Other" race category, and numerically highest for Black patients, though these results were not statistically significant. In 2008, odds of in-hospital mortality were significantly lower for weekday admissions vs. weekend admissions for White and Hispanic patients, and significantly higher for patients in the "Other" race category. No significant differences in odds of in-hospital mortality were noted in the overall cohort in 2010 (Tables 4a, 4b).

Among patients with DM, odds of in-hospital mortality were significantly lower for weekday vs. weekend admissions across all years studied (ORs, (95% CIs): 0.76, (0.63-0.91) 0.77, (0.64-0.93) 0.77, (0.62-0.97), respectively). No significant differences were observed in odds of in-hospital mortality for patients with CHF across all years studied. In patients with HTN, weekday admission was only associated with lower odds of in-hospital mortality in 2005, but not in later years (Table 4a, Figure 1).

PCI and CABG Use:

In the overall cohort, unadjusted analyses demonstrated lower odds of receiving PCI among weekday admissions in 2008 and 2010, but no significant difference was observed in 2005. No significant differences were observed in PCI use among patients with DM or CHF across all years studied, while HTN patients had significantly lower odds of PCI use on weekdays vs. weekends in 2008 only (Table 3). After adjusting for potential confounders, odds of PCI use was significantly lower for weekday admissions among the overall and HTN cohorts in 2008, but not in other years. An interaction in the CHF cohort was observed in 2008 between admission day and median household income level. In 2008, weekday admissions had significantly lower odds of PCI use vs. weekend admissions among those in the second highest median household income category. This interaction was not observed in other years, or among other cohorts (Tables 4a, 4b).

In contrast to PCI use, both unadjusted and adjusted analyses demonstrated significant increases in the odds of receiving CABG for weekday vs. weekend admissions in both the overall population, as well as the HTN cohort (Tables 3 and 4a). In the unadjusted analyses, odds of receiving CABG were significantly higher for weekday admissions among the DM cohort in 2005 and 2008, as well as the CHF cohort in 2005, but not in later years (Table 3). After adjustment for confounders, odds of receiving CABG were significantly higher among weekday admissions within the DM and CHF cohorts in 2005, and the HTN cohort across all years (Table 4a). In 2005, interactions were observed in the overall cohort and HTN cohort between admission day and median household income level. In both cohorts, patients in the second lowest and second highest median household income categories had significantly greater odds of receiving CABG when admitted on a weekday vs. a weekend (Table 4b).

Length of Stay and Total Cost of Hospitalization:

In the overall cohort, mean length of stay decreased from 5.00 days in 2005 to 4.52 days in 2010 ($p<0.0001$). Similar trends were observed among the DM, CHF, and HTN cohorts as well, though lengths of stay varied by cohort, with CHF patients having the longest mean length of stay (Table 2). In the overall cohort, weekday admissions were significantly longer than weekend admissions in 2005 ($p<0.05$), but no significant differences were observed between weekday and weekend admissions in later years (Figure 2, Table 2). In the DM and HTN cohorts, weekday admissions were significantly longer than weekend admissions in 2010, but not in earlier years ($p=0.028$, $p=0.0045$, respectively). No significant differences in length of stay were observed in the CHF cohort across all years studied.

As would be expected, significant variation was observed in length of stay among CABG patients vs. non-CABG patients, regardless of admission day. CABG patients had a mean length of stay ranging from 11.52 days in 2005 (SE 0.18 to

11.13 days in 2010 (SE 0.24). In contrast, non-CABG patients had a mean length of stay ranging from 4.32 days in 2005 (SE 0.04) to 4.05 days in 2010 (SE 0.05).

Regarding total cost of hospitalization, after adjusting for inflation using the CPI, total cost of hospitalization was generally not significantly different across cohorts over time. One exception was among weekend admissions in the overall cohort, where some significant fluctuation over time was noted (Table 2). In the overall, DM, and HTN cohorts, total costs did not significantly differ by weekend vs. weekday admission (Table 2, Figure 3). Among patients with CHF, total costs were significantly higher for weekend vs. weekday admissions in 2005 ($p=0.0204$) and 2008 ($p=0.0481$), but not in 2010.

Additional Supportive Analyses:

As a sensitivity analysis, we attempted to replicate our results using only hospitals which were included across all years studied; however, in our datasets, only approximately 4% of hospitals were the same across 2005, 2008, and 2010, therefore significant loss of power made such analyses difficult to interpret. Given that there is an ICD-9 code for old myocardial infarction (ICD-9-CM code 412), we also ran additional models including the presence of old myocardial infarction as a covariate. The prevalence of this condition was observed in approximately 30% of patients in each year studied. While this covariate was determined to be a significant positive predictor of in-hospital mortality ($p<0.01$ across all years studied), it's inclusion in the regression models did not meaningfully change the results reported here.

A similar approach was taken to determine if PCI use was a predictor of in-hospital mortality in the overall cohort. Additional models were run using PCI as a covariate across 2005, 2008, and 2010. Results indicated that PCI use was a significant negative predictor of in-hospital mortality, ($p<0.0001$ across all years studied), however, it's inclusion in the regression models did not meaningfully change the results reported here.

We also conducted additional analyses evaluating odds of in-hospital mortality among patients without DM, CHF, or HTN across the years 2005, 2008, and 2010. In patients without DM in 2005, patients in the "White" and "Other" race categories had significantly lower odds of in-hospital mortality when admitted on a weekday vs. a weekend. In contrast, in 2008, patients in the "Other" race category had significantly higher odds of in-hospital mortality when admitted on a weekday vs. weekend. No other significant differences were observed among the other race categories. In patients without CHF in 2008, those in the "Other" race category had significantly higher odds of in-hospital mortality when admitted on a weekday vs. a weekend, while patients in the "Unknown" race category had significantly lower odds of in-hospital mortality when admitted on a weekday vs. a weekend. Similar results were observed among patients without HTN in 2008 (Tables 5a, 5b).

Discussion:

The results of our study indicate that the mean age of STEMI admissions is decreasing, while the prevalence of comorbid DM and HTN are increasing over the years 2005, 2008, and 2010. After adjusting for covariates among the overall population, odds of in-hospital mortality for weekday vs. weekend admissions depended on patient's race during the years 2005 and 2008, with Hispanic patients tending to have a more favorable outcome when admitted on a weekday vs. a weekend; however no difference was observed in 2010. Among patients with comorbid DM, weekday admissions had significantly lower mortality vs. weekend admissions across all years studied. The interaction between admission day and median household income on likelihood of CABG in 2005 found that patients in lower income levels were more likely to receive CABG when admitted on a weekday vs. a weekend; however, such interactions were not observed in later years.

These findings are somewhat consistent with a study conducted by Kostis, et al, in their examination of weekday vs. weekend admissions in the state of New Jersey over the years 1987-2002. (23) In that study, investigators concluded that weekend admissions were associated with significantly higher mortality, as well as lower use of invasive cardiac procedures. While our study had similar mortality findings in 2005 and 2008 (though our findings depended on race category), by the year 2010 no significant differences were observed in the overall study population. Regarding invasive procedures, our study found higher use of CABG among weekday admissions across all years, consistent with Kostis, et al.; however, higher use of PCI among weekend admissions was observed in 2008.

Our 2008 results are also consistent with findings from Magid, et al., who evaluated the relationship between day of the week, timeliness of reperfusion, and in-hospital mortality among patients with STEMI from 1999-2002. (22) These investigators also concluded that most PCI patients were treated during “off” hours, and that patients admitted during “off” hours experienced significantly higher mortality rates vs. patients admitted during “regular” hours (p=0.02).

The findings from our 2010 analyses are consistent with previous research conducted by Gonzalez, et al (19), who found comparable outcomes between patients admitted on weekends vs. weekdays among patients admitted to a single U.S. hospital. Of note, the Gonzalez study was conducted using more recent data than was used by Kostis and by Magid, (December 2006-April 2009), which may partially explain our similar findings over this later timeframe.

The limitations of this study are consistent with those addressed in Chapter 1, particularly regarding data being limited to hospital UB-92 billing forms, as well as the lack of drug, alcohol, and tobacco use being available in these datasets.

Conclusions:

Despite the limitations noted, the results of this study suggest that in recent years, no differences have been observed in the odds of in-hospital mortality for weekend vs. weekday STEMI admissions among most of the cohorts studied; however, those with comorbid DM are still at higher risk of in-hospital mortality when admitted on a weekend vs. a weekday.

These findings may partly be viewed as a result of improvement in patient quality of care initiatives over the timeframe studied, or partially explained by the increased use of PCI over time. While differences in procedure type for weekday vs.

weekend admissions continued to be observed over the course of this study, in our most recent year of analysis, such differences did not appear to impact overall inpatient mortality. Future research addressing quality of care initiatives, particularly among STEMI patients with comorbid DM is warranted.

Table 1: Nationwide Estimates of Patient Demographics and Hospital Characteristics*

	2005 N=211,258	2008 N=183,947	2010 N=161,660	p-value
Admit Day (n,%)				
Weekday	156,117 (73.90)	132,213 (71.88)	115,250 (71.29)	<0.0001
Weekend	55,141 (26.10)	51,734 (28.12)	46,410 (28.71)	<0.0001
Mean Age (SE)	65.44 (0.07)	64.38 (0.07)	63.87 (0.07)	<0.0001
Comorbidities (n,%)				
DM	50,348 (23.83)	46,451 (25.25)	42,269 (26.15)	<0.0001
HTN	114,532 (54.21)	103,793 (56.43)	93,685 (57.95)	<0.0001
CHF	47,374 (22.42)	33,529 (18.23)	27,729 (17.15)	<0.0001
Gender (n,%Female)	75,332 (35.67)	61,631 (33.51)	51,537 (31.88)	<0.0001
Race (n,%)**				
White	122,867 (81.95)	116,542 (79.71)	108,808 (78.28)	<0.0001
Black	8,344 (5.57)	10,067 (6.89)	11,129 (8.01)	<0.0001
Hispanic	10,997 (7.33)	8998 (6.15)	10,124 (7.28)	<0.0001
Other	7722 (5.15)	10,604 (7.25)	8928 (6.42)	<0.0001
Median HH income (n,%)				
Lowest Quartile	54,211 (25.66)	48,105 (26.15)	42,823 (26.49)	<0.0001
Second Lowest	55,370 (26.20)	52,710 (28.65)	41,596 (25.73)	0.3798
Second Highest	51,768 (24.50)	42,262 (22.98)	38,725 (23.95)	<0.0001
Highest Quartile	44,496 (21.06)	36,827 (20.02)	34,162 (21.13)	0.2119
Hospital Region (n,%)				
Northeast	39,913 (18.89)	31,436 (17.09)	30,598 (18.93)	0.0042
Midwest	49,953 (23.65)	44,731 (24.32)	40,918 (25.31)	<0.0001
South	82,425 (39.02)	75,314 (40.94)	57,233 (35.40)	<0.0001
West	38,967 (18.45)	32,465 (17.65)	32,912 (20.36)	<0.0001
Hospital Bed Size (n,%)				
Small	13,273 (6.28)	15,588 (8.47)	13,668 (8.46)	<0.0001
Medium	49,344 (23.36)	39,972 (21.73)	30,688 (18.98)	<0.0001
Large	148,641 (70.36)	128,362 (69.78)	114,835 (71.03)	0.0018
Hospital Teaching Status (n,%)				
Teaching	89,693 (42.46)	85,829 (46.67)	78,936 (49.25)	<0.0001
Non-Teaching	121,565 (57.54)	98,093 (53.33)	80,795 (50.75)	<0.0001

*P-values represent differences over the years 2005, 2008, 2010 for each variable, and were determined using proc SURVEYREG for continuous outcome variables and Cochran-Armitage Trend test for categorical variables. Two-sided p-values used, where applicable. Sample discharge weights were used to determine nationally representative estimates. Numbers may not add to 100% of total sample due to missing data.

**Percentages calculated excluding "Unknown Race each year (Number of "Unknown in 2005: 61,328 , 2008: 37,736, 2010: 22,671)

Table 2: Unadjusted Nationwide Estimates for Outcome Variables*

	2005	2008	2010	p-Value
Overall	N=211,198	N=189,929	N=161,595	
In-hospital mortality (n,%)				
Overall	16,834 (7.97)	13,424 (7.30)	10,677 (6.61)	<0.0001
Weekday	12,245 (7.85)	9503 (7.19)	7616 (6.61)	<0.0001
Weekend	4589 (8.32)	3921 (7.58)	3061 (6.60)	<0.0001
PCI (n,%)				
Overall	121,668 (57.79)	129,485 (70.39)	123,123 (76.16)	<0.0001
Weekday	89,536 (57.35)	92,098 (69.66)	87,408 (75.84)	<0.0001
Weekend	32,133 (58.27)	37,388 (72.27)	35,715 (76.96)	<0.0001
CABG (n,%)				
Overall	20,043 (9.49)	14,925 (8.11)	10,817 (6.69)	<0.0001
Weekday	15447 (9.89)	11,067 (8.37)	8015 (6.95)	<0.0001
Weekend	4596 (8.34)	3858 (7.46)	2802 (6.04)	<0.0001
Mean Length of stay (SE)				
Overall	5.00 (0.07)	4.78 (0.06)	4.52 (0.06)	<0.0001
Weekday	5.04 (0.07)	4.78 (0.07)	4.53 (0.06)	<0.0001
Weekend	4.90 (0.07)	4.79 (0.08)	4.50 (0.07)	<0.0001
Mean Total Cost of Hospitalization (SE)				
Overall	23,466 (584)	25,378 (546)	24,713 (521)	0.0649
Weekday	23,511 (605)	25,285 (555)	24,734 (536)	0.0954
Weekend	23,340 (565)	25,612 (573)	24,662 (531)	0.0402
DM Cohort	n=50,323	n=46,447	n=42,244	
In-hospital mortality (n,%)				
Overall	3690 (7.33)	2817 (6.07)	2199 (5.21)	<0.0001
Weekday	2610 (6.93)	1986 (5.88)	11499 (4.94)	<0.0001
Weekend	1080 (8.52)	831 (6.56)	700 (5.89)	<0.0001
PCI (n,%)				
Overall	26,422 (52.46)	31,581 (67.99)	31,372 (74.22)	<0.0001
Weekday	19,776 (52.51)	22,825 (67.57)	22,509 (74.06)	<0.0001
Weekend	6635 (52.31)	8756 (69.09)	8863 (74.62)	<0.0001
CABG (n,%)				
Overall	5104 (10.14)	4186 (9.01)	3329 (7.88)	<0.0001
Weekday	3984 (10.58)	3131 (9.27)	2453 (8.07)	<0.0001
Weekend	1120 (8.83)	1055 (8.33)	876 (7.38)	<0.0001
Mean Length of stay (SE)				
Overall	4.90 (0.08)	4.36 (0.07)	4.17 (0.05)	<0.0001
Weekday	4.91 (0.09)	4.36 (0.07)	4.23 (0.06)	<0.0001
Weekend	4.87 (0.10)	4.36 (0.10)	4.03 (0.07)	<0.0001
Mean Total Cost of Hospitalization (SE)				
Overall	22,556 (638)	24,052 (574)	24,159 (568)	0.1313
Weekday	22,517 (675)	23,901 (578)	24,214 (580)	0.1203
Weekend	22,673 (656)	24,449 (684)	24,018 (627)	0.3002
CHF Cohort	n=47,355	n=33,511	n=27,713	
In-hospital mortality (n,%)				

Overall Weekday Weekend	7624 (16.10) 5620 (15.80) 2004 (17.00)	4377 (13.06) 3180 (13.02) 1197 (13.16)	3211 (11.59) 2299 (11.80) 912 (11.10)	<0.0001 <0.0001 <0.0001
PCI (n,%) Overall Weekday Weekend	 17,261 (36.44) 12,947 (36.39) 4314 (36.58)	 16,561 (49.39) 12,004 (49.16) 4557 (50.02)	 16,073 (57.96) 11,233 (57.58) 4839 (58.87)	 <0.0001 <0.0001 <0.0001
CABG (n,%) Overall Weekday Weekend	 5466 (11.54) 4264 (11.98) 1202 (10.19)	 3447 (10.28) 2539 (10.40) 908 (9.96)	 2521(9.09) 1780 (9.13) 741 (9.01)	 <0.0001 <0.0001 0.0108
Mean Length of stay (SE) Overall Weekday Weekend	 7.92 (0.12) 7.98 (0.13) 7.75 (0.17)	 7.02 (0.12) 6.95 (0.13) 7.19 (0.19)	 7.16 (0.14) 7.20 (0.15) 7.05 (0.21)	 <0.0001 <0.0001 0.0065
Mean Total Cost of Hospitalization (SE) Overall Weekday Weekend	 28,454 (846) 28,345 (898) 28,785 (923)	 29,928 (838) 29,549 (846) 30,921 (1049)	 30,139 (781) 30,248 (831) 29,885 (908)	 0.1431 0.0658 0.6539
HTN Cohort	n=114,496	n=103,793	n=93,645	
In-hospital mortality (n,%) Overall Weekday Weekend	 7360 (6.43) 5225 (6.15) 2135 (7.22)	 5428 (5.23) 3837 (5.13) 1592 (5.49)	 4327 (4.62) 3121 (4.66) 1206 (4.52)	 <0.0001 <0.0001 <0.0001
PCI (n,%) Overall Weekday Weekend	 64,412 (56.24) 47,686 (56.13) 16,726 (56.56)	 73,112 (70.44) 52,092 (69.66) 21,020 (72.45)	 71,688 (76.52) 51,052 (76.18) 20,636 (77.38)	 <0.0001 <0.0001 <0.0001
CABG (n,%) Overall Weekday Weekend	 10,752 (9.39) 8393 (9.88) 2359 (7.98)	 7631 (7.35) 5709 (7.63) 1923 (6.63)	 5993 (6.40) 4514 (6.74) 1479 (5.55)	 <0.0001 <0.0001 <0.0001
Mean Length of stay (SE) Overall Weekday Weekend	 4.60 (0.07) 4.60 (0.07) 4.58 (0.08)	 4.14 (0.05) 4.13 (0.06) 4.19 (0.07)	 3.92 (0.04) 3.97 (0.05) 3.79 (0.05)	 <0.0001 <0.0001 <0.0001
Mean Total Cost of Hospitalization (SD) Overall Weekday Weekend	 22,020 (580) 21,979 (596) 22,138 (591)	 23,196 (553) 22,887 (500) 23,196 (553)	 22,902 (492) 22,937 (510) 22,813 (502)	 0.4008 0.3367 0.5799

*P-values determined using PROC SURVEYREG for continuous variables, and Cochran-Armitage Trend test for categorical variables. Two-sided p-values used, where applicable. Total costs were inflated using CPI (1.12 for 2005-2010; 1.01 for 2008-2010). Sample discharge weights were used to determine nationally representative estimates. Numbers may not add to 100% of total sample due to missing data.

Table 3: Unadjusted Odds Ratios and 95% Confidence Intervals (CI) for Dichotomous Outcome Variables within Each Year. Weekend is Reference Group.*

	2005	2008	2010
Overall Cohort	N=42,153	N=36,619	N=30,979
In-hospital mortality (OR, 95% CI) Weekday vs. Weekend	0.95 (0.87-1.03)	0.94 (0.87-1.03)	1.01 (0.92-1.11)
PCI (OR, 95% CI) Weekday vs. Weekend	0.97 (0.92-1.01)	0.88 (0.83-0.92)	0.94 (0.88-0.99)
CABG (OR, 95% CI) Weekday vs. Weekend	1.21 (1.12-1.30)	1.15 (1.04-1.26)	1.16 (1.05-1.29)
DM Cohort	n=10,321	n=9245	n=8086
In-hospital mortality (OR, 95% CI) Weekday vs. Weekend	0.80 (0.68-0.94)	0.87 (0.73-1.04)	0.82 (0.67-1.00)
PCI (OR, 95% CI) Weekday vs. Weekend	1.01 (0.92-1.11)	0.92 (0.83-1.02)	0.97 (0.87-1.08)
CABG (OR, 95% CI) Weekday vs. Weekend	1.25 (1.08-1.44)	1.18 (1.00-1.40)	1.11 (0.93-1.31)
CHF Cohort	n=9429	n=6688	n=5322
In-hospital mortality (OR, 95% CI) Weekday vs. Weekend	0.93 (0.82-1.06)	0.99 (0.84-1.16)	1.08 (0.92-1.28)
PCI (OR, 95% CI) Weekday vs. Weekend	1.01 (0.91-1.11)	0.97 (0.87-1.07)	0.96 (0.85-1.08)
CABG (OR, 95% CI) Weekday vs. Weekend	1.18 (1.02-1.37)	1.06 (0.88-1.29)	1.02 (0.83-1.26)
HTN Cohort	n=22,865	n=20,677	n=17,963
In-hospital mortality (OR, 95% CI) Weekday vs. Weekend	0.86 (0.76-0.97)	0.94 (0.83-1.08)	1.01 (0.87-1.18)
PCI (OR, 95% CI) Weekday vs. Weekend	0.99 (0.92-1.05)	0.86 (0.81-0.93)	0.94 (0.87-1.01)
CABG (OR, 95% CI) Weekday vs. Weekend	1.27 (1.14-1.41)	1.19 (1.04-1.35)	1.22 (1.08-1.39)

*Sample discharge weights were used to determine nationally representative estimates.

Table 4a: Adjusted Odds Ratios and 95% Confidence Intervals (CI) for Dichotomous Outcome Variables within Each Year. Weekend is Reference Group.*

	2005	2008	2010
Overall Cohort	N=40,429	N=35,422	N=30,030
In-hospital mortality (OR, 95% CI) Weekday vs. Weekend	0.63-1.22 (0.38-2.01)†	0.62-1.92 (0.43-2.87)†	0.99 (0.88-1.12)
PCI (OR, 95% CI) Weekday vs. Weekend	1.01 (0.96-1.06)	0.89 (0.84-0.95)	0.97 (0.91-1.04)
CABG (OR, 95% CI) Weekday vs. Weekend	1.03-1.94 (0.86-1.78)†	1.15 (1.04-1.27)	1.16 (1.05-1.28)
DM Cohort	n=9672	n=8980	n=7865
In-hospital mortality (OR, 95% CI) Weekday vs. Weekend	0.76 (0.63-0.91)	0.77 (0.64-0.93)	0.77 (0.62-0.97)
PCI (OR, 95% CI) Weekday vs. Weekend	1.04 (0.94-1.15)	0.91 (0.82-1.01)	1.01 (0.90-1.15)
CABG (OR, 95% CI) Weekday vs. Weekend	1.26 (1.08-1.46)	1.18 (0.99-1.39)	1.11 (0.94-1.31)
CHF Cohort	n=9135	n=6496	n=5200
In-hospital mortality (OR, 95% CI) Weekday vs. Weekend	0.89 (0.77-1.02)	1.01 (0.86-1.20)	1.11 (0.92-1.34)
PCI (OR, 95% CI) Weekday vs. Weekend	1.04 (0.93-1.15)	0.72-1.11 (0.57-1.35)†	0.97 (0.91-1.03)
CABG (OR, 95% CI) Weekday vs. Weekend	1.23 (1.05-1.44)	1.05 (0.86-1.28)	1.15 (1.04-1.28)
HTN Cohort	n=22,012	n=20,056	n=17,466
In-hospital mortality (OR, 95% CI) Weekday vs. Weekend	0.82 (0.71-0.94)	0.88 (0.76-1.03)	0.96 (0.81-1.15)
PCI (OR, 95% CI) Weekday vs. Weekend	1.02 (0.95-1.09)	0.87 (0.81-0.94)	0.97 (0.89-1.05)
CABG (OR, 95% CI) Weekday vs. Weekend	See Table 4b	1.18 (1.03-1.34)	1.21 (1.07-1.38)

*Odds ratios adjusted for age, gender, race, length of stay (except for CABG analyses), median household income, Charlson comorbidity index, hospital region, hospital bedsize, hospital teaching status. Sample discharge weights were used to determine nationally representative estimates.

†Interactions were observed between admission day and race, and admission day and median household income (refer to Table 4b for details)

Table 4b: Interaction Results: Adjusted Odds Ratios and 95% Confidence Intervals (CI) for Interaction of Admission Day by Race or Median HH Income on In-Hospital Mortality*

	2005	Main Effect of Race (White=Ref) and Median HH Income (Lowest Quartile=Ref)	2008	Main Effect of Race (White=Ref) and Median HH Income (Lowest Quartile=Ref)
Overall Cohort	N=39,788		N=35,388	
In-hospital mortality (OR, 95% CI) Weekday vs. Weekend				
• Race=Black	1.22 (0.75-2.01)	1.26 (1.00-1.60)	1.00 (0.70-1.44)	1.17 (0.96-1.43)
• Race=Hispanic	0.77 (0.56-1.05)	1.46 (1.23-1.74)	0.62 (0.43-0.91)	1.27 (1.03-1.57)
• Race=White	0.83 (0.75-0.93)		0.88 (0.78-0.99)	
• Race=Other	0.63 (0.38-1.04)	1.27 (0.98-1.64)	1.92 (1.28-2.87)	1.22 (0.98-1.52)
• Race=Unknown	1.10 (0.91-1.33)	0.94 (0.84-1.05)	0.83 (0.69-1.01)	1.25 (1.08-1.46)
CABG (OR, 95% CI) Weekday vs. Weekend when Median HH Income=			See Table 4a	
• Lowest Quartile	1.06 (0.93-1.22)			
• Second Lowest	1.52 (1.29-1.78)	1.06 (0.90-1.23)		
• Second Highest	1.94 (1.03-1.38)	1.11 (0.94-1.30)		
• Highest Quartile	1.03 (0.86-1.23)	0.97 (0.82-1.16)		
CHF Cohort	n=9135		n=6496	
PCI (OR, 95% CI) Weekday vs. Weekend when Median HH Income=	See Table 4a			
• Lowest Quartile			1.11 (0.92-1.35)	
• Second Lowest			1.07 (0.86-1.34)	1.00 (0.86-1.16)
• Second Highest			0.72 (0.57-0.92)	1.17 (0.97-1.41)
• Highest Quartile			1.07 (0.85-1.35)	1.33 (1.08-1.64)
HTN Cohort	n=22,012		n=20,056	
CABG (OR, 95% CI) Weekday vs. Weekend when Median HH Income=			See Table 4a	
• Lowest Quartile	1.07 (0.90-1.28)			
• Second Lowest	1.67 (1.35-2.06)	0.99 (0.81-1.20)		
• Second Highest	1.38 (1.11-1.70)	0.93 (0.74-1.17)		
• Highest Quartile	1.02 (0.79-1.32)	0.82 (0.64-1.04)		

*Odds ratios adjusted for age, gender, race, length of stay (except CABG analyses), median household income, Charlson comorbidity index, hospital region, hospital bedsize, hospital teaching status. Sample discharge weights were used to determine nationally representative estimates.

Table 5a. Odds of In-Hospital Mortality Among Patients Without DM, CHF, or HTN within Each Year*

	2005	2008	2010
Without DM	n=30,757	n=26,442	n=22,165
In-hospital mortality (OR, 95% CI) Weekday vs. Weekend	0.59-1.26 (0.36-2.19)†	0.70-1.72 (0.43-2.74)†	1.05 (0.92-1.20)
Without CHF	n=31,294	n=28,926	n=24,830
In-hospital mortality (OR, 95% CI) Weekday vs. Weekend	0.90 (0.80-1.01)	0.62-2.01 (0.37-3.36)†	0.97 (0.84-1.11)
Without HTN	n=18,417	n=15,366	n=12,564
In-hospital mortality (OR, 95% CI) Weekday vs. Weekend	0.96 (0.85-1.09)	0.69-2.03 (0.42-3.42)†	1.01 (0.87-1.18)

*Odds ratios adjusted for age, gender, race, length of stay, median household income, Charlson comorbidity index, hospital region, hospital bedsize, hospital teaching status. Sample discharge weights were used to determine nationally representative estimates.

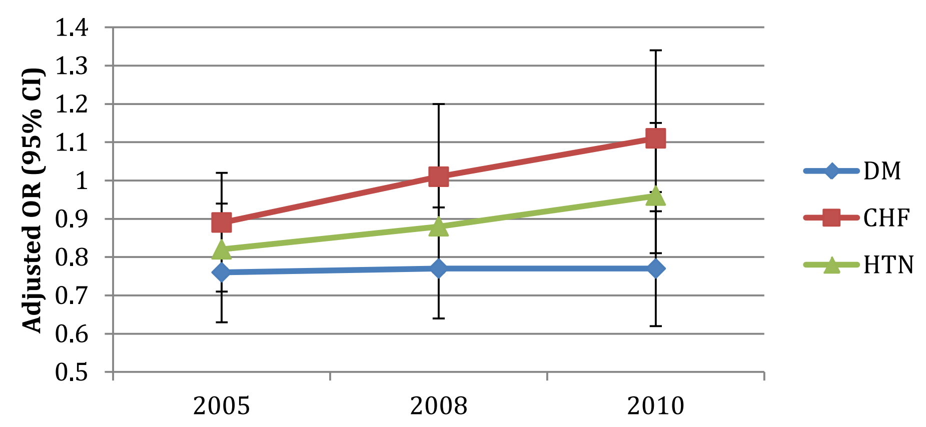
†Interactions were observed between admission day and race (refer to Table 5b for more details)

Table 5b: Interaction Results: Adjusted Odds Ratios and 95% Confidence Intervals (CI) for Interaction of Admission Day by Race or Median HH Income on In-Hospital Mortality*

	2005	Main Effect of Race (Ref=White)	2008	Main Effect of Race (Ref=White)
Without DM	n=30,757		n=26,442	
In-hospital mortality (OR, 95% CI) Weekday vs. Weekend				
• Race=Black	1.26 (0.72-2.19)	1.30 (1.01-1.68)	1.11 (0.74-1.66)	1.46 (1.19-1.80)
• Race=Hispanic	0.79 (0.51-1.19)	1.36 (1.08-1.70)	0.70 (0.43-1.14)	1.39 (1.08-1.77)
• Race=White	0.86 (0.77-0.97)		0.92 (0.81-1.05)	
• Race=Other	0.59 (0.36-0.96)	1.55 (1.19-2.01)	1.72 (1.12-2.74)	1.36 (1.06-1.74)
• Race=Unknown	1.24 (0.98-1.57)	0.90 (0.80-1.00)	0.83 (0.65-1.04)	1.16 (1.01-1.34)
Without CHF	n=31,294		n=28,926	
In-hospital mortality (OR, 95% CI) Weekday vs. Weekend	See Table 5a			
• Race=Black			0.73 (0.46-1.16)	1.20 (0.94-1.53)
• Race=Hispanic			0.62 (0.37-1.03)	1.35 (1.08-1.70)
• Race=White			0.86 (0.75-0.98)	
• Race=Other			2.01 (1.21-3.36)	1.36 (1.06-1.73)
• Race=Unknown			0.72 (0.58-0.90)	1.23 (1.05-1.44)
Without HTN	n=18,417		n=15,366	
In-hospital mortality (OR, 95% CI) Weekday vs. Weekend	See Table 5a			
• Race=Black			1.12 (0.60-2.09)	1.34 (0.99-1.81)
• Race=Hispanic			0.69 (0.42-1.12)	1.55 (1.21-1.99)
• Race=White			0.88 (0.75-1.02)	
• Race=Other			2.03 (1.20-3.42)	1.33 (0.99-1.81)
• Race=Unknown			0.77 (0.60-0.99)	1.19 (1.03-1.39)

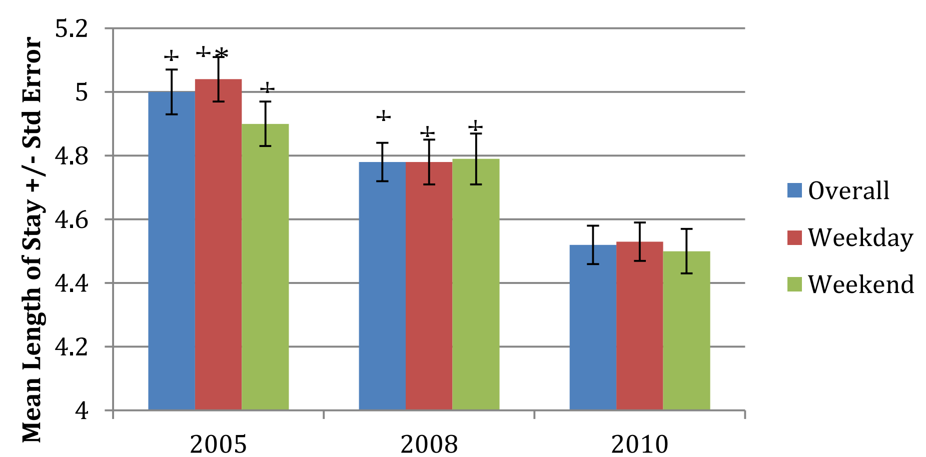
*Odds ratios adjusted for age, gender, race, length of stay, median household income, Charlson comorbidity index, hospital region, hospital bedsize, hospital teaching status. Sample discharge weights were used to determine nationally representative estimates.

Figure 1. In-Hospital Mortality: Adjusted Odds Ratios for Weekday vs. Weekend Admissions in 2005, 2008, 2010



*p<0.05 vs. weekend admissions; p=ns for interaction of admission day*year across all cohorts

Figure 2. Mean Length of Stay by Admission Day - Overall Cohort



*p<0.05 vs. weekend admissions; †p<0.05 vs. 2010

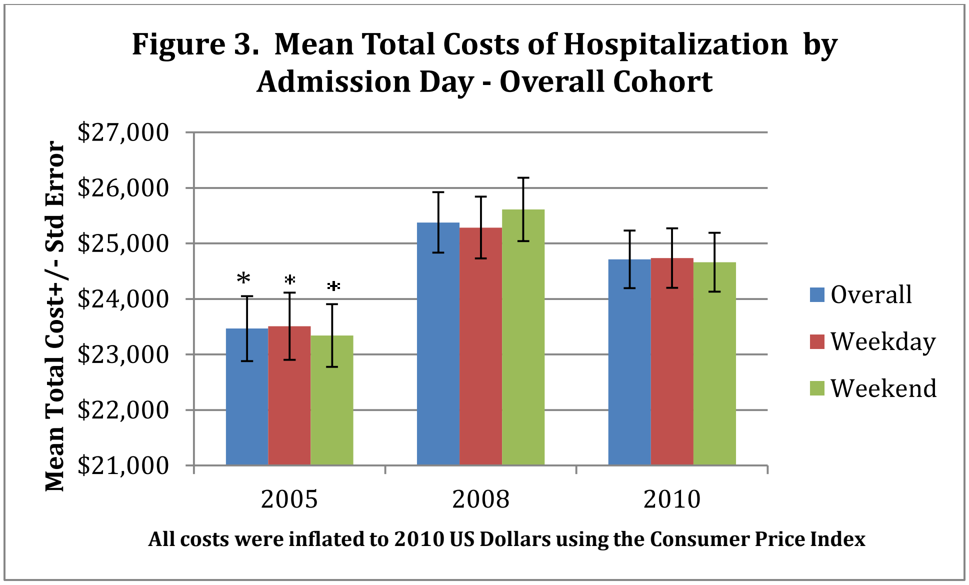


Figure 3. Mean Total Costs of Hospitalization by Admission Day - Overall Cohort
Mean Total Cost+/- Std Error
$27,000
$26,000
$25,000
$24,000
$23,000
$22,000
$21,000
*
*
*
2005
2008
2010
Overall
Weekday
Weekend
All costs were inflated to 2010 US Dollars using the Consumer Price Index

*p<0.05 vs. 2008

CHAPTER 3: EXAMINATION OF TRENDS IN MYOCARDIAL INFARCTION TYPE AMONG PATIENTS ADMITTED FOR ACUTE MYOCARDIAL INFARCTION WITHIN UNITED STATES COMMUNITY HOSPITALS

Study Objective:

The objectives of this study were to determine: 1) whether there was a difference in in-hospital mortality between STEMI and NSTEMI hospitalizations, and 2) whether or not there have been improvements in cardiovascular outcomes for such admissions, among patients admitted to U.S. community hospitals over the years 2000, 2005, and 2010. A longer timeframe was used for this analysis vs. the timeframe for Chapters 1 and 2 in order to allow more time to observe a potential trend.

Methods:

Data Source

We conducted a retrospective cohort study using discharge data including the years 2000, 2005, and 2010 from the Nationwide Inpatient Sample (NIS), Healthcare Cost and Utilization Project (HCUP), Agency for Healthcare Research and Quality. (27) As mentioned in Chapter 1, each year of data contains hospitalization information from approximately 8 million hospital stays from about 1000 hospitals, sampled to approximate a 20% stratified sample of U.S. community hospitals.

Study Population:

Patients were included if they had a primary diagnosis of STEMI or NSTEMI, identified using ICD-9-CM code 410.xx, or 410.71, and were age 40 or older. This age cutoff was implemented in order to exclude most non-atherosclerotic causes of STEMIs, consistent with previous literature (28). Patients were excluded if they were age <40.

Study Variables:

Similar to previous chapters, the primary outcome of interest was in-hospital mortality. Hospital length of stay was also examined. Given that cost-to-charge ratio data for the year 2000 was not available in this dataset, total cost of hospitalization was not analyzed in this chapter.

The primary independent variable was type of myocardial infarction (STEMI vs. NSTEMI). Patient–level covariates included age, gender, race, Charlson Comorbidity Index, median household income of patient's zip code, and length of stay. Analyses were stratified by the following comorbidities: diabetes (DM), hypertension (HTN), and congestive heart failure (CHF), since these comorbid conditions have been shown to be independent predictors of cardiovascular mortality in patients with STEMI. (30; 31; 32; 33) Hospital-level covariates included hospital region, bed size, and teaching status.

Statistical Analysis:

Statistical analyses were conducted in a similar fashion as was previously described in Chapters 1 and 2. Univariate analyses were conducted on patient and hospital demographic data, and bivariate analyses were conducted to describe the unadjusted associations between MI type and outcomes of interest. Potential differences over the years 2000, 2005, and 2010 were analyzed using SAS PROC SURVEYREG for continuous variables, and the Cochran-Armitage Trend test for categorical variables. In this chapter, we also used U. S. population denominators, obtained from census data to determine the secular trends in STEMI and NSTEMI over the decade. (38) As mentioned in earlier chapters, sample discharge weights were used in all analyses to enable the calculation of national estimates. P-values of <0.05 were considered statistically significant.

Logistic regression analyses were used to determine the odds of in-hospital mortality among STEMI and NSTEMI patients admitted to community hospitals in the U.S. in 2000, 2005 and 2010. Possible interactions between in-hospital mortality and MI type, by race and median household income, were also assessed.

As noted in earlier chapters, because patients within the same hospital were more likely to be treated similarly vs. patients treated in different hospitals, analyses were adjusted for clustering effects within hospitals using SAS PROC SURVEYLOGISTIC. Variables with a p-value of <0.05 were considered statistically significant, and therefore retained in the final models. This p-value was selected because it is the conventional threshold for statistical significance widely published in the scientific literature. Final models were constructed in the same manner as described in earlier chapters.

Statistical analyses were conducted using SAS v9.2 (SAS Institute, Cary, NC). The study was approved by the Institutional Review Board of The University of Medicine and Dentistry of New Jersey. Because the study only evaluated de-identified data acquired during routine care, patient informed consent was not required.

Results:

Patient Characteristics:

The mean age of patients across all years was 68, and remained relatively constant over time. The percentage of STEMI admissions decreased over time from 46.09% in 2000 to 29.01% in 2010 ($p<0.0001$), while the percentage of NSTEMI admissions increased over time, from 53.91% in 2000 to 70.99% in 2010 ($p<0.0001$). The prevalence of both DM and HTN increased, while the prevalence of CHF fluctuated over time. The percentage of White, Black, and Hispanic patients increased over time, though that may partially be explained by the decreased number of patients whose race was unknown over time (Table 1a).

The number of patients in the lowest median household income category grew almost 5-fold from 2000-2010, while the percent of patients in the highest income category declined by over 40% over this timeframe. Upon further investigation, this finding was consistent with the distribution in the overall HCUP-NIS 2000 dataset, with only 8.74% of total hospital admissions coming from the lowest income quartile. Regional variation was minimal over time, while growth was observed among the number of teaching hospitals included over time (Table 1a).

Using U.S. census data to approximate the U.S. population age 40 and older, we also noted a substantial decline in the rates of STEMI and NSTEMI admissions over the decade. The decline was greater for STEMI vs. NSTEMI, and more pronounced in patients age 65 or older (65% decrease in STEMI admissions vs. 15% decline in NSTEMI admissions). In the overall cohort, rates of STEMI hospitalizations decreased by nearly 54%, from 0.26% in 2000, to 0.12% in 2010, while NSTEMI hospitalizations decreased by only 9.6%, from 0.31% in 2000 to

0.28% in 2010. (Table 1b, Figure 1). It should be noted that HCUP-NIS data records hospital admissions rather than individual patient experiences, therefore some double-counting in the numerators may have occurred; hence, these numbers should be considered approximate.

In-hospital Mortality:

Overall, unadjusted in-hospital mortality rates significantly decreased over time for both STEMI and NSTEMI admissions, though in-hospital mortality rates for STEMI hospitalizations were significantly higher vs. NSTEMI hospitalizations across all years studied (Table 2, Figure 2). These results were consistent across the DM, CHF, and HTN cohorts as well (Table 2). In-hospital mortality rates were highest for the CHF cohort, relative to other cohorts studied, which could be expected, given that AMI is a risk factor for the development of CHF, and that CHF is associated with increased mortality among patients with AMI (Table 2). (39) In the unadjusted analyses, odds of in-hospital mortality in the overall cohort decreased from 1.80 (95%CI 1.72-1.89) in 2000 to 1.73 (95%CI 1.61-1.84) in 2010 ($p<0.05$). Similar trends were observed among the DM, CHF, and HTN cohorts (Table 3).

After adjusting for the confounders mentioned previously, the odds of in-hospital mortality remained significantly increased for STEMI vs. NSTEMI patients across all years and all cohorts studied (Table 4a, Figure 3). In 2005, significant interactions were observed in the overall, DM, and HTN cohorts between type of myocardial infarction and race. In all of these cohorts, odds of in-hospital mortality for STEMI vs. NSTEMI admissions were highest for Hispanic and Black patients, relative to other race categories (Table 4b, Figure 4).

<u>Length of Stay</u>:

Mean length of stay overall decreased from 5.62 days in 2000 to 4.79 days in 2010 ($p<0.0001$) (Table 2). In the overall, DM and HTN cohorts, NSTEMI admissions were longer than STEMI admissions across all years studied. In contrast, in the CHF cohort, STEMI admissions were significantly longer for patients with CHF vs. NSTEMI admissions across all years studied. Given the nature of this dataset, it is possible that in some cases, CHF was a result of a complication from STEMI, thus contributing to the longer length of stay noted here (Table 2).

<u>Discussion</u>:

The results of our study indicate that the clinical presentation of AMI within U.S. community hospitals has drastically changed over time. A greater proportion of AMI hospitalizations can be attributed to NSTEMIs vs. STEMIs over the decade. Among those admitted for AMI, the prevalence of comorbid DM and HTN have also increased over the timeframe studied. After adjusting for covariates among all cohorts studied, despite decreasing in prevalence over time, odds of in-hospital mortality remained significantly higher for STEMI vs. NSTEMI admissions during the years 2000, 2005, and 2010.

One may speculate that the decreasing odds of in-hospital mortality observed over the decade may be partially attributed to the decline in STEMI admissions of this timeframe. While we were not able to observe specific risk factor profiles (i.e. tobacco use, cholesterol levels, obesity, physical activity, etc.) in this study, the improved mortality trend noted here suggests that patients may have improved risk factor profiles over the past decade. Such improvements would be expected to reduce the severity of coronary atherosclerosis, and thus contribute to the improved outcomes observed with more recent STEMI admissions.

The findings of our study are largely consistent with previously published literature on this topic. (40; 25; 26; 41) A study conducted by Rogers, et al, examined STEMI vs. NSTEMI admissions using the National Registry of Myocardial Infarction. In that study, investigators found an increasing proportion of NSTEMI admissions, and a decreasing proportion of STEMI admissions from 1990-2006. Despite the increased prevalence of NSTEMI over time, mortality rates declined for both STEMI and NSTEMI admissions. (25)

Our results are also consistent with findings from Polonski, et al., who evaluated STEMI vs. NSTEMI outcomes after two years in a Polish registry database. Investigators found that after adjusting for covariates, long-term prognosis for STEMI was worse than NSTEMI . (26) One key difference between our study and this work is the duration of follow-up. Our study was limited to the hospitalization period, while Polonski, et al. were able to assess outcomes on a longer-term basis.

Another study by Shao also reported in-hospital mortality results consistent with our findings. In that study, in-hospital mortality in the state of New Jersey non-federal acute-care hospitals decreased over time from 13.42% in 1990, to 8.76% for Q-wave MI patients, and increased slightly from 5.12%, to 6.03% for non-Q wave MI patients. Our 2005 results are relatively consistent with the 2004 results reported in the Shao study (7.97% for STEMI, and 4.94% for NSTEMI in our study), though our study is representative of the entire U.S community hospital population, and does not differentiate by Q-wave specifically. Both studies also report a significant decline in the number of STEMI hospitalizations over time (27% in the Shao study from 1990-2004, and 37% in our study from 2000-2010). (41)

Our findings differ from the results of a study conducted by Montalescot, et al. In that study, investigators examined 2151 patients admitted for acute myocardial infarction at 56 centers in France. Results of that study found no significant difference in in-hospital mortality between STEMI and NSTEMI admissions. One reason for the different findings could be attributed to differences in the classification of STEMI and NSTEMI between the two studies. Montalescot, et al. classified STEMI and NSTEMI using clinical presentation, while our study used ICD-9 codes. Another explanation could be related to sample size differences, with only 18 (2.9%) of enrolled NSTEMI patients experiencing in-hospital mortality, and 48 (3.2%) of enrolled STEMI patients experiencing in-hospital mortality in their study. (24)

As noted in previous chapters, there are several limitations to our study which should be noted, including the fact that factors such as smoking history, alcohol use, and prescription drug treatments were not available, and such variables may also influence cardiovascular outcomes, regardless of type of myocardial infarction occurring. Other important limitations include the observation period being limited to the hospitalization only, without the ability for post-discharge follow-up, as well as the fact that clinical data were drawn from ICD-9 codes rather than from actual patient records. These limitations should be carefully considered when interpreting the results of our study.

Conclusions:

Despite the limitations noted, the results of this study suggest that the dramatic change in the clinical presentation of AMI among U.S. community hospitals has continued through 2010. Despite the decreasing prevalence of STEMI over time, such hospitalizations continue to result in a higher likelihood of in-hospital mortality vs. NSTEMI hospitalizations. These findings may partly be viewed as a result of improvement in patient quality of care initiatives to reduce STEMI admissions over the timeframe studied; however, further work is needed to continue to improve outcomes in both patient types.

Table 1a: Patient Demographics and Hospital Characteristics*

	2000 N=685,001	2005 N=593,789	2010 N=557,310	p-value
MI Type (n,%)				
STEMI	315,745 (46.09)	211,258 (35.58)	161,660 (29.01)	<0.0001
NSTEMI	369,256 (53.91)	382,531 (64.42)	395,650 (70.99)	<0.0001
Mean Age (SE)	68.45 (0.14)	68.58 (0.17)	68.02 (0.15)	0.0402
Comorbidities (n,%)				
DM	191,132 (27.90)	171,942 (28.96)	176,942 (31.75)	<0.0001
HTN	353,175 (51.56)	356,838 (60.10)	358,661 (64.36)	<0.0001
CHF	202,599 (29.58)	185,924 (31.31)	155,912 (27.98)	<0.0001
Gender (n,%Female)	280,031 (40.88)	241,755 (40.72)	221,190 (39.69)	<0.0001
Race (n,%)**				
White	440,154 (83.30)	348,376 (80.39)	369,972 (76.22)	<0.0001
Black	38,186 (7.23)	30,430 (7.02)	53,614 (11.05)	<0.0001
Hispanic	28,968 (5.48)	32,168 (7.42)	33,553 (6.91)	<0.0001
Other	21,070 (3.99)	22,378 (5.16)	28,273 (5.82)	<0.0001
Median HH income (n,%)				
Lowest Quartile	40,897 (5.97)	157,455 (26.52)	158,047 (28.36)	<0.0001
Second Lowest	212,617 (31.04)	152,271 (25.64)	146,519 (26.29)	<0.0001
Second Highest	188,859 (27.57)	144,662 (24.36)	129,850 (23.30)	<0.0001
Highest	228,096 (33.30)	124,675 (21.00)	108,351 (19.44)	<0.0001
Hospital Region (n,%)				
Northeast	155,646 (22.72)	132,414 (22.30)	111,911 (20.08)	<0.0001
Midwest	142,797 (20.85)	127,752 (21.51)	139,050 (24.95)	<0.0001
South	276,727 (40.40)	234,684 (39.52)	208,382 (37.39)	<0.0001
West	109,831 (16.03)	98,939 (16.66)	97,967 (17.58)	<0.0001
Hospital Bed Size (n,%)				
Small	69,519 (10.15)	40,116 (6.76)	52,999 (9.51)	<0.0001
Medium	179,019 (26.13)	143,318 (24.14)	115,898 (20.80)	<0.0001
Large	435,883 (63.63)	410,355 (69.11)	381,322 (68.42)	<0.0001
Hospital Teaching Status (n,%)				
Teaching	297,721 (43.50)	263,486 (44.37)	260,019 (47.26)	<0.0001
Non-Teaching	386,701 (56.50)	330,303 (55.63)	290,199 (52.74)	<0.0001

*P-values represent differences over the years 2000-2010 for each variable, and were determined using PROC SURVEYREG test for continuous variables and Cochran-Armitage Trend test for categorical variables. Two-sided p-values used, where applicable. Numbers may not add to 100% of total sample each year due to missing data.
**Percentages calculated excluding "Unknown Race" each year (Number of "Unknown" in 2000: 156,623, 2005: 160,437, 2010: 71,898)

Table 1b: Rates of STEMI and NSTEMI Hospitalizations over the years 2000, 2005, and 2010, using U.S. Population Census Data as the Denominator*

	2000	2005	2010
Total Population Age 40 and older	N=120,016,599	N=132,494,084	N=143,116,396
STEMI	0.26%	0.16%	0.12%
NSTEMI	0.31%	0.29%	0.28%
Age 45-64	N=62,428,040	N=73,137,401	N=81,779,634
STEMI	0.21%	0.13%	0.10%
NSTEMI	0.17%	0.16%	0.17%
Age 65 and older	N=35,069,568	N=36,649,798	N=40,437,581
STEMI	0.49%	0.29%	0.17%
NSTEMI	0.72%	0.68%	0.61%

*Note that HCUP-NIS data reflects hospitalizations, rather than individual patients, therefore some double-counting in the numerator might have occurred in some instances.

Table 2: Unadjusted Results for Outcome Variables*

	2000	2005	2010	p-Value
Overall	N=684,568	N=593,520	N=557,168	
In-hospital mortality (n,%)				
Overall	50,865 (7.43)	35,715 (6.02)	26,261 (4.71)	<0.0001
STEMI	30,319 (9.61)	16,834 (7.97)	10,677 (6.61)	<0.0001
NSTEMI	20,546 (5.57)	18,881 (4.94)	15,584 (3.94)	<0.0001
Mean Length of stay (SE)				
Overall	5.62 (0.06)	5.35 (0.06)	4.79 (0.05)	<0.0001
STEMI	5.42 (0.06)	5.00 (0.07)	4.52 (0.06)	<0.0001
NSTEMI	5.79 (0.07)	5.53 (0.07)	4.89 (0.06)	<0.0001
DM Cohort	N=117,709	N=121,527	N=134,616	
In-hospital mortality (n,%)				
Overall	13,338 (6.98)	8356 (4.86)	5968 (3.37)	<0.0001
STEMI	7441 (10.16)	3690 (7.33)	2199 (5.21)	<0.0001
NSTEMI	5897 (5.01)	4666 (3.84)	3769 (2.80)	<0.0001
Mean Length of stay (SE)				
Overall	5.76 (0.07)	5.21 (0.06)	4.46 (0.05)	<0.0001
STEMI	5.55 (0.08)	4.90 (0.08)	4.17 (0.05)	<0.0001
NSTEMI	5.89 (0.08)	5.34 (0.07)	4.55 (0.05)	<0.0001
CHF Cohort	N=202,378	N=185,780	N=155,868	
In-hospital mortality (n,%)				
Overall	25,917 (12.81)	19,421 (10.45)	11,162 (7.16)	<0.0001
STEMI	13,581 (17.89)	7624 (16.10)	3212 (11.59)	<0.0001
NSTEMI	12,336 (9.75)	11,797 (8.52)	7951 (6.20)	<0.0001
Mean Length of stay (SE)				
Overall	7.85 (0.09)	7.62 (0.09)	6.53 (0.08)	<0.0001
STEMI	8.29 (0.12)	7.92 (0.12)	7.16 (0.14)	<0.0001
NSTEMI	7.58 (0.10)	7.52 (0.10)	6.40 (0.08)	<0.0001
HTN Cohort	N=352,982	N=356,719	N=358,586	
In-hospital mortality (n,%)				
Overall	20,574 (5.83)	16,242 (4.55)	11,243 (3.14)	<0.0001
STEMI	11,840 (8.02)	7360 (6.43)	4327 (4.62)	<0.0001
NSTEMI	8734 (4.25)	8882 (3.67)	6916 (2.61)	<0.0001
Mean Length of stay (SE)				
Overall	5.30 (0.06)	4.90 (0.06)	4.23 (0.04)	<0.0001
STEMI	5.05 (0.06)	4.60 (0.07)	3.92 (0.04)	<0.0001
NSTEMI	5.47 (0.07)	5.04 (0.06)	4.34 (0.05)	<0.0001

*P-values determined using PROC SURVEYREG for continuous variables, and Cochran-Armitage Trend test for categorical variables. Two-sided p-values used, where applicable.

Table 3: Unadjusted Odds Ratios and 95% Confidence Intervals (CI) for In-Hospital Mortality within Each Year. NSTEMI is Reference Group.*

	2000	2005	2010
Overall	N=140,183	N=121,158	N=111,513
In-hospital mortality (OR, 95% CI) STEMI vs. NSTEMI	1.80 (1.72-1.89)	1.67 (1.58-1.76)	1.73 (1.61-1.84)
DM Cohort	N=39,081	N=35,079	N=35,374
In-hospital mortality (OR, 95% CI) STEMI vs. NSTEMI	2.14 (1.98-2.32)	1.98 (1.79-2.19)	1.91 (1.69-2.16)
CHF Cohort	N=41,311	N=37,896	N=31,179
In-hospital mortality (OR, 95% CI) STEMI vs. NSTEMI	2.02 (1.89-2.15)	2.06 (1.92-2.21)	1.98 (1.79-2.20)
HTN Cohort	N=72,268	N=72,777	N=71,708
In-hospital mortality (OR, 95% CI) STEMI vs. NSTEMI	1.96 (1.83-2.11)	1.81 (1.67-1.95)	1.81 (1.65-1.98)

*DM, CHF, HTN cohorts are not mutually exclusive

Table 4a: Adjusted Odds Ratios and 95% Confidence Intervals (CI) for In-Hospital Mortality within Each Year. NSTEMI is Reference Group.*

	2000	2005	2010
Overall	N=132,466	N=114,677	N=104,216
In-hospital mortality (OR, 95% CI) STEMI vs. NSTEMI	2.19 (2.09-2.31)	2.02-2.73 (1.78-3.36)†	2.32 (2.16-2.49)
DM Cohort	N=37,288	N=33,325	N=33,117
In-hospital mortality (OR, 95% CI) STEMI vs. NSTEMI	2.37 (2.18-2.59)	1.69-3.82 (1.05-5.24)†	2.45 (2.11-2.85)
CHF Cohort	N=39,774	N=36,395	N=29,490
In-hospital mortality (OR, 95% CI) STEMI vs. NSTEMI	2.12 (1.99-2.27)	2.17 (2.01-2.34)	2.33 (2.08-2.61)
HTN Cohort	N=68,715	N=69,079	N=67,128
In-hospital mortality (OR, 95% CI) STEMI vs. NSTEMI	2.21 (2.04-2.38)	1.82-3.33 (1.51-4.34)†	2.41 (2.17-2.68)

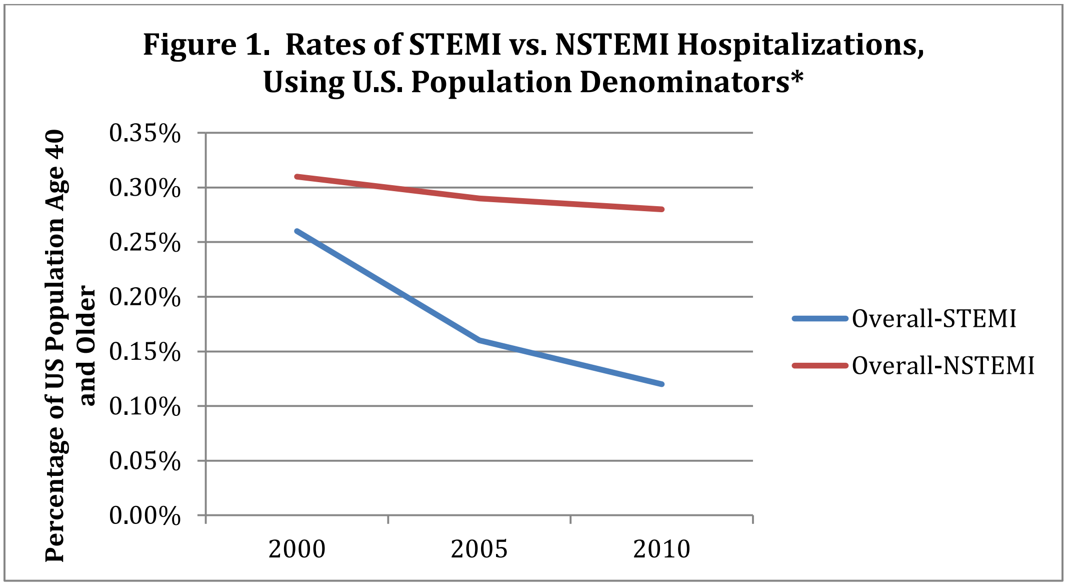
*Odds ratios adjusted for age, gender, race, length of stay, median household income, Charlson comorbidity index, hospital region, hospital bedsize, hospital teaching status.

†Interactions were observed between MI type and race (refer to Table 4b for details)

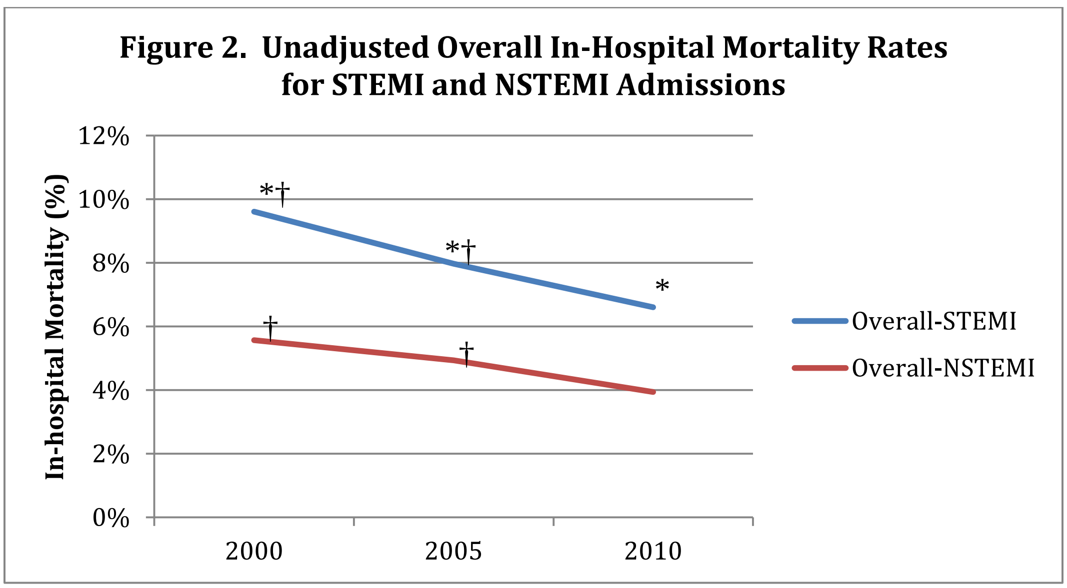
Table 4b. Interaction Results: Adjusted Odds Ratios and 95% Confidence Intervals (CI) for the Interaction of MI Type*Race on In-Hospital Mortality. NSTEMI is Reference Group.*

	2005	Main Effect of Race (White=Ref)
Overall Cohort	N=114,677	
In-hospital mortality (OR, 95% CI)		
STEMI vs. NSTEMI		
• Race=Black	2.49 (1.90-3.26)	1.12 (0.97-1.29)
• Race=Hispanic	2.73 (2.21-3.36)	1.19 (1.04-1.36)
• Race=White	2.04 (1.91-2.19)	
• Race=Other	2.41 (1.82-3.20)	1.15 (0.99-1.34)
• Race=Unknown	2.02 (1.78-2.29)	0.92 (0.84-1.01)
DM Cohort	N=33,325	
In-hospital mortality (OR, 95% CI)		
STEMI vs. NSTEMI		
• Race=Black	2.91 (1.79-4.74)	1.06 (0.82-1.36)
• Race=Hispanic	3.82 (2.78-5.24)	1.38 (1.10-1.72)
• Race=White	2.04 (1.77-2.37)	
• Race=Other	1.69 (1.05-2.73)	1.17 (0.88-1.54)
• Race=Unknown	2.56 (2.04-3.22)	0.96 (0.81-1.14)
HTN Cohort	N=69,079	
In-hospital mortality (OR, 95% CI)		
STEMI vs. NSTEMI		
• Race=Black	2.62 (1.97-3.49)	1.32 (1.10-1.59)
• Race=Hispanic	3.33 (2.56-4.34)	1.34 (1.09-1.64)
• Race=White	2.17 (1.95-2.42)	
• Race=Other	2.47 (1.66-3.67)	1.16 (0.95-1.42)
• Race=Unknown	1.82 (1.51-2.19)	0.94 (0.83-1.06)

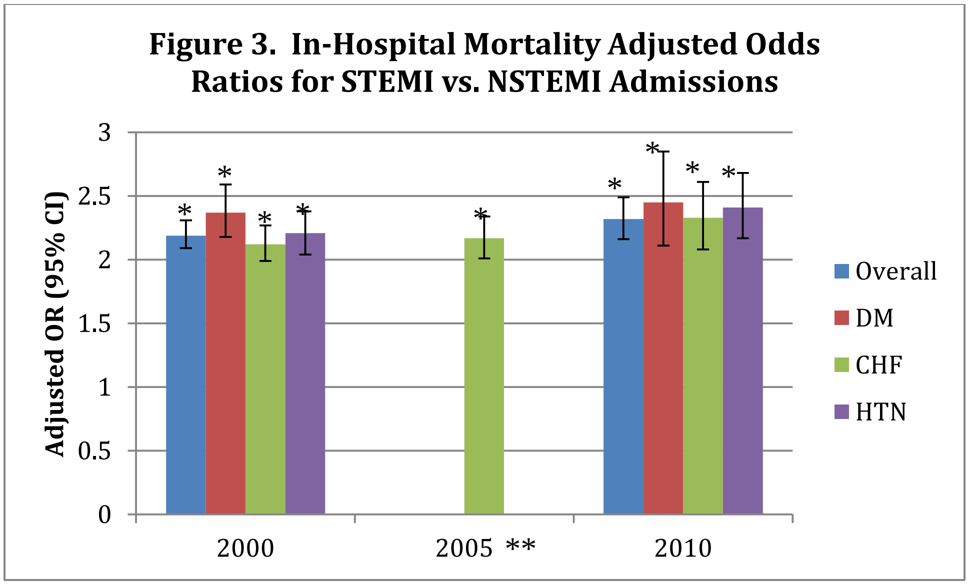
*Odds ratios adjusted for age, gender, race, length of stay, median household income, Charlson comorbidity index, hospital region, hospital bedsize, hospital teaching status.



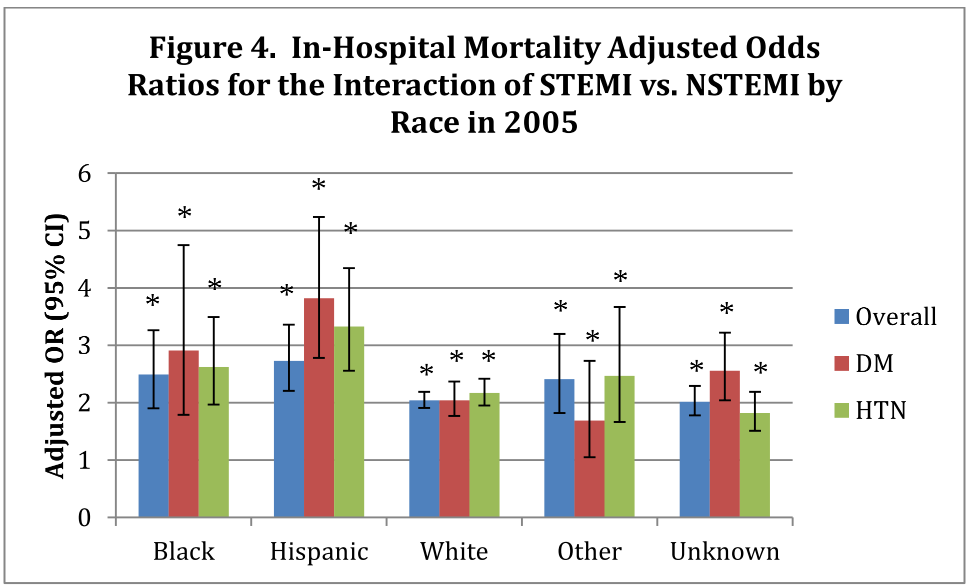
*Note that HCUP-NIS data reflects hospitalizations, rather than indivdual patients, so some double-counting in the numerator might have occurred in some instances



*p<0.0001 vs. NSTEMI;†p<0.0001 vs. 2010



*p<0.05 for STEMI vs. NSTEMI after adjusting for age, gender, race, length of stay, median household income, Charlson Comorbidity Index, hospital region, hospital teaching status, hospital bedsize
**Refer to Figure 4 for Overall, DM and HTN 2005 results, due to interactions



*p<0.05 for STEMI vs. NSTEMI after adjusting for age, gender, race, length of stay,
median household income, Charlson Comorbidity Index, hospital region, hospital teaching status, hospital bedsize

CONCLUDING REMARKS

This research focused on three main themes: the impact of payer type on – in-hospital mortality among STEMI admissions, the impact of admission day (weekday vs. weekend) on in-hospital mortality among STEMI admissions, and an evaluation of the clinical presentation and in-hospital mortality rates of AMI over a 10-year timeframe (2000-2010). Key findings suggest that among patients <65, those with Private health insurance tend to have lower odds of in-hospital mortality, and higher odds of receiving PCI vs. those with other forms of primary payments. The effect of payer type on in-hospital mortality was somewhat mediated by PCI use in certain payer categories. Given that the vast majority of patients age 65 and older receive Medicare, results of these analyses were less compelling, and minimal differences in outcomes were observed over time. Perhaps with the implementation of the Affordable Care Act, more patients will have access to Private insurance, and therefore see an improvement in in-hospital mortality in the future.

Regarding in-hospital mortality and weekday vs. weekend admissions for STEMI, those with comorbid diabetes seem to have better outcomes (lower odds of in-hospital mortality) when admitted on a weekday vs. a weekend. Closer examination of this specific population may be warranted to determine why such findings were observed. Differences in odds of in-hospital mortality in the overall cohort depended on race in earlier years, however, such differences were not observed in 2010, suggesting that race may not be a significant predictor of in-hospital mortality in current clinical situations, though examination of this association in future years may be reasonable.

The significant decline in STEMI hospitalizations observed in Chapter 3 is notable, and suggests a shift in the clinical presentation of AMI in recent years. While both STEMI and NSTEMI admissions decreased over time, STEMI admissions have been decreasing at a faster rate, though in-hospital mortality remains higher for STEMI vs. NSTEMI hospitalizations. Reasons for this change in AMI presentation could, in part, be due to increased preventative measures (i.e. diet/exercise, use of cholesterol-lowering medications, smoking cessation), though these changes may not fully explain our findings. Further research may be warranted to identify additional explanations for these changes over time.

In conclusion, rates of in-hospital mortality have generally decreased over time within each area of this study, suggesting increased quality of care among patients admitted for AMI within United States community hospitals. While progress has been noted, there is still room for future improvement, particularly among the uninsured, and those with comorbid diabetes.

REFERENCES:

1. *The evolving epidemiology of acute coronary syndromes.* **Ruff CT, Braunwald E.** 2011, Nature, Vol. 8, pp. 140-7.
2. *ST elevation myocardial infarction guidelines today: a systematic review exploring updated ACC/AHA STEMI guidelines and their applications.* **Loomba RS, Arora R.** 2009, American Journal of Therapeutics, Vol. 16, pp. e7-e13.
3. **Wang G, Zhang Z, Ayala C, et al.** Costs of Hospitalizations with a Primary Diagnosis of Acute Myocardial Infarction Among Patients Aged 18-64 Years in the United States. [ed.] D. Gaze. *Ischemic Heart Disease.* 2013, 5.
4. *2013 ACCF/AHA guideline for the management of ST-segment elevation myocardial infarction.* **O'Gara PT, Kushner FG, Ascheim DD, et al.** 2013, Circulation, Vol. 127, pp. 588-636.
5. *Fibrinolytic therapy - is it a treatment of the past?* **Grines CL, Serruys P, O'Neill WW.** 2003, Circulation, Vol. 107, pp. 2538-2542.
6. *Comparison of primary percutaneous coronary intervention and fibrinolytic therapy in ST-segment elevation myocardial infarction: bayesian hierarchical meta-analyses of randomized controlled trials and observational studies.* **Huynh T, Perron S, O'Loughlin J, et al.** 24, 2009, Circulation, Vol. 119, pp. 3101-3109.
7. *Primary angioplasty versus fibrinolysis in acute myocardial infarction: long-term follow-up in the Danish acute myocardial infarction 2 trial.* **Nielsen PH, Maeng M, Busk M, et al.** 13, 2010, Circulation, Vol. 121, pp. 1484-1491.
8. *Stenting versus thrombolysis in acute myocardial infarction trial (STAT).* **Le May MR, Labinaz M, Davies RF, et al.** 4, 2001, J Am Coll Cardiol, Vol. 37, pp. 985-991.
9. *Primary coronary intervention versus thrombolytic therapy in myocardial infarction patients in the Middle East.* **Al-Zakwani I, Zubaid M, Al-Rivami A, et al.** 3, Jun 2012, Int J Clin Pharm, Vol. 34, pp. 445-451.
10. *Stent choice in primary percutaneous coronary intervention: drug-eluting stents or bare metal stents?* **Valgimigli M, Airoldi F, Zimarino M.** 2009, J Cardiovasc Med, Vol. Suppl 1, pp. S17-26.
11. *Strategies for multivessel revascularization in patients with diabetes.* **Farkouh ME, Domanski M, Sleeper LA, et al.** 2012, NEJM, Vol. 367, pp. 2375-84.
12. *Propensity analysis of long-term survival after surgical or percutaneous revascularization in patients with multivessel coronary artery disease and high-risk features.* **Brener SJ, Lytle BW, Casserly IP, et al.** 2004, Circulation, Vol. 109, pp. 2290-2295.
13. *Comparison of coronary artery bypass surgery and percutaneous coronary intervention in patients with diabetes: a meta-analysis of randomized controlled trials.* **Verma S, Farkouh ME, Yanagawa B, et al.** 4, 2013, Lancet, Diabetes and Endocrinology, Vol. 1, pp. 317-328.
14. *Five-year outcomes of surgical or percutaneous myocardial revascularization in diabetic patients.* **Contini GA, Nicolini F, Fortuna D, et al.** 2, 2013, Int J Cardiol, Vol. 1668, pp. 1028-1033.

15. *Insurance status, not race, is associated with mortality after an acute cardiovascular event in Maryland.* **Ng DK, Brotman DJ, Lau B, et al.** 2012, Journal of General Internal Medicine, pp. 1368-76.
16. *Insurance status and hospital care for myocardial infarction, stroke, and pneumonia.* **Hasan O, Orav EJ, Hicks LS.** 8, 2010, Journal of Hospital Medicine, Vol. 5, pp. 452-9.
17. *Health care insurance, financial concerns in assessing care, and delays to hospital presentation in acute myocardial infarction.* **Smolderen KG, Spertus JA, Nallamothu BK, et al.** 14, 2010, JAMA, Vol. 303, pp. 1392-400.
18. *Insurance status and the treatment of myocardial infarction at acedemic centers.* **Hiestand BS, Prall DM, Lindsell CJ et al.** 4, 2004, Academic Emergency Medicine, Vol. 11, pp. 343-8.
19. *Does on- versus off-hours presentation impact in-hospital outcomes of ST-segment elevation myocardial infarction patients transferred to a tertiary care center?* **Gonzalez MA, Ben-Dor I, Wakabayashi K, et al.** 2010, Catheterization and Cardiovascular Interventions, Vol. 76, pp. 484-490.
20. *Off-hour primary percutaneous coronary angioplasty does not affect outcome of patients with ST-segment elevation acute myocardial infarction treated within a regional network for reperfusion.* **Casella G, Ottani, Ortolani P, et al.** 2011, J Am Coll Cardiol Intv , Vol. 4, pp. 270-8.
21. *Influence of presentation at the weekend on treatment an doutcome in ST-elevation myocardial infarction in hospitals with catheterization laboratories.* **Kruth P, Zeymer U, Gitt A, et al.** 2008, Clin Res Cardiol, Vol. 97, pp. 742-47.
22. *Relationship between time of day, day of week, timeliness of reperfusion, and in-hospital mortality for patients with acute ST-segment elevation myocardial infarction.* **Magid DJ, Wang Y, Herrin J, et al.** 2005, JAMA, Vol. 294, pp. 803-812.
23. *Weekend vs. weekday admission and mortality from myocardial infarction.* **Kostis WJ, Demissie K, Marcella SW, et al.** 2007, New England Journal of Medicine, Vol. 356, pp. 1099-109.
24. *STEMI and NSTEMI: are they so different? 1-year outcomes in acute myocardial infarction as defined by the ESC/ACC definition (the OPERA registry).* **Montalescot G, Dallongeville J, Van Belle E, et al.** 2007, European Heart Journal, Vol. 28, pp. 1409-1417.
25. *Trends in presenting characteristics and hospital mortality among patients with ST elevation and non-ST elevation myocardial infarction in the National Registry of Myocardial Infarction from 1990-2006.* **Rogers WJ, Frederick PD, Stoehr E, et al.** 2008, Am Heart J, Vol. 156, pp. 1026-34.
26. *A comparison of ST elevation versus non-ST elevation myocardial infarction outcomes in a large registry database.* **Polonski L, Gasior M, Gierlotka M, et al.** 2011, International Journal of Cardiology, Vol. 152, pp. 70-77.
27. **www.hcup-us.ahrq.gov/nisoverview.jsp, Agency for Healthcare Research and Quality Rockville.** HCUP Nationwide Inpatient Sample (NIS). Healthcare Cost and Utilization Project (HCUP). 2005, 2008, 2010. Rockville, MD : s.n.
28. *Trends in the age adjusted mortality from acute ST segment elevation myocardial infarction in the United States (1998-2004) based on race, gender, infarct location and*

comorbidities. **Movahed MR, John J, Hashemzadeh M, et al.** 2009, Am J Cardiol, Vol. 104, pp. 1030-1034.
29. **Statistics, United States Bureau of Labor.** [Online] [Cited: November 26, 2013.] http://www.bls.gov/data/inflation_calculator.htm.
30. *TIMI risk score for ST-elevation myocardial infarction: A convenient, bedside, clinical score for risk assessment at presentation.* **Morrow DA, Antman EM, Charlesworth A, et al.** 2000, Circulation, Vol. 102, pp. 2031-2037.
31. *Predictors of 30-day mortality in the era of reperfusion for acute myocardial infarction.* **Lee KL, Woodlief LH, Topol EJ, et al.** 1995, Circulation, Vol. 91, pp. 1659-1668.
32. *Comparing AMI mortality among hospitals in patients 65 years of age and older: evaluating methods of risk adjustment.* **Krumholz HM, Chen J, Wang Y, et al.** 1999, Circulation, Vol. 99, pp. 2986-2992.
33. *PREDICT: a simple risk score for clinical severity and long-term prognosis after hospitalization for acute myocardial infarction or unstable angina: the Minnesota heart survey.* **Jacobs DR, Kroenke C, Crow R, et al.** 1999, Circulation, Vol. 100, pp. 599-607.
34. **Muthen, L.K. and Muthen, B. O.** Mplus User's Guide: Seventh Edition. *http://www.statmodel.com.* [Online] 2012. [Cited: September 20, 2013.] http://www.statmodel.com/download/usersguide/Mplus%20user%20guide%20Ver_7_r6_web.pdf.
35. **Hayes, AF.** Andrew F. Hayes, PhD. [Online] [Cited: March 1, 2013.] http://afhayes.com/spss-sas-and-mplus-macros-and-code.html.
36. [Online] [Cited: November 18, 2013.] www.statmodel.com/discussion/messages/23.366.html.
37. [Online] [Cited: October 28, 2013.] www.medicare.gov.
38. [Online] [Cited: October 30, 2013.] http://www.census.gov/popest/data/intercensal/national/nat2010.html.
39. *Determinants and prognostic impact of heart failure complicating acute coronary syndromes.* **Steg PG, Dabbout OH, Feldman LT, et al.** 2004, Circulation, Vol. 109, pp. 494-499.
40. *Longitudinal trends in the severity of acute myocardial infarction: A population study in Olmsted County, Minnesota.* **Hellermann JP, Reeder GS, Jacobsen SJ, et al.** 3, 2002, Am J Epidemiol, Vol. 156, pp. 246-253.
41. **Shao, Yu-Hsuan.** [Online] October 2008. [Cited: November 26, 2013.] http://rucore.libraries.rutgers.edu/rutgers-lib/24880/.