OFFICE OF POLICY AND PLANNING
DEPARTMENT OF VETERANS AFFAIRS

PROGRAM EVALUATION OF CARDIAC CARE PROGRAMS IN THE VETERANS HEALTH ADMINISTRATION

PART 3
INPATIENT COST ANALYSIS FOR PATIENTS WITH HEART ATTACK
(Research Question 8)

FINAL REPORT

April 11, 2003

PRICEWATERHOUSECOOPERS

Department of Health Care Policy
Harvard Medical School

The LEWIN GROUP

IBM

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Department of Veterans Affairs

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Submitted by:
PricewaterhouseCoopers, LLP
Harvard Medical School Department of Health Care Policy
The Lewin Group
IBM Business Consulting Services

RESEARCH QUESTION 8

"How do VA healthcare costs for ischemic heart disease patients compare to non-VA settings? Is there a relationship between costs and outcomes?"

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1. Acknowledgements

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To obtain an electronic version of this report, or the other sections of this program evaluation visit: **www.va.gov/opp/organizations/progeval.htm**.

2. Executive Summary

The purpose of this research question is to compare the cost of care for ischemic heart disease patients treated within the VA to similar patients treated in non-VA settings.

To do so, the project team obtained inpatient cost data from the VA's Decision Support System (DSS) for veterans who had an acute myocardial infarction (AMI), or heart attack, between October 1, 1998 and September 30, 1999 (Fiscal Year 1999). The project team created a matched sample of veteran and non-veteran AMI patients for this time frame and obtained hospital and procedure utilization and charge data from the Medicare Hospital Inpatient (Part A) files. For physician services associated with the inpatient episode for these individuals, we obtained relative value unit (RVU) weighted dollar values from Medicare's Resource Based Relative Value Scale (RBRVS) physician fee schedule.

Based on the analysis of these data, we are able to describe the observable costs that were incurred in both the VA and Medicare inpatient settings, and compare them in the aggregate. Due to the differences between the two cost structures, we are unable to determine, with specificity, what accounts for variances in the comparative results; however, observed differences in procedure utilization between the two systems is likely to account for most, if not all, of the cost variance.

The overall results of the analysis of research question 8 are best illustrated by the comparison of costs per AMI patient for the two cohorts analyzed: 1) Matched VA and 2) Matched Medicare, as shown in Table 1. Unadjusted results for all VA AMI patients in FY 1999 are presented in Appendices A9-A13.

Table 1: Summary of Inpatient Costs per AMI Patient				
	Matched VA (N=3,758) (Including Facility and Physician Costs)	Matched Medicare (N=3,758)		
		Part A (Facility Costs)	Estimated Physician Charges (RVU weighted $ value)	Total Medicare (Facility Costs + Physician Charges)
Cost per AMI Patient by Episode Increment				
Index Admissions	**$13,530**	$13,793	$2,652	**$16,445**
Post Index ≤ 30 days	**$960**	$760	$148	**$908**
31-60 Days	**$464**	$521	$93	**$614**
61-90 Days	**$298**	$273	$58	**$331**
Cumulative Costs per AMI Patient				
1-30 Days	**$14,491**	$14,553	$2,800	**$17,353**
31-60 Days	**$14,954**	$15,074	$2,892	**$17,966**
61-90 Days	**$15,253**	$15,347	$2,950	**$18,297**

The inpatient VA cost data captured in DSS combines *facility* and *physician* costs. Therefore, in order to make a valid comparison between the index AMI admission in the Matched VA cohort and the Matched Medicare cohort, both *facility* and *physician* costs must be included. Therefore, the project team combined facility costs (Medicare Part A) with RVU weighted dollar values from Medicare's RBRVS physician fee schedule, which estimates *physician* charges for daily services and procedures. When both the *facility* and *physician* costs are considered, the Matched VA cohort costs for the index AMI admission are 17.7% lower than the Matched Medicare cohort total. This difference is statistically significant ($P < .01$). While the VA has a longer average length of stay (ALOS) than Medicare—as described in the AMI cohort analysis—the VA's cost of providing inpatient care to AMI patients is lower for the index admission when compared to inpatient care provided to similar AMI patients within Medicare.

However, observed differences in procedure utilization between these two systems—also described in the AMI cohort analysis (Table B4, page B13)—likely explains most of this difference. In fact, the project team completed a simple sensitivity analysis, which suggests that up to 100% of the cost difference observed between these two systems could be directly related to the variance in procedure utilization.

The project team believes that this approach improves upon previous analyses of VA costs. The DSS data used to assess VA costs is reportedly more standardized and detailed than other sources of VA cost information, such as the VA's Cost Distribution Report (CDR), ultimately providing the project team with a better foundation of data from which to work (Barnett and Rodgers, 1999). The project team also developed a highly complex and sophisticated case-mix adjustment strategy, controlling for patient demographics, clinical comorbidities, and socioeconomic variables. Finally, the project team created a "matched" sample of VA and Medicare patients, matching patients according to their propensity to obtain care within each system (VA or private-sector).

3. Question Introduction and Background

The Veterans Health Administration (VHA) manages one of the largest health care systems in the United States, providing health care services to approximately 3.6 million veterans with a budget of $22 billion in FY 1999. In order to gain an understanding of the VA's level of cost-efficiency, the project team was asked to analyze health care costs associated with the VA's ischemic heart disease treatment, within a single VISN (the same VISN used for research question 7), as compared to the private sector. The original intent of this Research Question was to provide the VA with recommendations for improving cost efficiency while maintaining or improving present levels of health outcomes.

Various cost analyses have been performed by many health services researchers—primarily but not exclusively from within the VA—in the past two decades. For the most part, these studies have demonstrated that VA costs appear to be lower than charges for similar care in the private sector (Hendricks et al, 1999). After an extensive review of existing studies and relevant literature on comparisons of VA and non-VA costs, Hendricks suggests that future studies should:

- compare incremental costs within the VA with best estimates of non-VA costs and reimbursements for specific types of services;
- require better diagnostic and population data to control for observable and unobservable case-mix differences;
- include measures of quality and outcomes; and
- use improved methods of cost standardization among VA facilities, and obtain cost data from a system other than the VA's Cost Distribution Report (CDR), which is known to vary significantly based on local practices (Swindle et al, 1996).

The project team's approach to addressing research question 8 incorporates many of these suggestions. For example, we obtained cost data for this analysis from DSS, which is likely to represent a significant improvement over the CDR (Barnett and Rodgers, 1999). First, the DSS VA-wide implementation was more standardized than implementation of CDR. Secondly, DSS is structured to be patient-centered, allowing the costs incurred by, or attributed to, individual patients to be identified with greater detail and accuracy.

As indicated in the Executive Summary, the project team developed a sophisticated case-mix adjustment strategy, controlling for patient demographics, clinical comorbidities, and socioeconomic variables. The project team also created a "matched" sample of VA and Medicare patients, matching patients according to their propensity to obtain care within each system (VA or private-sector).

However, due to data limitations, the project team could not address the relationship between costs and outcomes at this time. Further, due to DSS limitations, this analysis focuses exclusively on inpatient costs associated with an AMI. While understanding the importance of the costs of outpatient care provided to AMI patients after their index admission, the project team was unable to obtain outpatient data from DSS within the given project timeline and therefore had to limit the scope of this analysis to inpatient data.

The project team also wanted to present procedure-specific costs for the VA. However, these costs cannot be obtained directly through DSS as this data set does not contain a breakdown of the procedure-specific costs. Finally, the project team had only one year of data, FY 1999, so we were unable to identify any possible trends. This is specifically important when looking at VISN-level data; a few cost outliers could potentially distort the VISN-level cost averages for either the matched VA or matched Medicare cohort, although this is unlikely to affect the national comparisons.

4. Data Source Methodology

Originally, the scope of the research question was limited to one VISN. Further, the scope included all ischemic heart disease (IHD) related episodes, treatments, and/or procedures including, acute myocardial infarction (AMI), coronary artery bypass grafts (CABG), percutaneous coronary interventions (PCI), and cardiac catheterizations. However, due to the magnitude of the DSS cost data, and the multiple competing priorities facing the DSS team, the program evaluation team limited the request to one fiscal year of inpatient data (FY 1999) for the veteran AMI cohort in order to complete this analysis within the project timeline. Simultaneously, the team was able to obtain DSS-based cost data across all VISNs, rather than just a single VISN. Therefore, the program evaluation team analyzed inpatient costs across all VISNs for the FY 1999 AMI cohort—one of the same cohorts used to address the research questions related to utilization and outcomes within this program evaluation.

To address research question 8, the project team created two cohorts: the Matched VA cohort and the Matched Medicare cohort. Unadjusted (for demographic, clinical, and socioeconomic differences) results are also presented for all VA AMI patients in Appendix A9-A13.

All Veteran Patients Treated for an AMI Exclusively Within a VHA Facility (All VA Cohort)

Unadjusted (for demographic, clinical, and socioeconomic differences) results are presented in Appendix A9-A13 for 8,664 veteran patients, of all ages, who were treated for an Acute Myocardial Infarction (AMI) in a VA facility between October 1, 1998, and September 30, 1999. This AMI cohort included veterans with an AMI (ICD-9-CM codes 410, excluding 410.x2) in fiscal year 1999 subject to the following exclusion criteria: (1) those who were enrolled in a Medicare health maintenance organization; (2) those whose AMI was likely a complication of non-cardiac surgery, and for this determination the team used criteria

developed by Wright et al [Wright, 1999] (Appendix A1); (3) those who were discharged alive in less than 3 days; and (4) long term (> 180 days) residents of nursing homes[1].

Matched Veteran and Medicare Patients Treated for an AMI (Matched Cohorts)

We matched 4,502 veteran AMI patients, 65 years of age or older, (included in the 8,664 above) who were treated for an Acute Myocardial Infarction (AMI) in a VA facility between October 1, 1998 and September 30, 1999 to 4,502 Medicare patients treated in private facilities during the same time period. We did not attempt to match Veterans with Medicare patients (1) under the age of 65 (2) enrolled in a Medicare health maintenance organization; and (3) discharged alive in less than 3 days.

Once a patient was identified as meeting the inclusion criteria for a cohort, contiguous inpatient records were linked together to create an index episode of admission[2]. Patients identified through the VA records (Patient Treatment Files

[1] Because VHA facilities are sometimes used for long-term care, VA researchers commonly use this exclusion when studying AMI patients (including studies comparing treatment in Medicare and VA hospitals), see for example Wright, S. M., J. Daley, et al. (1997). "Where do elderly veterans obtain care for acute myocardial infarction: Department of Veterans Affairs or Medicare?" Health Services Research **31** (6): 739-754. This exclusion led to about 10 patients (out of approximately 9000 or .1%) being excluded in each VA cohort. Because acute care facilities are not generally used for long-term care in the private sector, we did not use this exclusion in the Medicare cohorts. There were about 25 (out of approximately 175,000 or 0.01%) cases with lengths of stay greater than 180 days in each of the Medicare cohorts.

[2] It was beyond the scope of this project to collect data on care received in the private sector that was covered under private insurance.

[PTF]) who also received care covered by Medicare in a non-VHA hospital, were excluded from this analysis[3].

Because patients with AMI treated in the VA differed with respect to many important socio-demographic and clinical characteristics (See Appendix A2) compared to Medicare patients treated in private sector facilities, we created a matched sample of the two cohorts for FY 1999. We used a propensity score approach to take into account these differences and matched patients according to their propensity to receive care in each system [Rosenbaum, 1983; Rubin, 1997; D'Agostino, 1998].

Creation of the matched cohorts required several steps. For each VA patient aged 65 or over hospitalized with AMI in a given year, we first selected a group of Medicare patients treated in the same quarter of the fiscal year who were cared for in a private sector facility located within the geographic boundary of the VISN in which the VA patient was treated. As a proxy for severity of the AMI we also matched according to the distance between the patient's residence and their admitting hospital (within 5 miles, 6 to 20 miles, 21 to 50 miles or greater than 50 miles)[4]. We then developed a score for each patient that represented their propensity to be treated in the VA system (the so-called "propensity score"); for

[3] It was also beyond the scope of this project to identify and study patients who received care for their index AMI in the private sector but who received follow up care in the VA. Previous research suggests that the number of patients in the Medicare cohort with cross utilization in the VA is relatively low. For example, Fleming et al [Fleming, C., E. S. Fisher, et al. (1992). "Studying outcomes and hospital utilization in the elderly: The advantages of a merged data base for Medicare and Veterans Affairs Hospitals." Medical Care **30**(5): 377-391.] found that only 1.8% of male Medicare patients hospitalized for AMI in New York or New England between 1983 and 1986 received inpatient care in the VA during this time period. However, veterans receiving index care for AMI under Medicare may represent a significant portion of VA users with an AMI. For example, Fleming et al. also found that 36% of hospitalizations for AMI among inpatient users of VA hospitals occurred in the private sector. The authors did not study outpatient care. Similarly Wright et al [Wright, S. M., J. Daley, et al. (1997). "Where do elderly veterans obtain care for acute myocardial infarction: Department of Veterans Affairs or Medicare?" Health Services Research **31**(6): 739-754.] found that 54% of a national sample of AMI patients with prior inpatient and outpatient use of VA services were initially admitted to a Medicare hospital.

[4] The use of distance has been subjected to a sensitivity analysis (see AMI cohort report for further discussion of this analysis). Results were insensitive to the use of distance in the case-mix adjustment.

this purpose we used a logistic regression model that included the entire set of risk adjustment variables described below. We then matched each elderly (65 years of age and older) VA patient to the Medicare patient with the closest estimated propensity to be treated in a VA facility.

Risk Adjustment Variables for Matched Cohorts

The Matched AMI cohorts (VA and Medicare) were adjusted for demographic characteristics of the patients (age, gender, and race), a set of 37 clinical comorbidities, and a set of socioeconomic variables derived from 1990 U.S. Census data. The clinical comorbidities were coded based on primary and secondary diagnosis codes from inpatient encounters.[5] We adapted a previous approach and divided clinical characteristics into those that were unlikely to be related to any treatment for an AMI and those that were possibly related to treatment for an AMI [Normand, 1995]. Information on comorbidities not related to treatment (see Appendix A3) was obtained from the index admission as well as from inpatient claims in the year prior to admission. Information on clinical characteristics possibly related to treatment (see Appendix A3) was obtained from inpatient claims only from the year prior to admission. For example, Congestive Heart Failure (CHF) during the index admission may be related to (potentially inadequate) treatment for the AMI. Thus we only considered diagnoses for CHF during the year prior to admission and did not adjust for differences in the prevalence of CHF during the index admission. We linked the zip code of each patient's residence to data from the 1990 U.S. Census to obtain information on their socioeconomic characteristics.

As described above, the Matched cohorts (VA and Medicare) have been risk-adjusted; therefore valid comparisons can be made at a national level, as well as

[5] Initially we planned on using information on comorbidities obtained from *both* inpatient data as well as outpatient data for the year prior to the index admission. However, outpatient data from the VA were not available for the FY 1994 and 1997 cohorts. For consistency, we also wanted to use the same risk adjustment approach for all years within the VA and Medicare cohorts.

within a particular VISN between the Matched VA and Matched Medicare cohorts. However, costs have not been adjusted for differences in demographic or clinical comorbidities across VISNs; therefore, Matched VA costs within one VISN cannot be validly compared to Matched VA costs within another VISN.

5. Data Collection

DSS Data

A "finder file" for all VA AMI patients (8,664 unique individuals), consisting of name, sex, Social Security Number, VISN, zip code of residence, and date of birth, was provided to the DSS Technical Support Office (DSS-TSO). This finder file was based upon identification of veterans with an AMI (ICD-9-CM codes 410, excluding 410.x2) in fiscal year 1999 subject to the exclusion criteria previously mentioned from the VA's Patient Treatment File (PTF). DSS-TSO staff retrieved records for inpatient admissions in FY 1999 for veterans found in the finder file. Each record covered one inpatient episode from DSS's Daily Cost & Resource Profiler system.

Among the 8,664 unique veteran AMI patients, there were 688 veterans that received care from both VA and non-VA facilities. Since we wanted to compare VA costs of care to non-VA settings, we excluded this small "mixed" cohort from further analysis. This reduced the number of VA AMI patients to 7,976 unique veterans. We obtained DSS records for 7,523 (94.3%)[6] of these veterans. After additional analysis to identify and confirm an index admission for an AMI, we

[6] Of the 8,664 veteran AMI patients in FY 1999, the project team was able to find DSS records for 8,170, or 94.3%. Although DSS and PTF are based on the same source, the Veterans Health Information Systems and Technology Architecture (VISTA), Barnett and Rodgers (1999) determined that 7.6% of stays in PTF were not reported to DSS, a match rate of 92.4%; our match rate was slightly better. Further, within the 8,170 persons found in DSS, 400 of these (4.6% of the total of 8,664) appeared to be miscoded in DSS with respect to a primary diagnosis of AMI (ICD-9 code 410.xx) for the index admission. These records matched the PTF on both date of admission and length of stay, and we considered these to be "miscodes" and included them in the analysis.

excluded an additional 59 veterans because we were missing too much data to merit inclusion in the analysis, leaving a final count of 7,464 unique veteran AMI patients.

For the Matched VA cohort of 4,502 unique veterans, we excluded 519 veterans who also were known to have received care in both the VA and Medicare systems during the period covered by the study. This reduced the cohort to 3,983. We obtained DSS records for 3,789 of these, a match rate of 95.1%. After additional analysis to identify and confirm an index admission for an AMI, we excluded an additional 31 veterans because we were missing too much data to merit inclusion in the analysis, leaving a final Matched VA AMI cohort of 3,758 unique veterans.

Medicare Data

The project team obtained inpatient claims data from the Centers for Medicare and Medicaid Services (CMS), for the 4,502 non-veteran AMI patients in the Matched Medicare cohort, described above. Claims data for hospital and procedure utilization and charges for inpatient episodes were obtained from the Hospital Inpatient (Part A) files. The Hospital Inpatient files contain charge information for the facility-related component of inpatient episodes (claims which are submitted to Medicare by hospital providers).

To obtain an estimate of physician services associated with the inpatient episodes, we obtained relative value unit (RVU) weighted dollar values from Medicare's Resource-based Relative Value Scale (RBRVS) physician fee schedule. The RBRVS is a system for measuring physician input to medical services for the purpose of calculating a physician fee schedule. The relative value of each service is the sum of relative value units (RVUs) physician work, practice expense, and malpractice insurance.

Since we were only able to obtain DSS cost data for 3,758 individuals in the Matched Veteran cohort, we had to reduce the size of the corresponding Matched

Medicare cohort to 3,758 as well. To be valid, both the veteran and his non-veteran matched counterpart had to have cost records.

6. Analytical Methodology

VA Costs

Due to DSS-TSO staff time and resource constraints, the team was only able to obtain inpatient cost data from DSS; therefore the scope of the analysis is limited to costs associated with inpatient episodes. DSS categorizes costs into more than 800 Intermediate Product Descriptions (IPDs). Building upon previous work done by the DSS-TSO staff, the project team developed 13 cost categories for use in the analysis, as shown in Appendix A4. These cost categories, while similar to those used in many private sector hospitals, are unique to the VA. Therefore, these cost categories established the foundation from which a comparison would be made with Medicare costs as illustrated in Table 2.

Table 2: Inpatient DSS Costs Compared to Medicare Charges			
VA DSS Inpatient Cost Categories	**How are these inpatient costs generally categorized in the Medicare system?**	**Where are these services captured in the Medicare data?**	**What data was the project team able to use to capture comparable costs?**
Physician Bed-Day[7]	Attending physician	Physician/Supplier claims	Estimated payments from physician fee schedule
	Cardiologist services[8]	*Physician/Supplier claims*	***Not** included in physician fee schedule estimate for the matched Medicare cohort*
Other Bed-Day (e.g., psychiatry, counseling, etc)	Miscellaneous	Hospital Inpatient (Part A) claims	Charges from patient claims data
Surgery[9]	Facility	Hospital Inpatient (Part A) claims	Charges from patient claims data
	Anesthesiologist[10]	*Physician/Supplier claims*	***Not** included in physician fee schedule estimate for the matched Medicare cohort*
	Physician procedure	Physician/Supplier claims	Estimated payments from physician fee schedule

[7] Physicians are assigned to a hospital department (e.g., Medicine, Surgery, Psychiatry, etc.) and their available time (and hence percent of salary and associated costs) to inpatient wards, clinics, research, teaching, etc. For inpatient wards within a department, total monthly physician costs can be computed, equal to the costs of the physicians assigned. Then, for example, the cost for one Physician Bed-Day in a medical ward is the total monthly physician costs for the Medicine wards divided by the total number of patient bed-days in the same wards in the same month. This cost will be different for each department, and changes monthly.

[8] Without reviewing the *actual* physician/supplier claims data for each patient, it is impossible to develop a reasonable estimate of costs attributed to Cardiologist services—as this may vary significantly from one episode of care to the next as well as from one geographic region to the next.

[9] Surgeon time spent performing procedures in the operating room is included here. Surgeons have their time allocated to the operating room, in addition to surgery wards and clinics. However, costs for surgeon time spent performing the procedure are captured directly, in 15-minute increments. Different types of surgeons (e.g., cardiac, general) have different unit costs, and these costs also vary monthly.

[10] Without reviewing the *actual* physician/supplier claims data for each patient, it is impossible to develop a reasonable estimate of costs attributed to the Anesthesiologist—as this may vary significantly from one episode of care to the next as well as from one geographic region to the next. According to the *2001 DRG Handbook*, which covers 1999 Medicare data, Anesthesiology—including facility (Medicare Part A data) and physician (Medicare physician/supplier data) costs—likely represents between 0.0-3.1% of the average cost per AMI patient. Therefore, we can estimate that physician costs related to the Anesthesiologist are less than 3.1% of the overall cost per AMI.

Table 2: Inpatient DSS Costs Compared to Medicare Charges			
VA DSS Inpatient Cost Categories	**How are these inpatient costs generally categorized in the Medicare system?**	**Where are these services captured in the Medicare data?**	**What data was the project team able to use to capture comparable costs?**
Physician Extenders	Room and Board	Hospital Inpatient (Part A) claims	Charges from patient claims data
ICU/Post-Op/ Recovery Nursing	Facility	Hospital Inpatient (Part A) claims	Charges from patient claims data
Ward Nursing	Room and Board	Hospital Inpatient (Part A) claims	Charges from patient claims data
Laboratory	Laboratory	Hospital Inpatient (Part A) claims	Charges from patient claims data
Pharmacy	Pharmacy	Hospital Inpatient (Part A) claims	Charges from patient claims data
Radiology/Nuclear Medicine	Radiology	Hospital Inpatient (Part A) claims	Charges from patient claims data
	Radiologist[11]	*Physician/Supplier claims*	***Not** included in physician fee schedule estimate for the matched Medicare cohort*
Administration[12]	Room and Board	Hospital Inpatient (Part A) claims	Charges from patient claims data
Teaching	Teaching	Hospital Inpatient (Part A) claims	Charges from patient claims data
Research	Research	Hospital Inpatient (Part A) claims	Charges from patient claims data
All Other	Combination of Room and Board, Facility, Teaching, Research	Hospital Inpatient (Part A) claims	Charges from patient claims data

[11] Without reviewing the *actual* physician/supplier claims data for each patient, it is impossible to develop a reasonable estimate of costs attributed to the Radiologist—as this may vary significantly from one episode of care to the next as well as from one geographic region to the next. According to the *2001 DRG Handbook*, which covers 1999 Medicare data, Radiology—including facility (Medicare Part A data) and physician (Medicare physician/supplier data) costs—likely represents between 2.1-5.0% of the average cost per AMI patient. Therefore, we can estimate that physician costs related to the Radiologist are less than 5.0% of the overall cost per AMI.

[12] Although defined as separate categories in DSS, no costs were observed for administration, teaching, or education in the DSS data provided. However, Barnett and Rodgers (1999) found that the costs for these activities were allocated to, and included in, the costs of departments that produce patient care. Thus, we assume these costs are included in the data we obtained, though not separately identifiable.

Medicare Costs

Since the project team was only able to obtain inpatient costs for the VA, we only considered comparable inpatient costs from Medicare. For the Matched Medicare cohort patients, we obtained charge data from claims in Medicare's Hospital Inpatient (Part A) files. These files contain charge information for the facility-related component of inpatient episodes (claims are submitted to Medicare by hospital providers). To estimate hospital costs from charges submitted to Medicare, we obtained ratios of costs to charges (RCCs) for each hospital provider listed in the Medicare claims, based on cost data submitted separately to Medicare by each hospital provider.[13] Estimating costs from charges using RCCs is an accepted health services research technique. We derived hospital costs by multiplying the charges listed in the claims data by the corresponding RCC for each hospital provider. If a provider was missing an RCC value, we used the average value for 1999 for all the hospital providers (RCC=0.476581) identified in the claims for the Matched Medicare cohort.[14] In other words, a claim submitted with a charge of $100.00 would be based on costs of approximately $47.66.

For physicians, we obtained RVU weighted dollar values for each IHD-related procedure and multiplied these weighted dollar values (after adjusting for geographical variations) by the number of each procedure type (e.g., CABG, PCI, and cardiac catheterization) occurring during the inpatient stay. The project team also obtained daily RVU weighed dollar values for the attending physician's services, and multiplied these weighted dollar values (again, after adjusting for

[13] Under ideal circumstances, the project team would have used the department-specific RCCs as they are somewhat more precise; however, data and resource limitations prohibited the team from pursing this approach.

[14] A total of 126 (or 5.9%) of the 2,147 providers were missing a RCC value, and therefore were assigned the average RCC value for 1999. However, because of linked claims between providers, and different claim density across providers, 785 (or 18.4%) of the 4,268 Matched Medicare cohort claims used the average RCC value at least once in the claim.

geographical variations) by the patient's length of stay. In the context of this analysis, we know that the Medicare physician costs are somewhat understated because the project team did not have a precise way to incorporate anesthesiology and radiology physician services; however, these physician costs collectively represent less than 8.1% of the total cost per AMI. Additional charges associated with cardiology services also could not be included due to data limitations.

Index Admissions

Once the project team obtained the DSS cost records for the VA patients, as well as the Medicare claims for the Matched Medicare patients, we began to identify "index" AMI admissions, i.e., the first AMI experienced by an individual, defining the beginning of an episode of treatment for AMI and including any contiguous admissions. First, VA and Matched Medicare patients were matched to the corresponding cost files (DSS or Medicare) based on patient identifier (scrambled Social Security Number). Then, to identify index admissions from these cost files, we sorted and "scored" them based on the degree to which they matched the admit date, primary diagnosis, and length of stay specified in the cohort files. Ultimately, the project team excluded 59 veterans because we were missing too much data to merit inclusion in the analysis; resulting in a final count of 7,464 unique veteran AMI patients.

Post-Index Admissions

In addition to determining the costs related to the index admission, the project team also decided to determine the costs related to the episode of cardiac illness initiated by the onset of an AMI. The project team decided to capture costs for all IHD-related admissions for a period of 90 days from the date of the index admission. IHD-related admissions are all those with a primary diagnosis of

410.xx-414.xx inclusive, as specified in the project statement of work (see Appendix A5 for a detailed list of codes).[15]

The project team captured costs from DSS records (for all VA AMI patients) and from Medicare Hospital Inpatient claims and RVU weighted dollar values from Medicare's RBRVS physician fee schedule (for the Matched Medicare cohort), and categorized them into three additional episode increments:

- **Post index ≤ 30 days**. Costs for 410-414 admissions occurring post-index admission (from the date of discharge—if there were contiguous admissions, this is the discharge date for the last contiguous admission), up to and including 30 days.
- **31-60 days**. Costs for 410-414 admissions occurring 31-60 days, inclusive, post-index admission.
- **61-90 days**. Costs for 410-414 admissions occurring 61-90 days, inclusive, post-index admission.

For all episode increments, the date of the index admission was counted as day one. Records were not combined in the non-index episode increments (i.e., readmissions that occurred within the 1-30, 31-60, or 61-90 day increments) to create contiguous admissions—all costs were captured, but they were treated as separate admissions regardless of any overlap in lengths of stay.

Table 3 shows the number of unique individuals included in the analysis, by cohort and episode increment.

[15] Again, it was beyond the scope of this project to identify and study patients who received care for their index AMI in the private sector, but who received follow up care in the VA.

Table 3: Number of Patients by Episode Increment and Analysis Cohort		
Episode Increment	Matched Cohorts	
	VA	Medicare
Index Admissions	3,758	3,758
Post Index ≤30 Days	303	234
31-60 Days	163	165
61-90 Days	116	111

Procedures

Inpatient procedure utilization is a significant component of the inpatient costs associated with an AMI. Further, in order to calculate physician procedure costs, as described above, the project team had to establish how many procedures were performed in the Matched Medicare cohort. Therefore, for IHD-related procedures (i.e., coronary artery bypass grafts [CABG], percutaneous coronary interventions [PCI], and cardiac catheterizations [Cath]) occurring in the Matched Medicare cohort, we calculated the number of procedures and the estimated average charge for each type of procedure by episode increment. (Refer to Appendix A6 for a list of the ICD-9-CM and CPT-4 codes used to identify these procedures).

For the Matched Medicare cohort, a total of 9,894 IHD-related procedure codes were reported in the Hospital Inpatient claims in the 90-day period following the beginning of the index admission. However, since multiple procedure codes are often linked to a single procedure (CABG, PCI, or cardiac catheterization), the project team bundled related procedure codes during a given episode of care, to ascertain a more realistic ratio of procedures for each patient. For example, ICD-9-CM procedure code 36.06—insertion of a coronary artery stent(s) is associated with ICD-9-CM procedure code 36.01 single vessel PTCA; therefore these two codes would be counted as one procedure. Based on this bundling logic, the project team estimated a total of 4,530 IHD-related procedures, as shown in Table 4.

Table 4: Procedures in the Matched Medicare Cohort (N=3,758)			
Episode Increment	**IHD Procedure Type**		
	Cath	**CABG**	**PCI**
Index Admissions	2,343	615	1,120
Post Index ≤ 30 Days	95	58	62
31-60 Days	61	32	51
61-90 Days	43	15	35
Total	2,542	720	1,268

In the Matched VA cohort, procedure costs are included in the total cost of each inpatient episode reported by DSS; however these costs are not separately identifiable. The PTF Procedures and Surgeries sub-files contain ICD-9-CM procedure codes, similar to those found in the Medicare Hospital Inpatient claim records. Thus, we were able to apply the bundling logic described above to the PTF records for the Matched VA cohort. Based on this bundling logic, the project team estimated a total of 2,239 IHD-related procedures, as shown in Table 5.

Table 5: Procedures in the Matched VA Cohort (N=3,758)			
Episode Increment	**IHD Procedure Type**		
	Cath	**CABG**	**PCI**
Index Admissions	428	197	1291
Post Index ≤ 30 Days	47	48	88
31-60 Days	12	30	60
61-90 Days	8	8	22
Total	495	283	1,461

7. Results

For all cohorts, we calculated three types of results, for each episode increment: 1) average length of stay, 2) average cost per AMI patient, and 3) cumulative cost per AMI patient. We also calculated the average cost per discharge; these results are included in Appendix A7-A8. This section contains summary results for the Matched VA and Matched Medicare cohorts by episode increment. Unadjusted VISN-specific results for all VA AMI patients are included in Appendix A9-A13.

- **Average Length of Stay (ALOS)**. Average length of stay is the total number of inpatient bed days divided by the number of discharges. It is important to note that the number of discharges varies; it is not the same for each episode increment (the number of discharges per episode increment is presented in Table 3). Thus, "average" length of stay in each episode increment is based on a different denominator. Matched VA and Matched Medicare ALOS results are shown in Table 6.

Table 6: Average Length of Stay (ALOS) (in days)

Episode Increment	Matched Cohorts	
	VA	Medicare
Index Admissions	10.3 (N=3,758)	8.4 (N=3,758)
Post Index ≤30 Days*	10.7 (N=303)	7.0 (N=234)
31-60 Days*	8.4 (N=163)	6.5 (N=165)
61-90 Days*	11.7 (N=116)	6.2 (N=111)

*Contiguous admissions were not linked for the post index admission episode increments and therefore the ALOS may be slightly understated.

- **Average Cost per AMI Patient**. The number of AMI cases is determined by the number of index admissions, regardless of the number of AMIs actually experienced. Thus, the number of AMIs for the Matched VA cohort and Matched Medicare cohort is 3,758. We obtained average costs per AMI

patient by aggregating the costs in each episode increment and dividing by the number of AMIs. The Matched VA and Matched Medicare results are shown in Table 7.

Table 7: Average Cost per AMI Patient

Episode Increment	Matched Cohorts			
	VA (N=3,758) (Facility and Physician Costs)	Medicare (N=3,758)		
		Part A (Facility Cost)	Estimated Physician Charges (RVU weighted $ value)	Total (Facility + Physician Costs)
Index Admissions	**$13,530**	$13,793	$2,652	**$16,445**
Post Index ≤ 30 Days	**$960**	$760	$148	**$908**
31-60 Days	**$464**	$521	$93	**$614**
61-90 Days	**$298**	$273	$58	**$331**
Total	**$15,253**	$15,347	$2,950	**$18,297**

The VA costs are lower than Medicare costs during all episode increments, with the exception of the post index ≤ 30 days increment.

- **Cumulative Costs per AMI Patient**. We aggregated the cost per AMI in 30-, 60-, and 90-day increments. The Matched VA and Matched Medicare results are shown in Table 8.

Table 8: Cumulative Costs per AMI Patient

Episode Increment	Matched Cohorts			
	VA (N=3,758) (Facility and Physician Costs)	Medicare (N=3,758)		
		Part A (Facility Cost)	Estimated Physician Charges (RVU weighted $ value)	Total (Facility + Physician Costs)
1-30 Days	**$14,491**	$14,553	$2,800	**$17,353**
31-60 Days	**$14,954**	$15,074	$2,892	**$17,966**
61-90 Days	**$15,253**	$15,347	$2,950	**$18,297**

- **Medicare Physician Charge by Type of Procedures**. In order to estimate the average physician charge for each of the three types of IHD-related procedures (CABG, PCI, and cardiac catheterization), we cross-walked the ICD-9-CM procedure codes from the Hospital Inpatient claims data to the corresponding CPT-4 based RVU weighted dollar values from the RBRVS physician fee schedule.[16] Then, we applied geographic-specific factors and bundled associated charges to develop appropriate procedure charges for each VISN. Results of this calculation are shown in Table 9.

Table 9: Estimated Average Physician Charge by Type of Procedure (Matched Medicare Cohort)

Episode Increment	IHD Procedure Type		
	CABG	PTCA	Cath
Index Admissions	$2,983	$762	$1,987
Post Index ≤ 30 Days	$3,106	$766	$1,995
31-60 Days	$2,843	$764	$2,023
61-90 Days	$3,011	$775	$2,004

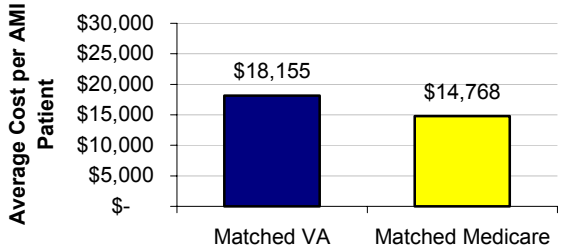
- **Estimated Medicare Physician Charges**. To develop the *total* average cost per AMI patient for the matched Medicare cohort, we estimated average physician charges, which include 1) *physician procedure* charges per AMI and 2) *physician attending* charges per AMI. The team used the average charge by type of procedure (Table 9) to calculate the estimated average *physician procedure* charge per AMI. To calculate the estimated average *physician attending* charge per AMI, the team used RVU weighted dollar values from the RBRVS physician fee schedule and length of stay results. These results are shown in Table 10 by episode increment.

[16] There is no industry accepted cross-walk between ICD-9-CM procedure codes and CPT-4 procedure codes, so the project team used a team of clinicians and coding experts to create a "reasonable" match. However, due to the differences between the ICD-9-CM and CPT-4 procedure codes, a perfect match could not be achieved.

Table 10: Estimated Average Physician Charge per AMI (N=3,758) (Matched Medicare Cohort)			
	Estimated Average Physician		Total Estimated Physician Charge
Episode Increment	Procedure Charge per AMI	Attending Charge per AMI	
Index Admissions	$ 1,954	$ 698	$2,652
Post Index ≤ 30 Days	$ 111	$ 37	$148
31-60 Days	$ 67	$ 25	$93
61-90 Days	$ 42	$ 16	$58

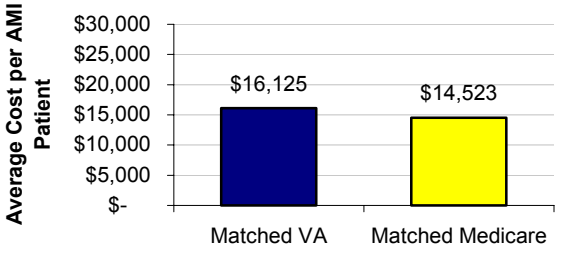
- **Cost per AMI by VISN**. Figures 1-22 depict the average cost per AMI, for a patient's index admission. Figures A1-A22 in the Appendix depict the cumulative cost per AMI up to 90 days. "Cost" reflects all observed facility and physician inpatient costs for both the VA and Medicare Matched cohorts. While these analyses are risk adjusted (for socio-demographic and clinical differences) for VISN-level comparisons with Medicare; as stated in the risk adjustment section, they are *not* risk adjusted for comparisons across VISNs (e.g. Matched VA in one VISN cannot be compared to Matched VA in another VISN). Based upon other analyses, the project team knows that VA patients do differ by demographic and clinical characteristics across VISNs.

Figure 1: Average Cost per AMI VISN 1



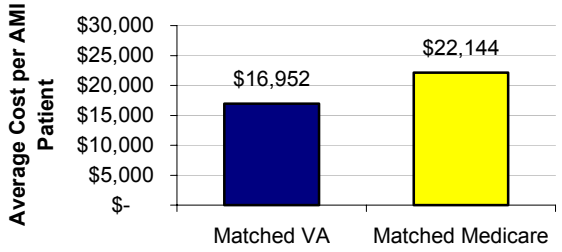
Matched VA = 122.9% of Matched Medicare Costs

Figure 2: Average Cost per AMI VISN 2



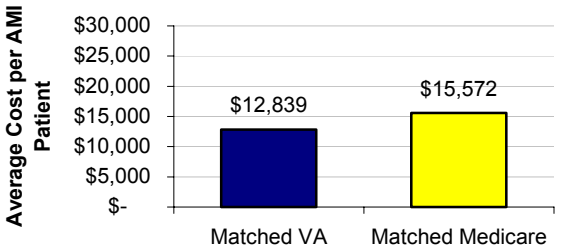
Matched VA = 111.03% of Matched Medicare Costs

Figure 3: Average Cost per AMI VISN 3



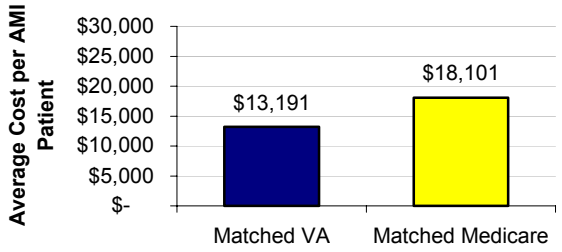
Matched VA = 76.5% of Matched Medicare Costs

Figure 4: Average Cost per AMI VISN 4



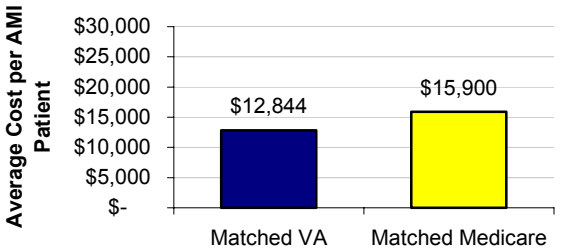
Matched VA = 82.5% of Matched Medicare Costs

Figure 5: Average Cost per AMI VISN 5



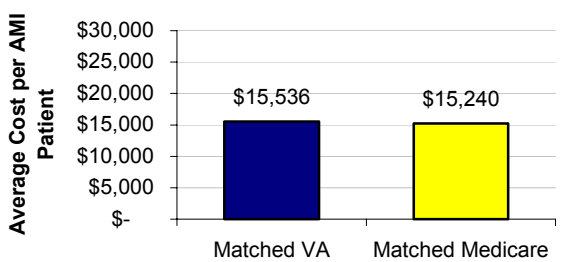
Matched VA = 72.9% of Matched Medicare Costs

Figure 6: Average Cost per AMI VISN 6



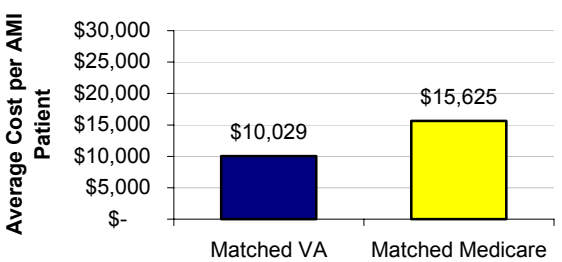
Matched VA = 80.8% of Matched Medicare Costs

Figure 7: Average Cost per AMI VISN 7



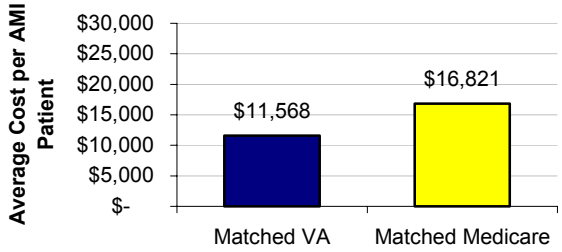
Matched VA = 101.9% of Matched Medicare Costs

Figure 8: Average Cost per AMI VISN 8



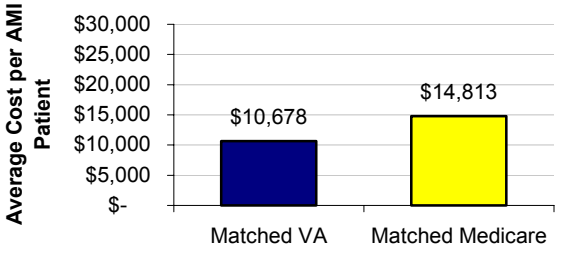
Matched VA = 64.2% of Matched Medicare Costs

Figure 9: Average Cost per AMI VISN 9



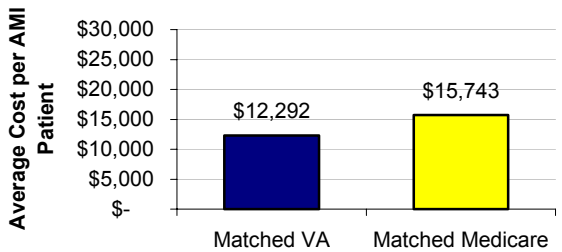
Matched VA = 68.8% of Matched Medicare Costs

Figure 10: Average Cost per AMI VISN 10



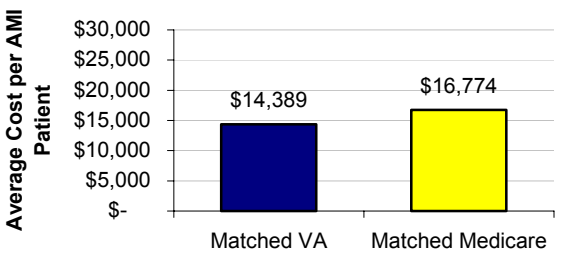
Matched VA = 72.1% of Matched Medicare Costs

Figure 11: Average Cost per AMI VISN 11



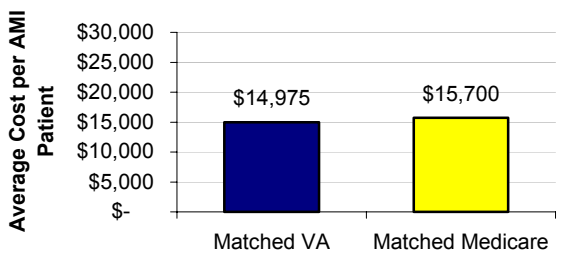
Matched VA = 78.1% of Matched Medicare Costs

Figure 12: Average Cost per AMI VISN 12



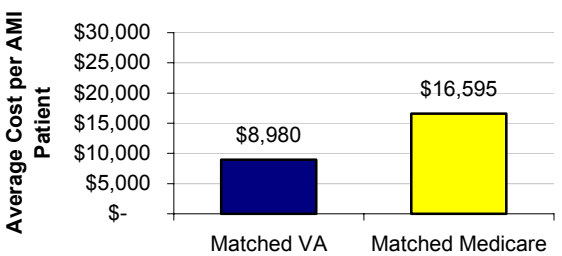
Matched VA = 85.8% of Matched Medicare Costs

Figure 13: Average Cost per AMI VISN 13



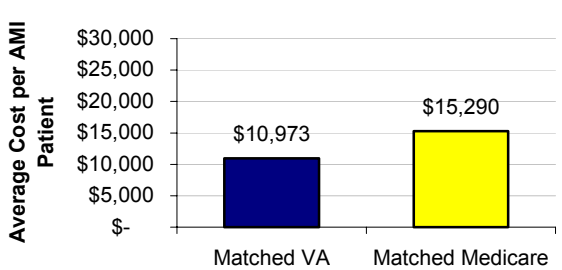
Matched VA = 95.4% of Matched Medicare Costs

Figure 14: Average Cost per AMI VISN 14



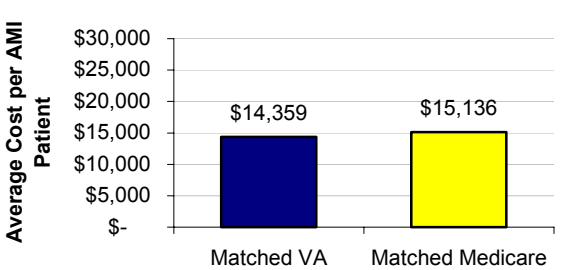
Matched VA = 54.4% of Matched Medicare Costs

Figure 15: Average Cost per AMI VISN 15



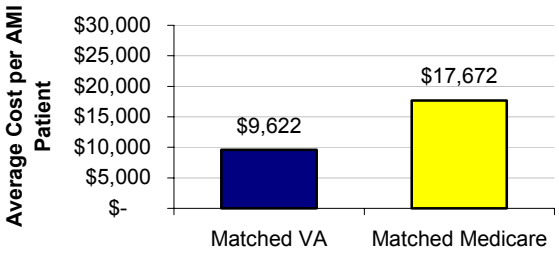
Matched VA = 71.8% of Matched Medicare Costs

Figure 16: Average Cost per AMI VISN 16



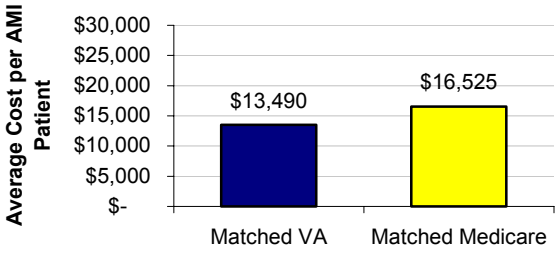
Matched VA = 94.9% of Matched Medicare Costs

Figure 17: Average Cost per AMI VISN 17



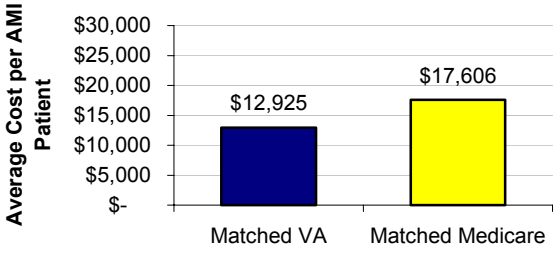
Matched VA = 54.4% of Matched Medicare Costs

Figure 18: Average Cost per AMI VISN 18



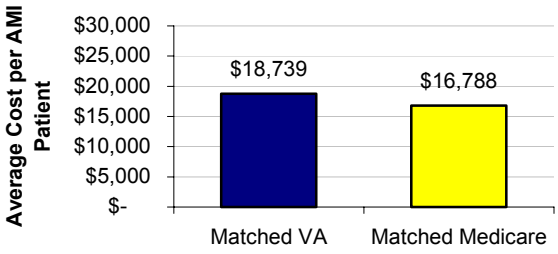
Matched VA = 81.6% of Matched Medicare Costs

Figure 19: Average Cost per AMI VISN 19



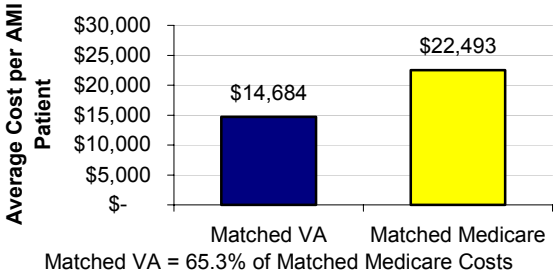
Matched VA = 73.4% of Matched Medicare Costs

Figure 20: Average Cost per AMI VISN 20



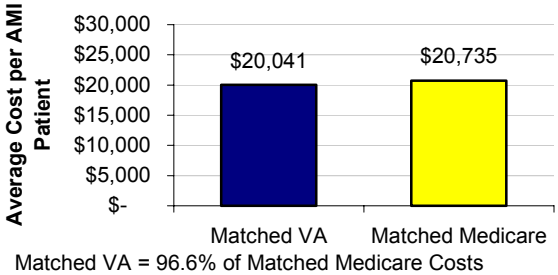
Matched VA = 111.6% of Matched Medicare Costs

Figure 21: Average Cost per AMI VISN 21



Matched VA = 65.3% of Matched Medicare Costs

Figure 22: Average Cost per AMI VISN 22



Matched VA = 96.6% of Matched Medicare Costs

- **Summary**. Table 11 displays the summary results of cost per AMI, combining several of the results in the previous tables.

Table 11: Summary of Inpatient Costs per AMI Patient

	Matched VA (N=3,758) (Facility and Physician Costs)	Matched Medicare (N=3,758)		
		Part A (Facility Costs)	Estimated Physician Charges (RVU weighted $ value)	Total Medicare (Facility Costs + Physician Charges)
Cost per AMI Patient by Episode Increment				
Index Admissions	**$13,530**	$13,793	$2,652	**$16,445**
Post Index ≤ 30 days	**$960**	$760	$148	**$908**
31-60 Days	**$464**	$521	$93	**$614**
61-90 Days	**$298**	$273	$58	**$331**
Cumulative Costs per AMI Patient				
1-30 Days	**$14,491**	$14,553	$2,800	**$17,353**
31-60 Days	**$14,954**	$15,074	$2,892	**$17,966**
61-90 Days	**$15,253**	$15,347	$2,950	**$18,297**

8. Limitations

The results of this study should be viewed in light of several important limitations.

- It was beyond the scope of this project to collect cost data on care received in the private sector that was covered under private insurance; therefore, we may not have complete cost information related to some AMI patients. Consequently, the Medicare costs could be understated suggesting that the difference between the Matched VA and Matched Medicare cohorts is actually larger than represented in this report.
- While DSS captures outpatient costs, DSS-TSO staff time and resource constraints made it impossible to obtain those costs within the project timeline. Consequently, the project team was only able to address *inpatient* costs associated with AMI for one fiscal year.
- Procedure-specific costs are not available in DSS, therefore the project team had to *estimate* the impact of procedure utilization differences between these two systems.
- Due to resource constraints, the team was unable to use physician/supplier claims to complete this analysis and therefore had to estimate physician costs, using RVU weighted dollar values from Medicare's RBRVS physician fee schedule. Further, the team did not include an estimate of costs associated with cardiology, radiology or anesthesiology physician services, since these costs are impossible to reasonably predict without actual claims data.
- RCCs are only considered to be an approximation; however they represent the best method available.
- These costs should only be considered in the context of this analysis and not assumed to be consistent with current costs in either the VA or private sector as there have been a number of advances in cardiac care treatments over the

past few years that would significantly impact these cost estimates. Further, without more detailed information, these costs can only be used to gain a general understanding of the overall cost comparison between the VA and private sector.

9. Findings

- For the index admissions, average cost per AMI for the Matched VA cohort is $13,530. Average total cost for the Matched Medicare cohort (including facility costs and estimated physician charges) is $16,445. When both the facility costs and physician charges are included, the Matched VA cohort costs for the index AMI admission are 17.7% lower than Matched Medicare costs. This difference is statistically significant ($P < .01$).
- The gap between Matched VA and Medicare costs remains relatively stable as costs accumulate over the 90-day period following the index admission. At 30 days following the date of the index admission, Matched VA costs are 83.5% of the corresponding Matched Medicare charges; 83.2% at 60 days; and 83.3% at 90 days.
- We note that although LOS in the VA is greater than in Medicare, costs are lower. However, patients receiving care for an AMI in the VA received substantially fewer procedures than those in Medicare. For the episode increment up to 30 days following an AMI:
  - Matched VA patients received 245 CABG procedures (6.5%) compared to 673 (17.9%) in the matched Medicare cohort
  - Matched VA patients received 475 PCI procedures (12.6%) compared to 1,182 (31.5%) in the matched Medicare cohort
  - Matched VA patients received 1,379 (36.7%) cardiac catheterization procedures compared to 2,438 (64.9%) in the matched Medicare cohort.

- Since procedure use is a significant component of total cost per AMI patient, the team conducted a simple sensitivity analysis, controlling for the number of procedures performed in both systems. The team started with the total cost per AMI patient in the 1-30 day episode increment, which was $54.5 million in the matched VA cohort and $65.2 million in the matched Medicare cohort, a difference of $10.7 million. Then, the team reduced the number of procedures performed in the matched Medicare cohort so that the numbers of AMI patients that received a procedure was the same in both systems. Corresponding *facility* (approximately $12.9 million) and *physician* (approximately $3.9 million) costs were also reduced in the matched Medicare cohort. Thus, after controlling for the difference in procedure utilization, the total cost per AMI patient in the 1-30 day episode increment was $48.4 million in the matched Medicare cohort, or $6.1 million lower than the matched VA cohort results. Since we know that the Medicare costs are likely to be understated, it is difficult to determine the precise cost difference between these two systems after controlling for differences in procedure utilization; however, it is reasonable to suggest that the difference in procedure utilization observed between these two systems explains up to 100% of the difference in costs observed between these two systems.
- There are some variations among the VISNs for IHD-related costs when comparing the Matched VA to the Matched Medicare cohort during the index admission episode increment. For example, VISN 1, 2, and 20 are the only VISNs where the Matched VA cohort costs per AMI patient are higher than the Matched Medicare cohort costs; although VA and Medicare costs are similar in VISN 7.[17] Further, the Matched VA cost per AMI patient in VISN 14 and 17 are less than 55% of the corresponding Matched Medicare costs; versus 82.3% of the Matched Medicare costs across all VISNs. Results are

[17] VISN 20 includes the Portland VAMC (Station No. 64), the designated cardiac transplant facility within the VA. When Portland is excluded, VISN 20 averages are commensurate with the VA-wide averages.

similar for the cumulative costs per AMI patient up to 90 days (Figures A1-A22 in the Appendix).

- As mentioned earlier, several prior studies have found that VA costs appear to be lower than charges for similar care in the private sector (Hendricks et al, 1999). This is certainly true in the present study; however, the reader is cautioned that while the study results are similar, the methodological approach employed in the present study is markedly different than those reported on by Hendricks and others (see, for example, Barnett (1999) and Menke, et al (1999). As far as the project team is aware, no previous study of VA and Medicare costs has employed a population-based approach rather than an institutional facility-based one; has rigorously controlled for case-mix factors; and has used patient-centered VA transaction data (DSS) rather than departmental-level budget and cost accounting data (CDR).

10. Conclusions

Based upon these findings, the average cost per AMI is higher for patients treated in the Matched Medicare cohort than for patients treated in the Matched VA cohort. As noted above, the difference in procedure use between the VA and Medicare may explain most, or even all, of the observed difference in costs.

Additionally, there are a number of unobserved factors that could also contribute to the observed difference in costs.

- There may be unidentified biases due to different methodologies in deriving costs that could not be identified due to the differences in cost structures.
- There are more *indirect* medical education costs in the private sector, which are reflected in Medicare costs.
- Physician RVUs may be global and include pre- and post-inpatient encounter visits that are not included in the VA data.

There are also unobserved factors that may cause the Medicare costs to be understated.

- The exclusion of estimated cardiology, radiology and anesthesiology physician costs related to each episode of care due to data limitations.
- Early discharge from the hospitals to home care, rehabilitation hospitals, or other non-acute care that is not included in the Medicare inpatient stay that may be included in the VA.

11. Recommendations

- From this analysis, we found that inpatient costs per AMI patient treated in the VA are less than private sector costs for similar AMI patients. Further, from the AMI cohort analysis, we found that AMI patients treated in the VA are less likely to receive a procedure when compared to similar patients in the private sector, although VA patients on average experience a longer length of stay. Even though differences in utilization may explain most of the difference in cost between the VA and private sector, VA might benefit from a more detailed cost analysis for several components of care incurred during hospitalization for a heart attack. Apart from procedure use, for example, VA may be more efficient than the private sector in bed-day costs (tests and procedures excluded).
- The project team also found that there is not complete congruence between DSS and the PTF, considering that both originate (in theory) from the same source. Further, we found that approximately 4.6% of persons known to have received care for a heart attack as recorded in PTF were miscoded with respect to primary diagnosis in DSS. Additional research is needed to understand the causes of the mismatch between DSS and PTF.
- We found the DSS data difficult to obtain although potentially useful. Therefore, we believe greater accessibility of the data to health services

researchers is essential to timely completion of similar program evaluations of population-based health care services for specific conditions or disease management studies. VA should consider investing in DSS to develop standardized research data sets, including methodologies to track procedures specific costs, in addition to current DSS resources supporting the internal VA budgeting process.

- The VA should consider attempting to replicate the results using the same methodology on another (perhaps smaller) disease management group or population, to ascertain whether the differences between the VA and Medicare are directionally similar.

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Appendix

Table A1: ICD-9 Codes for Non-Cardiac Surgery Used to Exclude Patients With AMI Because AMI Was Likely to be a Complication of Surgery		
ICD-9 Surgical Code	**Include**	**Exclude**
0.00-34.99		Central & peripheral nervous system; endocrine; eye; ear; nose; oral cavity and pharynx; respiratory system.
35.00-35.99		Cardiac valve or septa surgery
36.00-36.99	PTCA and CABG	
37.00-37.19		Pericardial surgery
37.20-37.23	Cardiac catheterization	
37.24-37.59		EP studies; other heart repair; heart transplant
37.60-37.89	IABP and pacemaker	
37.90-37.99		Open cardiac massage; insertion or re-wiring of AICD
38.00-39.59		Non-coronary vascular surgery
39.60-39.66	Heart-lung bypass; ECMO	
39.70-39.99		Miscellaneous vascular
40.00-86.99		Lymph node and BMT; GI; renal and bladder; genital; orthopedic; skin and breast
87.00-99.99	Various minor diagnostic & therapeutic procedures	

Table A2: Demographic and Clinical Characteristics of the VA and Medicare FY 1999 AMI cohorts (age 65 and older)

	Prior to Matching		Matched Sample	
	VA	Medicare	VA	Medicare
	(n=4588)	(n=114933)	(n=4502)	(n=4502)
Age 65-69	**24.6**	**20.6**	24.6	26.3
70-74	**27.8**	**24.1**	27.5	26.7
75-79	**27.6**	**23.0**	27.6	26.5
80-84	**14.5**	**17.5**	14.6	14.8
85 and older	**5.6**	**14.9**	5.7	5.7
Male	**79.3**	**91.7**	**80.6**	**83.1**
Race: White	**11.5**	**5.5**	**11.5**	**9.1**
Black	**5.3**	**1.2**	**4.0**	**3.7**
Hispanic	**3.9**	**1.7**	**3.9**	**4.2**
Missing/other	**28.8**	**14.4**	28.8	27.6
Socioeconomic Variables[a]:				
% with college degree	**19.3**	**22.5**	**19.5**	**18.9**
Median household income	**32383.7**	**37903.4**	**32783.6**	**31909.4**
% professional	**20.1**	**22.7**	**20.3**	**19.8**
% Black	**12.4**	**8.6**	**12.4**	**10.4**
% Hispanic	**5.3**	**5.0**	5.3	5.4
% public assistance	**9.1**	**7.8**	9.2	9.0
% > 64 with public assistance	**10.3**	**9.1**	10.4	10.5
Missing zip code	**8.6**	**6.1**	7.5	7.5
Clinical Variables[a]:				
Prior MI	12.7	13.1	12.6	12.8
Chronic angina	**6.8**	**5.6**	6.8	6.8
Unstable angina	**8.3**	**5.1**	7.9	8.5
Arrhythmia	10.1	9.6	10.1	9.5
Cardiac arrest	1.4	1.6	1.4	1.2
Arthritis	**10.2**	**9.3**	10.2	10.2
Cancer	**7.0**	**5.6**	7.0	6.5
CHF	**16.5**	**13.0**	16.3	15.7
Coagulation disorder	1.0	1.0	1.0	1.0
Conduction abnormality	2.7	2.7	2.7	3.1
Conduction disorder	0.3	0.5	0.3	0.3
COPD	**33.2**	**28.1**	33.3	34.0
Connective tissue disease	0.5	0.6	0.5	0.5
CVA	**2.9**	**2.3**	2.8	2.7
Dementia	**6.8**	**6.0**	6.8	6.3
Diabetes	**34.9**	**24.6**	34.3	33.7
Diabetes w/ end organ damage	**8.0**	**5.2**	7.9	7.6

Table A2: Demographic and Clinical Characteristics of the VA and Medicare FY 1999 AMI cohorts (age 65 and older)				
	Prior to Matching		Matched Sample	
	VA	Medicare	VA	Medicare
	(n=4588)	(n=114933)	(n=4502)	(n=4502)
Clinical Variables (continued)[a]:				
Alcohol/drug abuse	**4.6**	**2.5**	4.5	4.9
Thyroid disease	**6.1**	**5.2**	6.1	5.6
Fluid disorder	4.6	4.4	4.6	4.6
GI bleeding	**2.2**	**1.2**	2.2	2.0
Hypertension	**63.6**	**49.0**	63.0	62.2
Hypertension w/complications	**3.2**	**4.6**	**3.2**	**2.6**
Liver disease	**0.6**	**0.4**	0.5	0.5
Neurological disorder	**2.8**	**4.5**	2.8	2.8
Paralysis	**0.5**	**0.2**	0.4	0.3
Pneumonia	**5.8**	**4.5**	5.8	5.7
Psychosis	**3.5**	**1.7**	3.3	3.1
Neurotic disorder	**1.9**	**0.9**	**2.0**	**1.1**
Lung disease	1.0	0.9	1.0	1.1
Renal failure	**5.9**	**4.2**	5.7	6.1
Hypotension	4.0	4.1	4.0	4.1
Syncope	**2.2**	**1.4**	2.1	1.9
Ulcers	**1.7**	**0.8**	1.6	1.7
UTI	**4.4**	**2.9**	4.4	4.2
Endocarditis	**3.1**	**4.5**	3.1	3.0
PVD	**13.8**	**11.4**	13.6	12.9

[a] Obtained from 1990 census by linking to the zip code of the patient's residence.
[b] Obtained from primary and secondary diagnoses from inpatient claims.
Bolded numbers represent significant differences at 10% level.

Table A3: Clinical Characteristics of FY 1999 VA AMI Cohort (n=8,664)	
Variables not Related to Treatment[a]	**Percent**
Hypertension	60.8
Diabetes	32.0
COPD	23.6
Arthritis	8.7
Diabetes (end organ damage)	7.3
Psychosis	4.6
Alcohol/drug abuse	8.2
PVD	11.2
Prior MI	11.3
Cancer	4.8
Renal Failure	4.6
Thyroid disease	5.2
Hypertension w/ complications	2.5
Dementia	4.3
Neurological disorders	2.2
Paralysis	0.4
Connective Tissue Disorder	0.5
Liver Disease	0.7
Lung Disease	0.7
Variables Possibly Related to Treatment[b]	**Percent**
Chronic angina	5.6
CHF	12.5
Unstable angina	7.4
Arrythmias	7.2
Neurotic disorders	3.0
CVA	2.2
Hypotension	3.2
Ulcer	1.4
Pneumonia	4.1
Fluid disorder	3.7
Urinary tract infection	3.2
Endocarditis	2.3
GI bleeding	1.6
Syncope	1.7
Cardiac arrest	1.1
Coagulation disorders	1.6
Conduction abnormalities	1.8
Conductive disorders	0.3

[a] Coded based on secondary diagnoses from the index admission as well as primary and secondary diagnoses from inpatient claims in the year prior to admission.

[b] Coded based on primary and secondary diagnoses from inpatient claims in the year prior to admission.

Table A4: DSS Cost Categories			
Category Number	**Category**	**IPD* Codes**	**IPD Description**
1	**ICU/Post-Op/Recovery Nursing**	UE11	SICU
		UE21	TICU
		UE31	MICU1
		UE41	MICU2
		UE51	NICU
		UE61	CCU
		UE71	Stepdown 1
		UE81	MICU/SICU Comb
		UEJ1	Recovery room
2	**Ward Nursing**	U2**	Ward Nursing
		UEK1-UES1	Ward Nursing
		UF**	Ward Nursing
		UG**	Ward Nursing
		UH**	Ward Nursing
		UJ**	Ward Nursing
3	**Physician Bed-Day**	*081	Staff Physician Labor associated with the inpatient stay
4	**Physician Extenders**	*0N1	Staff Physician Extender Labor
5	**Other Bed-Day**	P4A*	Psychiatry Residential Rehab Treatment
			Centers - General PRRTP
		P4C*	SARRTP (Substance Abuse)
		P4D*	Compensated Work Therapy Transitional
			Residence -CWTTR-HCMI
		P4E*	CWTTR-Substance Abuse
		P4F*	CWTTR-PTSD
		P4G*	CWTTR General
		32**	NUR-IPD NUMBER
		40**	NUR-IPD NUMBER
		45**	NUR-IPD NUMBER
		4L**	NUR-IPD NUMBER
6	**Surgery**	S31*	Operating Room
		S34*	Cysto Uro Rooms
		S36*	Implants
		S3S*	Minor Surg in OR
		SSJ*	Pre-Op Anesthesia
		SSX*	Amb Surg OR
		G31*	Anesthesia in OR
		G3S*	Anesthesia in Non-OR
		GSJ*	Pre-Op Anesthesia
		ASX*	Ambulatory Surgery
		C31*	SCI Operat Rm products

Table A4: DSS Cost Categories			
Category Number	**Category**	**IPD* Codes**	**IPD Description**
7	**Laboratory**	L***	All Lab departments
8	**Pharmacy**	D***	All Pharmacy departments
9	**Radiology/Nuclear Medicine**	X***	Diagnostic Radiology
		H***	Nuclear Medicine
		Z06*	Radiation Therapy
		Z07*	Radiation Therapy
		Z08*	Radiation Therapy
		Z6U*	Radiation Therapy
		ZT**	Radiation Therapy Cl
		MTB*	Ultra-Sound Cl
10	**Administration**[18]	*001	
11	**Teaching**	*021	
12	**Research**	*011	
13	**All Other**	Everything not otherwise identified above	

[18] Although defined as separate categories in DSS, no costs were observed for administration, teaching, or education in the DSS data provided. However, Barnett and Rodgers (1999) found that the costs for these activities were allocated to, and included in, the costs of departments that produce patient care. Thus, we assume these costs are included in the data we obtained, though not separately identifiable.

Table A5: ICD-9-CM Diagnosis Codes 410.xx-414.xx	
ICD-9-CM Diagnosis Code*	**Diagnosis**
410	**Acute myocardial infarction**
410.0	Of anterolateral wall
410.1	Of other anterior wall
410.2	Of inferolateral wall
410.3	Of inferoposterior wall
410.4	Of other inferior wall
410.5	Of other lateral wall
410.6	True posterior wall infarction
410.7	Subendocardial infarction
410.8	Of other specified sites
410.9	Unspecified site
411	**Other acute & subacute forms of ischemic heart disease**
411.0	Postmyocardial infarction syndrome
411.1	Intermediate coronary syndrome
411.8	Other
411.81	Coronary occlusion without myocardial infarction
411.89	Other
412	**Old myocardial infarction**
413	**Angina pectoris**
413.0	Angina decubitus
413.1	Prinzmetal angina
413.9	Other & unspecified angina pectoris
414	**Other forms of chronic ischemic heart disease**
414.0	Coronary atherosclerosis
414.00	Of unspecified type of vessel, native or graft
414.01	Of native coronary artery
414.02	Of autologous biological bypass graft
414.03	Of nonautologous biological bypass graft
414.04	Of artery bypass graft
414.05	Of unspecified type of bypass graft
414.1	Aneurysm of heart
414.10	Of heart (wall)
414.11	Of coronary vessels
414.19	Other
414.8	Other specified forms of chronic ischemic heart disease
414.9	Chronic ischemic heart disease, unspecified

Table A6: Procedure Codes		
Procedure Category	**Identifying Codes**	
	ICD-9	**CPT-4**
Coronary Artery Bypass Graft (CABG)	36.10 36.11 36.12 36.13 36.14 36.15 36.16 36.19	33510 33511 33512 33513 33514 33516 33517 33518 33519 33521 33522 33523 33533 33534 33535 33536
Percutaneous Coronary Interventions (PC1)	36.01 36.02 36.05 36.06	92980 92981 92982 92984
Catheterization	37.22 37.23 88.53 88.54 88.55 88.56 88.57	93508 93510 93511 93524 93526 93539 93540 93545

Table A7: Average Cost per Discharge (Matched Cohorts)[a]				
Episode Increment	Matched VA Cohort (Facility and Physician Costs)	Matched Medicare Cohort		
		Part A (Facility Cost)	Estimated Physician Charges (RVU weighted $ value)	Total (Facility + Physician Costs
Index Admissions	**$13,530 (N-3,758)**	$13,793	$ 2,652	**$16,445 (N-3,758)**
Post Index ≤30 Days[b]	**$11,910 (N-303)**	$12,201	$ 2,377	**$ 14,578 (N-234)**
31-60 Days[b]	**$10,692 (N-163)**	$11,874	$2,101	**$ 13,975 (N-165)**
61-90 Days[b]	**$9,663 (N-116)**	$9,229	$1,961	**$ 11,190 (N-111)**

[a]We obtained the average cost for each discharge in each episode increment by aggregating the costs of all discharges and dividing by the number of discharges.

[b]Due to the relatively small "N" in the post index episode increments, the differences may not be statistically significant.

Table A8: Estimated Average Physician Charges per Discharge				
Episode Increment	N	Estimated Average Physician Charges (Matched Medicare Cohort)		
		Procedure Charge per Discharge	Attending Charge per Discharge	Total Charge per Discharge
Index Admissions	3,758	$ 1,954	$ 698	$ 2,652
Post Index ≤30 Days	234	$ 1,783	$ 594	$ 2,377
31-60 Days	165	$ 1,535	$ 566	$2,101
61-90 Days	111	$ 1,428	$ 533	$1,961

Table A9: Unadjusted Average Length of Stay (All VA AMI patients[a])				
VISN	**Index Admissions (N=7,464)**	**Post Index ≤30[c] (N=665)**	**31-60[c] (N=361)**	**61-90[c] (N=221)**
1	12.0	9.7	4.5	19.1
2	9.7	7.2	6.9	56.3
3	12.2	9.8	6.6	5.4
4	10.5	7.7	5.6	42.2
5	11.4	6.4	4.0	7.2
6	10.7	10.1	6.6	7.4
7	11.5	7.6	6.9	5.3
8	9.5	5.9	6.0	6.2
9	9.2	5.9	6.4	7.3
10	8.7	22.5	14.3	3.0
11	8.3	6.4	6.2	8.0
12	8.8	9.6	3.6	5.0
13	8.3	9.1	5.3	5.2
14	7.6	7.5	6.5	4.0
15	8.0	11.3	7.2	5.2
16	9.6	10.2	9.4	8.2
17	9.2	10.2	7.2	11.8
18	9.1	10.2	13.2	7.0
19	8.4	9.0	6.0	6.3
20	8.6	6.3	6.9	7.7
21	8.8	11.8	5.7	9.8
22	9.6	5.9	9.3	12.3
Multiple VISNs[b]	10.7			
ALL VISNs	**9.4**	**8.9**	**7.2**	**9.5**

[a]Represents unadjusted costs for the 94.3% of all VA AMI patients captured in DSS.

[b]Discharges within the index admission in more than one VISN.

[c]Contiguous admissions were not linked for the post index admission episode increments and therefore are likely understated.

Table A10: Unadjusted Average Cost per Discharge (All VA AMI patients[a])				
VISN	**Index Admissions (N=7,464)**	**Post Index, ≤30 (N=665)**	**31-60 Days (N=361)**	**61-90 Days (N=221)**
1	$17,389	$15,029	$ 5,879	$22,746
2	$14,391	$10,089	$ 9,163	$19,466
3	$16,928	$ 9,352	$12,705	$ 6,924
4	$12,224	$10,403	$ 5,324	$19,055
5	$13,985	$ 6,084	$ 8,790	$11,234
6	$12,571	$11,629	$ 7,920	$ 8,460
7	$14,957	$11,443	$ 6,776	$ 5,562
8	$ 9,180	$ 6,207	$ 7,333	$ 5,381
9	$11,264	$10,952	$ 7,188	$ 5,757
10	$10,401	$14,610	$10,679	$ 2,878
11	$12,031	$ 8,896	$10,647	$11,242
12	$12,298	$19,466	$ 5,856	$12,263
13	$16,192	$13,268	$ 7,540	$ 7,768
14	$ 9,071	$ 7,353	$ 6,954	$ 4,104
15	$10,904	$10,395	$ 9,647	$ 6,180
16	$13,320	$10,775	$11,747	$ 7,925
17	$11,206	$12,900	$ 9,993	$ 9,957
18	$12,927	$ 9,273	$12,048	$ 5,980
19	$11,737	$ 9,797	$ 8,526	$ 6,902
20	$18,545	$ 9,148	$13,335	$ 8,147
21	$14,546	$22,742	$11,052	$12,698
22	$17,335	$ 8,662	$15,790	$26,725
Multiple VISNs[b]	$16,311			
ALL VISNs	**$13,000**	**$10,938**	**$ 9,582**	**$ 8,917**

[a]Represents unadjusted costs for the 94.3% of all VA AMI patients captured in DSS.

[b]Discharges within the index admission in more than one VISN.

Table A11: Unadjusted Average Cost per AMI (All VA AMI patients—N=7,464[a])				
VISN	**Average Index**	**Post Index ≤30**	**31-60**	**61-90**
1	$17,389	$ 259	$ 203	$1,177
2	$14,391	$ 913	$ 393	$ 278
3	$16,928	$1,033	$ 517	$ 362
4	$12,224	$1,075	$ 213	$ 572
5	$13,985	$ 425	$ 246	$ 393
6	$12,571	$ 764	$ 390	$ 243
7	$14,957	$ 801	$ 214	$ 201
8	$ 9,180	$ 533	$ 438	$ 274
9	$11,264	$ 848	$ 351	$ 141
10	$10,401	$1,613	$ 277	$ 19
11	$12,031	$ 839	$ 578	$ 225
12	$12,298	$1,677	$ 154	$ 184
13	$16,192	$1,569	$ 382	$ 236
14	$ 9,071	$ 566	$ 321	$ 63
15	$10,904	$ 833	$ 596	$ 175
16	$13,320	$1,166	$ 542	$ 263
17	$11,206	$ 958	$ 495	$ 185
18	$12,927	$ 942	$ 596	$ 140
19	$11,737	$ 980	$ 335	$ 222
20	$18,545	$ 907	$ 965	$ 262
21	$14,546	$2,924	$ 526	$ 363
22	$17,335	$ 841	$ 966	$ 385
Multiple VISNs[b]	$16,311	$ -	$ -	$ -
ALL VISNs	**$13,000**	**$ 974**	**$ 463**	**$ 264**

[a]Represents unadjusted costs for the 94.3% of all VA AMI patients captured in DSS.

[b]Discharges within the index admission in more than one VISN.

Table A12: Unadjusted Cumulative Costs per AMI (All VA AMI patients—N=7,464[a])			
VISN	**1-30 Day**	**31-60 Day**	**61-90 Day**
1	$ 17,648	$ 17,851	$ 19,028
2	$ 15,304	$ 15,697	$ 15,975
3	$ 17,961	$ 18,478	$ 18,840
4	$ 13,299	$ 13,512	$ 14,084
5	$ 14,410	$ 14,656	$ 15,049
6	$ 13,335	$ 13,725	$ 13,969
7	$ 15,758	$ 15,972	$ 16,173
8	$ 9,713	$ 10,151	$ 10,425
9	$ 12,111	$ 12,463	$ 12,603
10	$ 12,014	$ 12,291	$ 12,310
11	$ 12,869	$ 13,447	$ 13,672
12	$ 13,975	$ 14,129	$ 14,313
13	$ 17,761	$ 18,143	$ 18,380
14	$ 9,637	$ 9,958	$ 10,021
15	$ 11,737	$ 12,333	$ 12,508
16	$ 14,486	$ 15,028	$ 15,291
17	$ 12,165	$ 12,660	$ 12,845
18	$ 13,868	$ 14,464	$ 14,605
19	$ 12,717	$ 13,052	$ 13,274
20	$ 19,452	$ 20,418	$ 20,680
21	$ 17,470	$ 17,997	$ 18,359
22	$ 18,176	$ 19,142	$ 19,526
Multiple VISNs[b]	$ 16,311	$ 16,311	$ 16,311
ALL VISNs	**$ 13,974**	**$ 14,437**	**$ 14,702**

[a]Represents unadjusted costs for the 94.3% of all VA AMI patients captured in DSS.

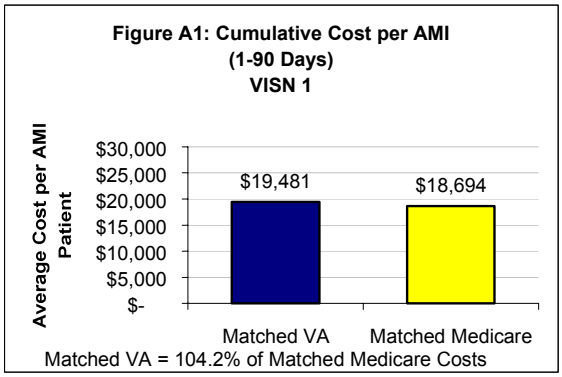
[b]Discharges within the index admission in more than one VISN.

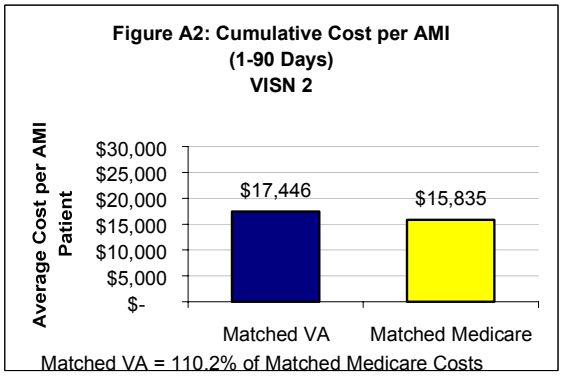
Table A13: Unadjusted VA Costs by DSS Category (All VA AMI Patients—N=7,464[a])

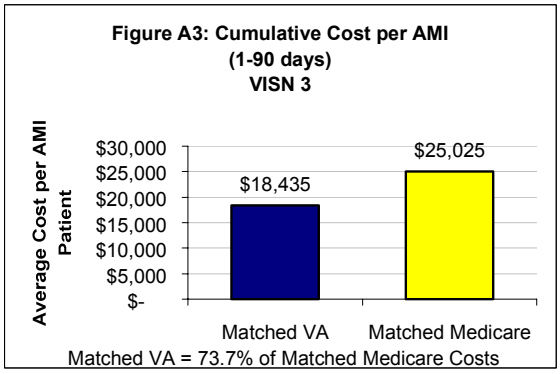
	ICU Post-op	Ward Nursing	Physician Bedday	Physician Extenders	Other Bedday	Surgery	Laboratory	Pharmacy	Radiology	Admin	Teach	Research	All Other	Total Costs
1	$2,959	$2,898	$1,539	$ -	$ -	$ 948	$ 924	$2,011	$ 771	$ -	$ -	$ -	$5,339	$17,389
2	$4,913	$1,771	$ 937	$ -	$ -	$ 422	$ 589	$1,239	$ 570	$ -	$ -	$ -	$3,951	$14,391
3	$4,207	$2,173	$2,802	$ -	$ -	$ 545	$ 871	$2,774	$ 730	$ -	$ -	$ -	$2,828	$16,928
4	$3,039	$1,657	$1,308	$ 0.05	$ 0.05	$ 478	$ 569	$ 924	$ 698	$11.60	$2.54	$ -	$3,536	$12,224
5	$5,593	$1,889	$1,385	$ -	$ 2.63	$ 173	$ 859	$1,368	$ 505	$ -	$ -	$ -	$2,209	$13,985
6	$4,264	$1,568	$1,045	$ -	$ 0.21	$ 992	$ 704	$ 842	$ 678	$ -	$ -	$ -	$2,476	$12,571
7	$5,039	$1,789	$1,300	$ 4.05	$ -	$ 998	$ 784	$1,559	$ 683	$ -	$ -	$ -	$2,800	$14,957
8	$3,950	$ 896	$ 693	$ -	$ 8.33	$ 374	$ 494	$ 698	$ 500	$ -	$ -	$ -	$1,567	$ 9,180
9	$3,034	$1,304	$1,295	$ -	$ 0.07	$ 319	$ 561	$1,334	$ 580	$ -	$ -	$ -	$2,836	$11,264
10	$3,916	$1,264	$ 954	$ -	$ -	$ 717	$ 874	$ 569	$ 588	$ -	$ -	$ -	$1,521	$10,401
11	$3,944	$1,556	$ 852	$ -	$ 0.20	$ 926	$ 749	$ 851	$ 513	$ -	$ -	$ -	$2,639	$12,031
12	$4,039	$1,260	$ 495	$ -	$ 0.17	$ 925	$ 713	$1,007	$ 619	$ -	$ -	$ -	$3,241	$12,298
13	$4,849	$ 842	$ 919	$ -	$ 0.61	$ 825	$ 796	$1,066	$ 568	$ 5.85	$ -	$ -	$6,321	$16,192
14	$2,610	$1,205	$1,029	$ 0.81	$ -	$ 140	$ 520	$ 661	$ 580	$ -	$ -	$ -	$2,325	$ 9,071
15	$3,270	$1,879	$ 685	$ -	$ 0.52	$ 140	$ 491	$1,076	$ 378	$ -	$ -	$ -	$2,983	$10,904
16	$4,885	$1,149	$1,467	$12.57	$ 0.08	$ 450	$ 654	$1,060	$ 536	$ -	$ -	$ -	$3,106	$13,320
17	$2,737	$1,219	$1,214	$ -	$13.70	$1,572	$ 724	$1,503	$ 542	$ -	$ -	$ -	$1,682	$11,206
18	$2,752	$2,633	$ 673	$ -	$ 0.39	$ 783	$ 662	$ 751	$ 598	$ -	$ -	$1.16	$4,081	$12,927
19	$2,991	$1,296	$1,128	$ -	$ -	$ 487	$ 736	$1,419	$ 414	$ -	$ -	$ -	$3,266	$11,737
20	$4,103	$1,262	$1,342	$ -	$ 0.58	$1,078	$ 681	$6,194	$ 528	$ -	$ -	$ -	$3,357	$18,545
21	$6,669	$1,040	$ 788	$ -	$ -	$ 831	$ 696	$1,151	$ 962	$ -	$ -	$ -	$2,410	$14,546
22	$5,630	$1,424	$1,623	$ 0.02	$ 9.13	$ 889	$1,112	$1,495	$ 658	$ -	$ -	$ -	$4,495	$17,335
Multiple VISNs	$4,968	$1,176	$1,248	$ -	$ -	$2,084	$ 573	$1,377	$ 678	$ -	$ -	$ -	$4,208	$16,311
ALL VISNs	**$4,026**	**$1,488**	**$1,106**	**$ 1.42**	**$ 1.91**	**$ 670**	**$ 681**	**$1,393**	**$ 578**	**$ 0.70**	**$0.10**	**$0.06**	**$3,053**	**$13,000**

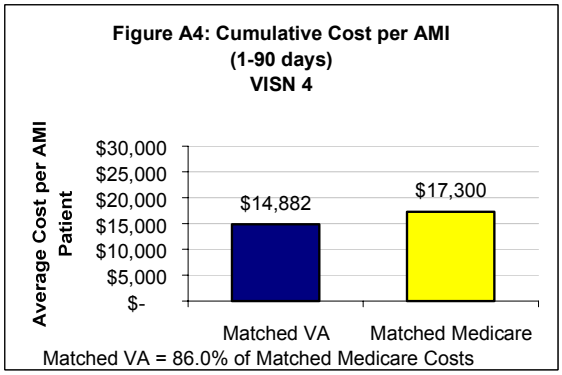
[a]Represents unadjusted costs for the 94.3% of all VA AMI patients captured in DSS.

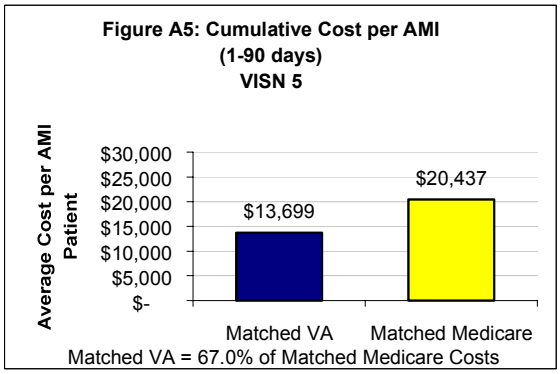
Figure A1-A22, Matched Cohorts

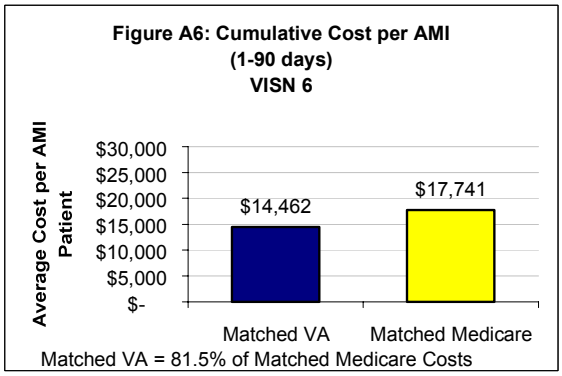


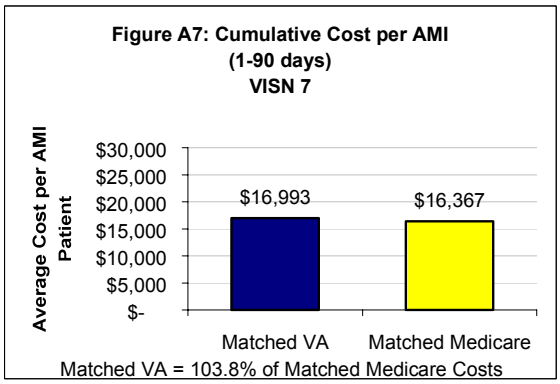












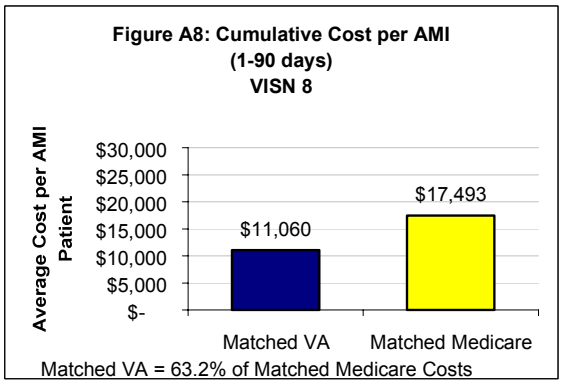
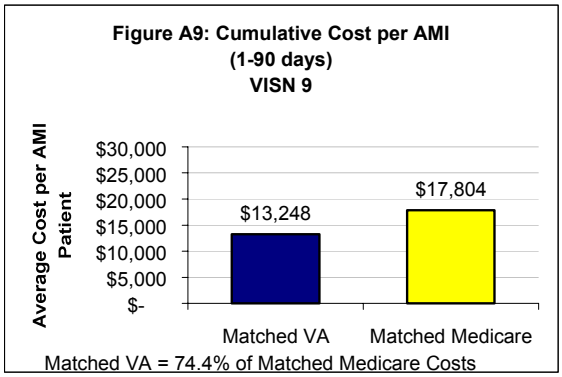
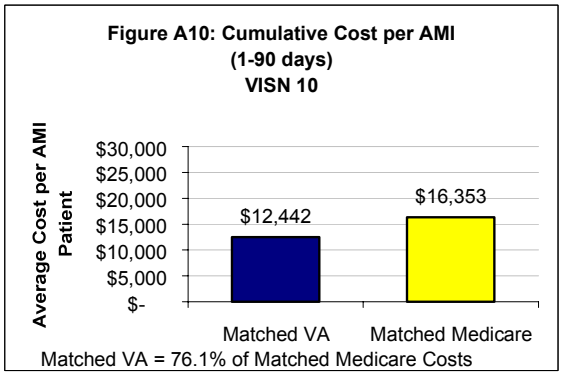
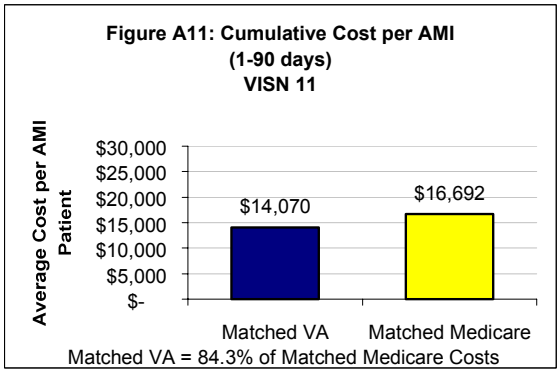
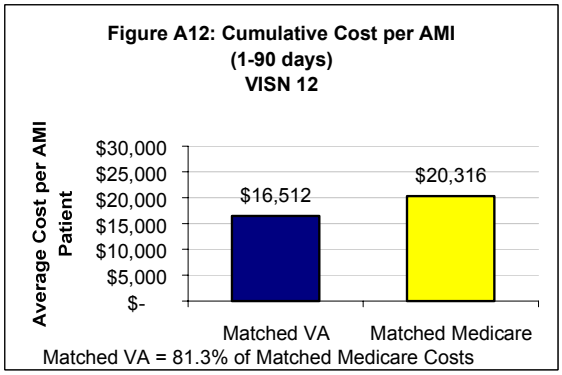


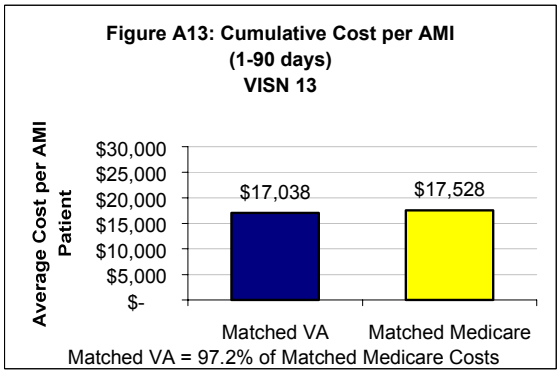
Figure A1-A22, Matched Cohorts

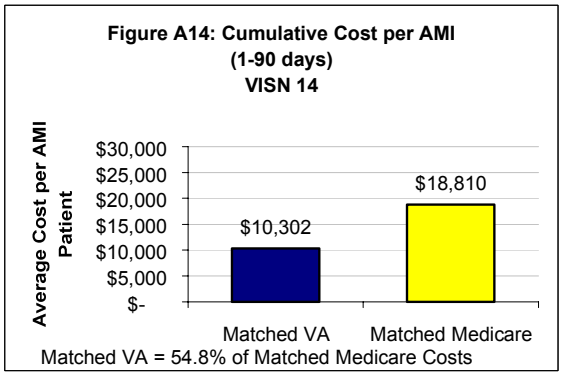


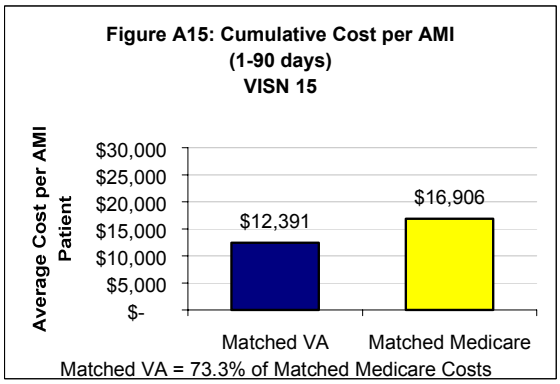












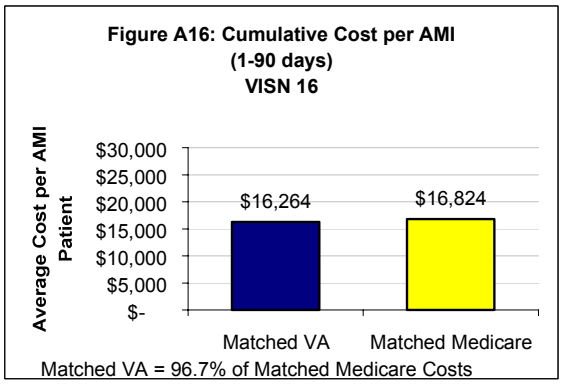
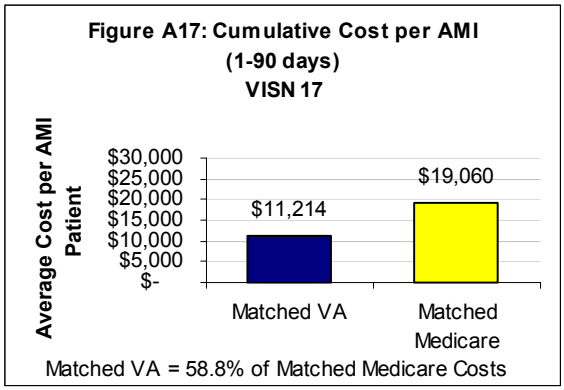
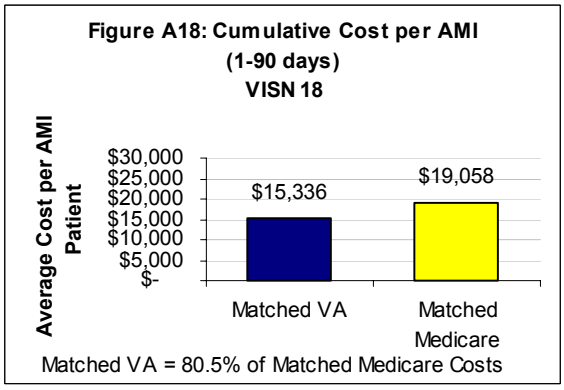
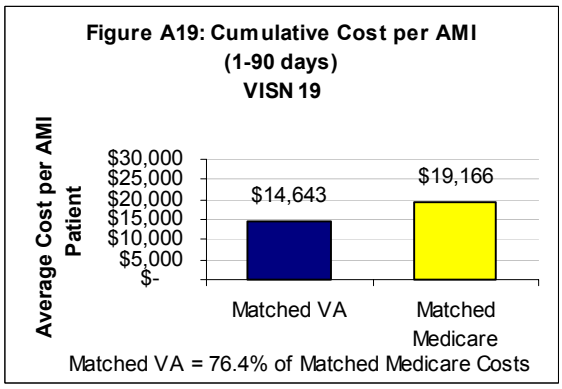
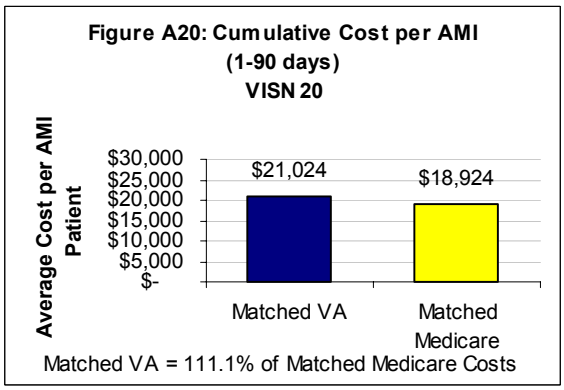


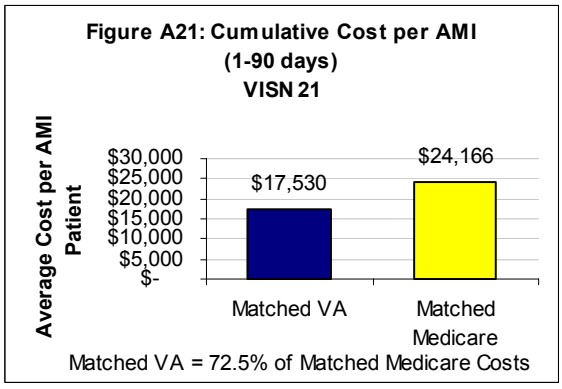
Figure A1-A22, Matched Cohorts

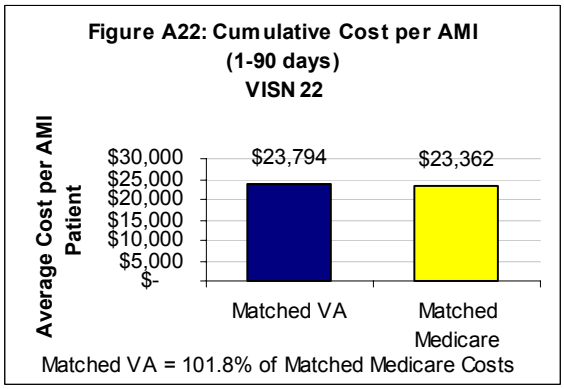












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