Longitudinal Study of Ischemic Heart Disease Among Aged Medicare Beneficiaries

Final Report

Volume 1
Chapters 1-6

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Executive Summary

1.0 Origins of Study

Because of continuing disparities in the burden of illness and death experienced in racial and ethnic minority communities, the President's Initiative on Race committed the nation to eliminate these disparities in six areas of health – infant mortality, cancer screening and management, cardiovascular disease, diabetes, HIV infection/AIDS, and immunizations. (http://raceandhealth.hhs.gov/sidebars/sbinitOver.htm) In response to the President's Initiative, The Department of Health and Human Services (DHHS) is examining its current programs, identifying gaps in knowledge, and developing research agendas to address these gaps. (http://raceandhealth.hhs.gov/sidebars/sbinitOver.htm) Staff in the Centers for Medicare and Medicaid Services (CMS) have already published research on disparities among racial and ethnic groups using Medicare claims (Gornick, Eggers, Reilly, 1996; Eggers and Greenberg, 2000; Gornick, 2000).

CMS subsequently issued a Request for Proposal to study racial and ethnic differences in the utilization of services and outcomes for aged Medicare patients with ischemic heart disease (IHD). Staff at Health Economics Research (now merged with Research Triangle Institute) were awarded the contract and submit the following detailed report documenting beneficiary access and outcomes of care over the 1997-1999 period by racial/ethnic group and socioeconomic status. This is an Executive Summary of the data bases, methods, and key findings of the report.

2.0 Brief Literature Review

For the first 15-20 years after the Medicare program was established, access to and utilization of health services was thought to be essentially equal for beneficiaries because it was a national program with universal coverage policies. Then, beginning with a few key articles in the early 1990s (Ayanian JZ, Udvarhlyi S, Gatsonis CA, *et al.,* 1993; Blustein J and BC Weitzman, 1995a; Escarce JJ, Epstein KR, *et al*., 1993; Ford E, Cooper R, Castaner A, *et al.,* 1989; McBean AM; Warren JL; and Babish JD, 1994; McClellan M, McNeil, and BJ, Newhouse, JP, 1994; Mitchell JB and R Khandker, 1995; Udvarhelyi IS, Gatsonis C, Epstein AM, *et al.,* 1992), disturbing differences were uncovered in the rates at which elderly Blacks utilized new high-tech cardiac services despite the evidence that Blacks have equivalent or higher prevalence rates of coronary heart disease compared to Whites (Gillum RF, 1982; American Heart Association, 2000).

More recent studies have confirmed the lower rates of complex diagnostic testing and reperfusion therapies for Blacks compared to Whites (Peterson ED, Shaw LK, DeLong ER, *et al.,* 1997; Gornick ME, Eggers PW, and Reilly TW, 1996; Lee AJ, S Gehlbach, D Hosmer, *et al.*, 1997; Mitchell JB, Ballard DJ, Matchar DB*, et al.,* 2000; Weitzman S, Cooper L, Chambless L, *et al.,* 1997; Eggers PW and Greenberg LG, 2000). Much less research has been published on other minorities besides Blacks and, when available, has produced conflicting findings. For example, some studies have found Hispanics less likely than Whites to undergo open heart surgery (Blustein J and BC Weitzman, 1995a; Blustein J, Arons R, and S Shea, 1995b; Giacomini MK, 1996) while others find no such differences (Mayberry RM, Mili F, Vaid IGM, *et al.,* 1999; Canto JG, Allison JJ, Kiefe CI, *et al.,* 2000). Lower use rates of complex interventions is especially puzzling in light of evidence that elderly Blacks and other minorities appear to have higher admission rates to acute care hospitals (Peterson ED, Shaw LK, DeLong ER, *et al.,* 1997; Eggers PW and Greenberg LG, 2000). Even fewer utilization and mortality studies are available for Asians and American Indians (Eggers PW and Greenberg LG, 2000; Giacomini MK, 1996; Canto JG, Taylor HA Jr., Rogers WJ, *et al.,* 1998).

Rural location and poverty area residence have both been linked to lower use rates among Blacks (Escarce JJ, Epstein KR, Colby DC, *et al*., 1993; Mitchell JB and R Khandker, 1995), as has socioeconomic status more generally (Gornick ME, Eggers PW, Reilly TW, 1996). Minorities may have less access to costly high-tech procedures because they cannot afford them. Among Medicare beneficiaries, Blacks are 2-3 times less likely to have supplemental insurance that pays their hospital deductibles and physician copays (Chulis GS, Eppig FJ, Hogan MO, *et al.,* 1993; Chulis GS, Eppig FJ, and JA Poisal, 1995). Consequently, they are more than twice as likely as elderly Whites to incur out-of-pocket payments (Rice T and N McCall, 1985).

Even controlling for socioeconomic status, research has shown that Blacks are often treated differently in the same hospital (Maynard C, Fisher LD, Passamani ER, *et al*., 1986; Yergan J, Flood AB, LoGerfo JP, *et al*., 1987; Chen J, Rathore SS, Radford MJ, *et al.,* 2001) and are less often referred for cardiac catheterization (Schulman KA, *et al.,* 1999; LaViest TA, A Morgan, M Arthur, *et al*., 2002) or to a specialist (Mitchell JB, Ballard DJ, Matchar DB*, et al.,* 2000). Reasons given in the literature include: (a) racial and cultural differences in seeking health care based on prior experience and financial fears (Chen J, Rathore SS, Radford MJ, *et al.,* 2001; Ell K and I Castaneda, 1998), (b) a feeling that suffering is inevitable or that the patient is unfamiliar with the procedure (Uba L, 1992), (c) a lack of education more generally (Joe JR, 1996), (d) communication difficulties (Cook LS, de Mange BP, 1995), (e) disagreements with physician recommendations (Maynard C, Fisher LD and ER Passamani, 1987; Schecter AD, Goldschmidt-Clermont PJ, McKee G, *et al.,* 1996), or (f) an aversion to surgery (Oddone EZ, Horner RD, Diers T, *et al.,* 1998). At least one study has found that Whites are more likely than Blacks to bypass the nearest hospital to receive care at a high-tech facility (Blustein J and BC Weitzman, 1995a).

Although extensive, the literature has certain drawbacks in studying race/ethnic disparities. First, it often is not national in scope but, rather, focused on one or two hospitals or states. Second, it is somewhat limited in its sample sizes in studying other than Black minorities. Third, it is limited in its distinction among different kinds of high-tech diagnostic and therapeutic interventions - especially within minority groups. Fourth, it hardly ever distinguishes between services provided on an ambulatory basis prior to admission versus in the hospital. And fifth, it rarely follows the discharged patient to the referral hospital, if any, when describing hospital choice and the sequence of care.

This project constructed a unique, national, longitudinal claims-based data base to study race/ethnic disparities in ischemic heart disease access and utilization in the Medicare population. We take advantage of recent major improvements in race/ethnic coding in Social Security and Medicare data bases to provide new estimates of elderly admission and mortality rates for five race/ethnic groups: Whites, Blacks, Hispanics, Asians, and American Indians. Once admitted to an acute hospital for IHD in 1997, utilization of services is described both during and six months prior to admission. Readmissions and transfers to other hospitals are also reported. Mortality rates through 2½ years post-admission are explained using a combination of socio-demographic and illness severity indicators as well as access to complex cardiovascular testing and revascularization procedures.

3.0 Data Sources & Methods

Part A Claims. The Medicare longitudinal IHD file developed for this study includes a sample frame of all elderly (age 65+) short stay acute care hospital inpatient claims for patients with a primary diagnosis of ischemic heart disease that were admitted and discharged in 1997. We used a standard definition of IHD based on ICD-9-CM codes 410.0-414.9 that range from heart attacks (AMIs) to asymptomatic sclerosis (37). Based on each patient's first, or index, admission in 1997, all subsequent inpatient admissions through January, 2000, were merged onto our 1997 index admission file. Next, we extracted all SNF, home health, and other provider claims to describe treatment for the three-year period following an acute admission for IHD. Although available, these claims are not analyzed in this paper.

Part B Claims. Particularly unique to the analysis of disparities are the several million Medicare Part B physician claims that also were merged onto the index admission file both 6 months prior to and during the index admission.

Enrollment Data. Beneficiary enrollment information from CMS' denominator file provided annual information on program eligibility and demographic information such as state and zip code of residence, age, gender, race, reasons for entitlement, and monthly indicators for different types of eligibility coverage (Part A, Part B, HMO coverage, and Medicaid Buy-In).

Census Data. A census-based zip code level population and income database from a commercial vendor (40) was used to impute SES characteristics of patients' local market area, e.g., income, education, labor force participation.

Hospital Characteristics. The American Hospital Association (AHA) annual provider files and CMS's Provider of Service (POS) files supplied facility zip code location, ownership, level of teaching activity, number of beds, and provision of services (e.g., open heart surgery). The AHA file also included hospital longitude and latitude that was used to calculate patient travel distances to facilities.

Exclusions & Calculation of Rates. All patients in 1997 under age 65 and those who did not reside in the 50 states and the District of Columbia were deleted. The final 1997 file has 700,682 unique patients admitted with a principal diagnosis of IHD: Whites (633,609); Blacks (44,235); Asians (4,015); Hispanics (9,868), American Indians (847). Counts of beneficiaries, used in calculating population-based admission rates, were weighted by the number of months alive and enrolled in Medicare Part A and B fee-for-service (non-HMO) in 1997. Mortality rates were calculated as the proportion of unique (or index) IHD inpatients who died 30, 90 and 365 days after their first admission date in 1997. Two sets of procedure rates were developed: one including services in the six months prior to admission in the second half of 1997, and another incorporating utilization both prior to and during the admission. Admission, mortality, and procedure rates reported by race/ethnicity were age/gender adjusted using the direct method. Income was used as a fourth adjustor within some sub-populations to test its effects on utilization and mortality.

4.0 Summary of Major Findings

We summarize the report's key findings by addressing five important policy questions (stated below with findings).

What disparities exist in admission rates between aged Medicare Whites and other minorities with ischemic heart disease?

In 1997, after adjusting for age and gender differences, Whites were more likely to be admitted for ischemic heart disease than all other minority groups except Hispanics (who exhibited equivalent rates). Blacks were about 20 percent less likely to be admitted and Asians one-third less likely to be admitted compared with Whites. The discrepancies in rates were especially pronounced among minority men, including American Indians. For example, Black men were admitted for the disease at rates nearly 40 percent below those of Whites. Even Hispanic men showed lower admission rates (20 percent) than Whites, which were offset by higher admission rates for Hispanic women.

Dramatically lower IHD admission rates for Blacks versus Whites is opposite that reported by Gornick (2000; p. 39) for elderly admissions across all illnesses. Moreover, the prevalence of cardiovascular disease among Black and Hispanic men is slightly higher than among White men, which implies higher, not lower, admission rates for ischemic heart disease (American Heart Association, 2000). The higher prevalence of the disease among Black and Hispanic women, however, is consistent with our finding of similar or higher IHD admission rates for these women relative to White women.

Living in wealthier neighborhoods is associated with lower admission rates for Whites and Hispanics but not for Blacks or Asians. Access to inpatient care is likely better in wealthier places because of broader insurance coverage. Thus, lower White admission rates in wealthier neighborhoods are probably the result of healthier lifestyles and continual access to preventive care. Why Blacks in wealthy areas do not enjoy the same health access of Whites -- and even Hispanics -- is unknown, but it does not appear to be due to restricted access to tertiary care facilities (as shown below).

Do elderly racial/ethnic minorities have the same access as Whites to sophisticated diagnostic and therapeutic technologies?

Hospitalization often is a necessary condition for undergoing complex diagnostic angiography and revascularization. Lower admission rates, therefore, explain at least part of the lower use rates of these services for Blacks. Yet, even when admitted, Blacks, Hispanics, and American Indians are less likely to undergo complex invasive interventions such as angioplasty or open heart surgery (discussed further below). Asians are quite different from other racial/ethnic groups in experiencing similar revascularization rates to Whites. Although not undergoing diagnostic catheterization as often as Whites, Blacks do show higher rates of stress testing, 24-ECG monitoring, and echocardiography. Whether more complex diagnostic testing is substituting for invasive therapy among Blacks compared to other racial/ethnic groups is worthy of further study.

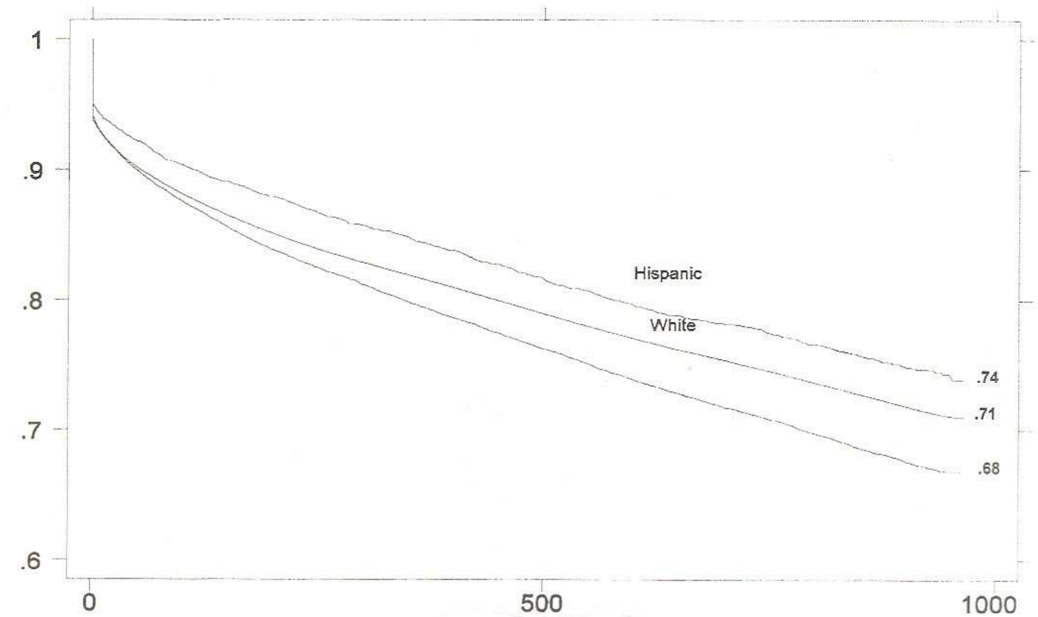
How significant are the disparities in mortality rates among race/ethnic groups with ischemic heart disease and what factors explain these differences?

Elderly mortality rates from ischemic heart disease are quite high. Once admitted during the year (1997), 8 percent of elderly beneficiaries die within 30 days and nearly 18 percent die within one year. Although Whites are less likely to die than Blacks after 2½ years post-admission (see Figure E-1 survival curves), they are about equally likely to die within 30 days of an IHD admission. The survival gap widens consistently over time resulting in 71 percent survival rates for Whites versus 68 percent rates for Blacks after 2½ years. Survival rates for Hispanics are uniformly higher (74 percent) than every race/ethnic group, including Whites. This is consistent with other researchers' findings (Gornick, 2000).

After controlling for race/ethnicity differences in age, gender, and health risk factors upon an IHD admission, <u>elderly Blacks are no longer more likely to die than Whites after 2½ years</u>. Underlying risk factors largely explain the disparities in observed mortality rates between Whites and Blacks. Blacks are sicker upon admission as indicated by higher emergency admissions, heart attacks, and comorbid illnesses. Hispanics, already less likely to die than Whites after 2½ years before any adjustments, experience even higher survival rates after adjusting for demographic and health risk factors. Why this is the case is unknown. Adjustments for risk factors had only minor effects on Asian and American Indian survival rates compared with Whites.

Figure E-1

Unadjusted Kaplan-Meier Survival Curves for Blacks, Hispanics & White Beneficiaries Following IHD Admission, 1997



NOTES:
1. Survival rates are unadjusted for age, comorbidity or other factors.

SOURCE: RTI/HER analysis of SOURCE 1997-1999 100% Denominator and MedPAR files.

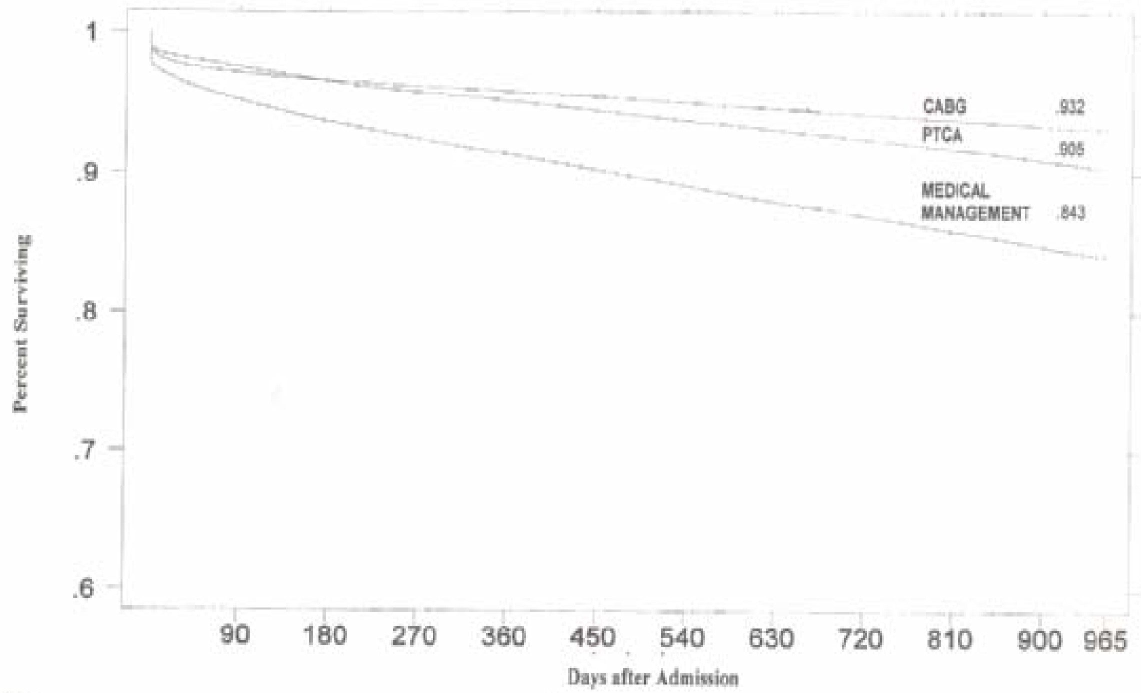
What explains the disparities in revascularization rates among elderly race/ethnic groups with ischemic heart disease and how do any differences affect mortality and survival?

Dramatically lower revascularization rates were found among elderly Black and American Indian beneficiaries relative to Whites. Asians and Whites had equivalent rates while Hispanic rates were slightly lower than Whites. The clinical practice guideline developed by the Agency for Healthcare Research and Quality (AHRQ) for diagnosing and treating unstable angina provided the framework for explaining cardiac catheterization and revascularization rates among our elderly population. The goal of the guideline for clinicians is to identify the risk of an adverse event and triage patients to the appropriate medical or surgical therapies. The guideline also provides a blueprint, or model, for explaining why certain patient risk factors result in aggressive surgical versus more conservative medical care on any given admission. Applying the AHRQ guideline in explaining revascularization disparities, we found that Blacks and American Indians were still far less likely to undergo either angioplasty or open heart surgery (approximately one-third less likely) even after controlling for factors that might have made them poorer candidates for revascularization on a particular admission.

After adjusting for all socio-demographic characteristics and risk factors, Whites, Asians, and Hispanics were equally likely to undergo revascularization during an admission (approximately 40 percent).

Revascularization improves survival (see Figure E-2). Controlling for comorbidities and severity of heart disease, over 93 percent of elderly beneficiaries

Figure E-2
Kaplan-Meier survival Curves for All Beneficiaries by Revascularization Procedure, Adjusted for Race/Ethnicity, Comorbidities, Sociodemographic Factors, Severity Upon Admission. Diagnostic Procedures



NOTES:
1. PTCA, CABG, Other Medical Management groups are based on assigning patients to one type of intervention; patients receiving both CABG and PCTA are in both groups.
2. Survival rates are adjusted for race/ethnicity, age, comorbidity, severity of admission and diagnostic procedures.
3. Curves are estimated from a Cox proportional hazards regression stratified by treatment group.
SOURCE: RTI/HER analysis of SOURCE 1997-1999 100% Denominator and MedPAR files.

undergoing open heart surgery (CABG) were still alive after 2½ years compared with only 84 percent experiencing medical management alone. Angioplasty (PTCA) patients had roughly 91 percent survival rates, again controlling for all other factors. Note that PTCA and CABG curves cross roughly six months post-admission. Elderly beneficiaries were more likely to survive within a few months of undergoing angioplasty, but the long-term survival benefits to heart surgery, instead, were greater.

Both forms of revascularization raise survival rates for all race/ethnic groups when studied separately. The gain is most for Whites, but minorities also benefit substantially from either angioplasty or open heart surgery. Controlling for revascularization had the greatest effect on White-Black mortality disparities because Blacks are much less likely than other minorities to undergo either potentially life-saving procedure.

Can referrals to hospitals with differing cardiac capabilities explain some or all of the disparities in revascularization and mortality rates?

Not according to our results. Blacks are more, not less, likely than Whites to be first admitted to a major teaching hospital and equally likely to be admitted to one offering open heart and angioplasty services. Blacks live closer to these facilities and travel shorter distances even when transferred. Even a lower rate of cardiac catheterization cannot explain the disparities in revascularization rates. While it is true that elderly Blacks are 15 percent less likely to be catheterized than Whites upon first admission, they are still less likely (28 percent) than Whites to undergo revascularization even when catheterized. When the elderly are not initially catheterized, Blacks are one-third less likely than Whites to be transferred to another facility. Moreover, for those beneficiaries actually transferred to another facility without first being catheterized, Blacks are one-quarter less likely than Whites to undergo revascularization at the second facility.

Lower revascularization rates even when catheterized at the initial or transferred facility implies that factors other than "system biases" are at work. If discrimination is a major reason for lower Black revascularization rates, it is not the result of systematic referrals to lower quality institutions lacking the needed complex diagnostic and therapeutic services. A systematic bias on the part of physicians could explain why Blacks do not undergo revascularization even when catheterized if they are more often rejected by surgeons. And while a system bias might explain their lower transfer rate without initial catheterization, it hardly explains Blacks' lower revascularization rate versus Whites when both are transferred. It is not even clear that lower catheterization rates are the result of a system failure-to-refer (as suggested by LaVeist, 2002) versus a preference on the part of Black patients to avoid invasive testing antecedent to risky surgery (Maynard *et al*., 1986; Schecter, 1996). We agree with LaVeist, *et al*., (2000, p. 958) when they suggest that "African American patients may be signaling to physicians…that they would be unwilling to submit to invasive procedures *[even] if recommended*." [italics added]

Gornick (2000) rejects a "culture of poverty" as a primary reason for disparities in the use of medical services--especially for high-tech services that require a knowledgeable physician referral. Instead, she hypothesizes that "socially advantaged individuals...[who] expect to receive high-quality medical care services" may explain the higher revascularization rates of Whites (p. 43). But if this were the case, it is difficult to explain the higher rates of Blacks undergoing other complex diagnostic testing (e.g., echocardiograms, 24-hour ECG monitoring, complex diagnostic imaging). It appears to us that something is driving a wedge between the initial diagnosis of IHD disease among Blacks and actually undergoing an invasive procedure with some risk of early death. One possibility is that "[d]isadvantaged persons may...be more likely to see pain as part of the human condition, to be fatalistic about illness, and to assume that not much can be done to alter the course of the disease." (Gornick, 2000, p. 41) Alternatively, an "aversion to high-risk surgery" on the part of Blacks, not fatalism, could be the root cause (see Oddone, Horner, and Diers, 1998).

What research and policy questions remain?

As with many studies in this field, new questions arise during the course of the analysis. This is particularly true in our project given its preliminary nature working with a very large, flexible, longitudinal data base.

Most intriguing are the reasons behind the failure of Blacks, and to a lesser extent American Indians, to undergo higher risk revascularization. Exactly how much of the disparity is due to the fact that they are poorer candidates for revascularization upon admission versus how much is due to physicians simply not referring them for cardiac catheterization, or to cardiologists and surgeons being unwilling to perform revascularization, is unknown. Finally, and how much may simply be an aversion to surgery on the patient's part?

All of the mortality and survival analyses, including our own, implicitly assume that death is the result of ischemic heart disease--even after 2½ years post-discharge. McClellan, Newhouse, and McNeil (1994) hypothesize that tertiary facilities might save lives of heart attack victims because of their enhanced ability to treat the patient's associated comorbidities over the long run. Are higher long-run mortality rates of Blacks and American Indians due to any system failures to treat IHD versus other comorbid illnesses (e.g., diabetes)?

Our study focused on a relatively narrow window of time six months prior to the first admission in 1997, through any immediate transfer to another acute facility. The new Medicare IHD longitudinal data file provides an excellent source for studying the longer-term treatment of the disease by race/ethnic group. At issue is the possibility of "delayed intervention" if Blacks postpone riskier care in favor of medical management. In so doing, they risk fatal heart attacks with no life-saving admission or enter the hospital as a candidate too poor for revascularization. "Delayed intervention" using medical management may explain lower Black admission rates per year, possibly coupled with more admissions over a longer episodic window and a revascularization rate that eventually converges to that of Whites. The longitudinal file provides excellent opportunities to describe in detail the temporal patterns of diagnostic and therapeutic services provided Blacks and other minorities.

Turning to other minorities, Hispanics and Asians exhibit very different utilization and mortality patterns than Blacks and American Indians. Hispanics are admitted at equal rates to Whites yet are less likely to die even when not controlling for their poorer health status upon admission. Why? Asians are far less likely to be admitted for IHD and die less frequently than Whites when they are admitted. Again, why? Practically nothing is known about the patterns of treatment and outcomes of elderly American Indians. Our single year sample sizes were too small to test for many differences. They travel farther for inpatient care, are the least likely of our minority groups to be admitted to a major teaching or open heart facility, and consequently are least likely to receive complex diagnostic or revascularization procedures. Why?

Other policy variables are worth studying. Why are dual Medicare/Medicaid eligibles 15-30 percent more likely to die within one year of an IHD admission? The physician Part B claims contain “sociological” codes such as “family problems with housing...etc.” and “unavailable local services” that occasionally are correlated with IHD utilization and mortality. These codes may be worth closer examination by race/ethnic group to explain lower use and shorter survival rates.

1 Introduction

1.1 Motivation of Study

1.1.1 Growing Perceptions of Inequalities in Beneficiary Access

For the first 15-20 years after the Medicare program was established, access to and utilization of health services was thought to be essentially equal for beneficiaries because, after all, Medicare is a national program with universal coverage policies. Then, beginning with a few key articles in the early 1990s, reviewed in Chapter 2, disturbing differences were uncovered in the rates at which blacks utilized new high-tech services even within the Medicare population. To many, these differences were surprising given the egalitarian eligibility and coverage policies of the federal program.

Because of continuing disparities in the burden of illness and death experienced in racial and ethnic minority communities, the President's Initiative on Race committed the Nation to eliminate these disparities in six areas of health status – infant mortality, cancer screening and management, cardiovascular disease, diabetes, HIV infection/AIDS, and immunizations. (http://raceandhealth.hhs.gov/sidebars/sbinitOver.htm) In response to the President's Initiative, The Department of Health and Human Services (DHHS) is examining its current programs, identifying gaps in knowledge, and developing research agendas to address these gaps. (http://raceandhealth.hhs.gov/sidebars/sbinitOver.htm)

As part of DHHS's overarching goals, the Center for Medicare and Medicaid Services (CMS) released a Request for Proposal to study racial and ethnic differences in the utilization of services and outcomes for aged Medicare patients with ischemic heart disease (IHD). Staff at Health Economics Research (now merged with Research Triangle Institute) were awarded the contract and submit the following report documenting access to, and outcomes of, care by race/ethnicity and socioeconomic status for Medicare IHD beneficiaries over a three-year period, 1997-1999. Disparities related to cardiovascular disease are particularly important because of cardiovascular disease kills nearly as many Americans as all other diseases combined. (http://raceandhealth.hhs.gov/3rdpgBlue/Cardio/3pgGoalsCardio.htm)

1.1.2 Limited Availability of Data on Causal Factors

A large literature now exists on inequalities in medical use rates by race. This is true even for cardiovascular disease. Much less exists, however, specifically on the elderly Medicare beneficiary and even fewer studies go beyond black/white comparisons to study other race/ethnic groups. Indeed, the whole field is limited by the lack of data on a national scale. Clinical trials, often the source of utilization and outcomes information, are usually conducted in one or a few sites not randomly selected to represent the U.S. population, let alone oversampling minorities. Also, information on utilization, costs, risk factors, disease incidence rates, out-of-pocket burdens, and outcomes are extremely costly to collect on other than a narrow geographic scale.

At the very least, rigorous study of utilization and access inequalities in medical care requires very large samples composed of very specific information. Utilization rates must be disease specific because so many diagnostic and treatment services focus on a single illness. Comorbid conditions should also be controlled for as well. Next, availability of services in local markets must be quantified along with patient ability to pay. Finally, outcomes are multi-dimensional, ranging from slight discomfort to death. Thus, if the study's scope must be reduced to a specific disease while many different kinds of data are required to properly judge access and effectiveness, then very large geographically dispersed populations are needed to avoid overlooking true racial differences in access. Very large samples are even more necessary in studying minority populations--especially non-black populations.

1.2 Research Agenda

1.2.1 Overview of Longitudinal File

In response to the challenges in studying race/ethnic differences, our staff assembled an analytic file of all aged Medicare Part A claims from acute hospitals with a principal IHD diagnosis (700,682 in 1997).[1] Pertinent demographic and eligibility information were merged onto the core file along with all Part B outpatient and physician

[1] Because of small samples of some minority groups in 1997, complete samples of all minority groups were extracted from the Part A claims files for 1998 and 1999 as well. These data were not used in the present study but are available for future research.

claims for the year (several million claims). Patients in the core file were followed through 1999 in terms of survival--again using Medicare enrollment information. Special, privately collected zip code demographic and economic data were also merged onto the file by the beneficiary's zip code.

1.2.2 Research Questions

Using the augmented claims file, five broad questions frame the research:

1. How large, and for what kinds of services, are there significant gaps in medical care utilization rates between aged Medicare whites and minorities?
2. What factors explain such differences?
3. What are the 30-day, 1-year, and 2.5-year mortality and survival rates of Medicare aged racial/ethnic groups?
4. What role do pre-admission and inpatient diagnostic and therapeutic interventions play in explaining differences in mortality rates?
5. Are race/ethnic groups systematically referred to different kinds of hospitals, both upon first admission and for subsequent transfers?

1.2.3 Usefulness of Medicare Claims

The Medicare Part A and B claims, judiciously enhanced, are clearly a large, comprehensive database, albeit with limitations. Testimony to their usefulness is the demand for Medicare files by outside researchers and firms in studying medical interventions, devices, and drugs. CMS staff (e.g., Gornick, *et al.*, 1996) have also conducted internal research in the general area of technology, race, and utilization, creating unique databases when needed. To support further research on cardiovascular disease, this project has as a major goal the construction of a linked database on a specific, high incidence, disease – Ischemic Heart Disease. The longitudinal database will grow over time, supporting analyses of longer run utilization and outcome trends.

The great strength of the claims, besides their unique payment and service utilization information, is their detail on inpatient diagnostic and therapeutic interventions. Enrollment data add another critical dimension of demographic and payment information plus dates of death. Patient zip code residency can be used in merging on small-area economic and health care provider information. Non-hospital Part B claims provide a rich utilization data set for studying episodes of care, which is usually only possible through very extensive patient surveys.

Claims, of course, have some critical limitations, some of which can be fairly easily overcome though census, AHA, AMA, and similar data. What is much more difficult is detailed clinical information deemed important in fully describing risk factors and complications. For IHD, missing information would include ejection fraction, stenotic anatomy, history of smoking, renal function, body mass, etc. While we suggest ways of using proxy correlates of these factors, it will always be the case that clinical differences across race and ethnic backgrounds will go unmeasured using claims--unless CMS undertakes a special medical records abstraction.

Notwithstanding these limitations, much can be done with a comprehensive longitudinal database grounded in Medicare claims. The present effort builds on earlier and continuing CMS staff interest in the topic of racial/ethnic disparities in health.

1.3 Summary of Key Findings

1.3.1 Admission Rates of IHD

Independent evidence suggests that Blacks, Hispanics, and Native Americans have equivalent or higher rates of coronary heart disease compared to Whites (Gillum, 1982; http://www.americanheart.org, 2000). The American Heart Association reports that the age-adjusted prevalence rate of coronary heart disease (CHD) is 7.1 percent and 9.0 percent for non-Hispanic black men and women, respectively, and 7.2 percent and 6.8 percent for Mexican American men and women, respectively. These rates are comparable to the rates reported by the American Heart Association for non-Hispanic white men (6.9%) and higher than the rates for non-Hispanic white women (5.4%).

Our study is based on elderly IHD hospitalizations (using ICD-9 codes 410-414) and, therefore, is not a prevalence analysis. The American Heart Association uses a broader definition of IHD in that they include ICD-9 code 429.2 (arteriosclerotic cardiovascular disease) (American Heart Association, 2002). Given the reported prevalence of CHD, one might expect admission rates to be comparable, if not higher, among minority beneficiaries compared to whites. This was not always the case. In our study of elderly Medicare eligibles with a first (index) IHD admission in 1997, we found that:

- The overall IHD index admission rate was 23.7 per 1,000 Medicare elderly eligibles. This rate adjusts eligible counts for past-year fee-for-service eligibility.

- The index admission rate, which is equivalent to number of unique beneficiaries admitted per 1,000 eligibles, was only three-fourths of the overall IHD admission rate including all admissions during 1997.
- The admission rate of white beneficiaries with a principal diagnosis of IHD was 26 percent greater than for blacks and 50% greater compared to Asians.
- Hispanics had a statistically greater admission rate for IHD (24.9) than whites (24.2).
- Black, Asian, and Native American admission rates did not vary by zip code income (ranging from 19.2-19.9).
- Whites living in high income zip codes, by contrast, had significantly lower admission rates compared to whites living in the lowest income quartile.
- Men had significantly higher admission rates for IHD compared to women, with the differences narrowing with age.
- Admission rates of IHD were the greatest for beneficiaries aged 75-84 (27.0 per 1,000) compared to those aged 85 and older and 65-74.
- Over 18 percent of IHD patients were readmitted within 30-days of discharge.
- Readmission rates were significantly higher for blacks compared to whites but uniformly lower for Asians.
- Readmission rates increased with age and patients aged 85 and older were readmitted over 60 percent of the time within one year.

1.3.2 Mortality and Survival Rates

In previous HCFA research, Gornick, *et al*. (1996) found higher mortality rates and hospital discharge rates for black Medicare patients compared to white Medicare patients (see, also, American Heart Association, 2000). Using the new IHD longitudinal file, and adjusting only for age-gender-income, we found:

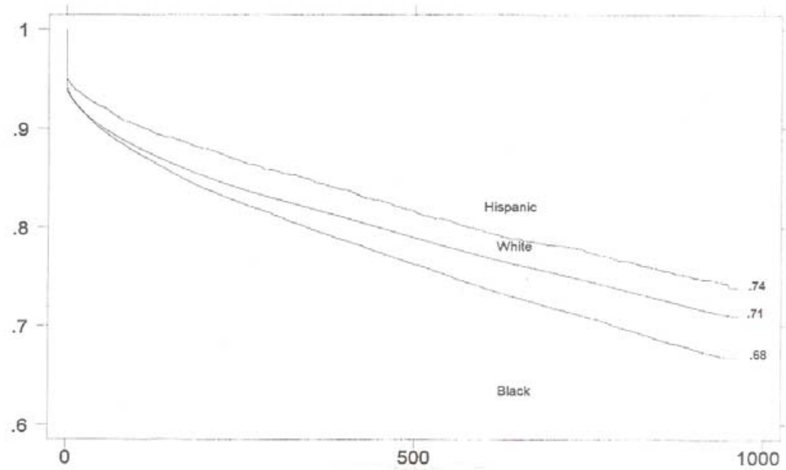
- Approximately 6 percent of the IHD sample died in the hospital during their index IHD admission.

- Over 8 percent of our IHD sample patients died within 30 days of their 1997 index IHD admission.
- Within 30-days of the index admission, whites had a higher mortality rate compared to blacks and Hispanics. However, the mortality rate among blacks was statistically higher than whites in the 90-day and one-year periods.
- Mortality rates for black and white men in the lowest income quartile were significantly higher than mortality rates among patients in the top 2 quartiles.
- Mortality rates increased dramatically with age. Nearly 18 percent of those aged 85 and older dying within 30 days of their index admission.
- Nearly 40 percent of IHD hospitalized patients ages 85 and older died within one-year of their 1997 index IHD admission.
- For all ages and within age groups, women tended to have lower mortality rates than men.

In our multivariate analyses controlling for demographics, low income residence, comorbidities, and revascularization, we found:

- Aged Medicare blacks increase their likelihood of dying within 30 days or one year by roughly 8 percentage points by their lower rates of diagnostic angiography and revascularization.
- Dual Medicare/Medicaid eligibles are more likely to die because they undergo revascularization less often. The same is true of the over-75 IHD patients (as well as blacks).
- Two-and-a-half year survival rates, unadjusted for age or health status, varied from a low of 68 for blacks to 74 percent for Hispanics, with the white rate mid-way (71 percent) between the two extremes (see Figure 1-1).
- Survival rates of aged Medicare blacks are equivalent or even exceed those of whites after controlling for demographics, dual eligibility, low income area residence, comorbidities prior and during admission, and for revascularization. Hence, these variables explain all of the 14-17 percent higher black IHD mortality rate observed after one and 2.5 years. By contrast, (relatively high) Hispanic survival rates compared to whites change little after making various adjustments.

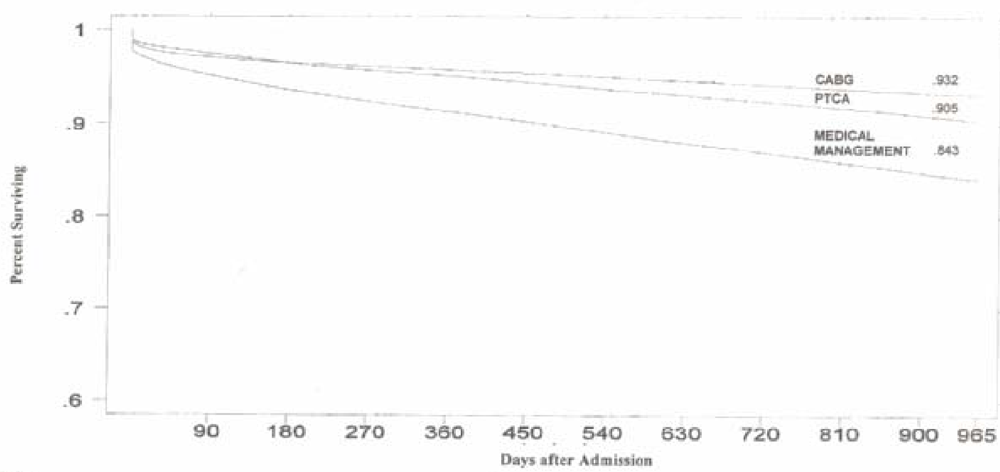
Figure 1-1
Unadjusted Kaplan-Meier Survival Curves for Blacks, Hispanics & White Beneficiaries Following IHD Admission, 1997



NOTES:
1. Survival rates are unadjusted for age, comorbidity or other factors.

SOURCE: RTI/HER analysis of SOURCE 1997-1999 100% Denominator and MedPAR files.

Figure 1-2
Kaplan-Meier Survival Curves for All Beneficiaries by Revascularization Procedure, Adjusted for Race/Ethnicity, Comorbidities, Sociodemographic Factors, Severity Upon Admission, and Diagnostic Procedures



NOTES:
1. PTCA, CABG, Other Medical Management groups are based on assigning patients to one type of intervention; patients receiving both CABG and PCTA are in both groups.
2. Survival rates are adjusted for race/ethnicity, age, comorbidity, severity of admission and diagnostic procedures.
3. Curves are estimated from a Cox proportional hazards regression stratified by treatment group.

SOURCE: RTI/HER analysis of SOURCE 1997-1999 100% Denominator and MedPAR files.

- Controlling for health status and other factors, Medicare patients undergoing bypass surgery experience 93 percent survival rates over 2.5 years versus 91 percent of PTCA (see Figure 1-2). Patients with only medical management have an 84 percent survival rate.
- Survival rates are higher for PTCA versus CABG 6 months post-discharge, but after 2.5 years, the CABG survival rate exceeds PTCA by 2-3 percentage points.

1.3.3 Diagnostic and Therapeutic Utilization Rates

Even after adjusting for the severity of coronary disease and other characteristics, studies have shown that blacks are less likely than whites to be recommended or undergo heart surgery or less invasive angioplasty (Eggers and Greenberg, 2000). We examined the use of procedures in the hospital during the index IHD admission and the characteristics of hospitals to which the IHD patients were admitted. The key descriptive findings are:

- Approximately one-half of all IHD patients received an invasive diagnostic cardiac catheterization and/or angiocardiography during their index hospitalization. These rates were significantly lower for older beneficiaries, women and all minorities.
- With few exceptions, Medicare beneficiaries age 75 years and older, women, and blacks, Hispanics, and Native Americans had lower rates for all types of coronary artery invasive procedures (e.g. CABG and PTCA) when compared to Medicare beneficiaries under age 75, men, and whites, respectively. Asians had rates similar to those for whites.
- Beneficiaries age 75 and older, women, and blacks generally had lower rates of hemodynamic and respiratory monitoring and life support services than their respective comparison groups. The other racial/ethnic minorities generally had similar rates of life support services as whites.
- Beneficiaries age 75 and older and all minorities except Asians had lower rates of ICU visits and generally had lower rates of all types of

specialty consults, including cardiology and cardiothoracic surgical consults, than younger white beneficiaries.

Multinomial analysis of the likelihood of undergoing PTCA or CABG surgery versus medical management revealed the following after controlling for socio-demographic characteristics, prior and concurrent admission risk factors, and previous PTCA and CABG:

- Blacks were still far less likely than whites to undergo either invasive PTCA or CABG procedure as were Native Americans (although the latter differences were only significant for PTCA due to small samples). Asians and Hispanics were equally likely to undergo either procedure controlling for other factors.
- Dual Medicare/Medicaid IHD eligibles were far less likely to undergo PTCA or CABG.
- Patients admitted with extremely serious conditions were less likely to undergo PTCA or CABG during the admission or immediate transfer. However, they were more likely to undergo either procedure if they had a prior history of such problems and were not admitted through the emergency room, or the physician (on claim) reported these procedures had not been performed in the past due to contraindications. Hence, the timing of the risk indicator, prior or during admission, can result in conflicting interpretations if not accounted for.
- A family history of heart disease and specialized diagnostic testing (e.g., echocardiogram), based on physician claims, were the strongest predictors of undergoing either procedure.
- A physician reported unavailability of needed facilities for care (on claim) significantly reduced the likelihood of PTCA and CABG (although insignificant in the latter).
- Patients with a previous CABG are more likely to undergo PTCA on a subsequent admission than another bypass but are more likely to be given only medical management than either invasive procedure.
- Patients with a previous PTCA are far more likely to undergo the same procedure on a subsequent admission than either CABG or medical

management--possibly because of their preferences and/or stenotic anatomy that is indicative of angioplasty.

1.3.4 Choice of Hospital

- Blacks (along with Asians) were more likely than whites to be admitted to a major teaching hospital (as defined by CMS) and far more likely than Native Americans. This is explained almost entirely by the closer proximity of blacks to these facilities.
- Blacks were no more likely than whites to be first admitted to hospitals with open heart surgery despite being more likely to go first to a teaching hospital. Native Americans were least likely to be admitted or transferred to an open heart hospital.
- Even when undergoing cardiac catheterization during an admission, blacks are only 72 percent as likely as whites to then undergo revascularization. Moreover, they are far less likely than whites to be transferred to another hospital if not cathed in their first hospital. By contrast, Native Americans are almost twice as likely as blacks to be transferred if not cathed in the first admission.
- The higher likelihood of PTCA over CABG for blacks and Native Americans narrows 6-9 percentage points when transfers are taken in account.
- Blacks travel fewer miles on average to their first hospital than any other race/ethnic group. Only Native Americans travel farther than whites to their first hospital.
- The median travel distance for transferred patients ranged for a low of 10 miles for Asians to 65 miles for Native Americans.

1.4 Overview of Report

The rest of the report is in 6 chapters plus supplemental appendices. Chapter 2 reviews the literature on racial disparities focusing on heart disease. A longer review can be found in an earlier report (Cromwell, *et al.*, 2001a). Chapter 3 provides a stylized model of patient health care utilization and access that guides the analysis by identifying domains of explanatory variables and generating testable hypotheses. Chapter 4 describes the various data sources used to build the longitudinal IHD file and how key variables were constructed. It also gives basic counts of beneficiaries and admissions used in the analyses. Chapter 5 presents descriptive results on IHD admission rates, readmission rates, and lengths of stay by race/ethnic group. It begins by reproducing an earlier CMS table in the RFP updated to 1997 and then presents several tables of rates stratified by age, gender, race, and beneficiary zip code income. Chapter 6 first presents extensive descriptive rates of diagnostic and interventional procedure rates and concludes with a multinomial analysis of the three interventions: PTCA, CABG, or medical management. Chapter 7 first presents descriptive tables of 30, 90, and one-year post-discharge mortality by race/ethnic group. It next presents logistic results of the likelihood of dying within 30 days and one-year post-discharge that control for numerous risk factors and other patient and hospital characteristics. It concludes with an analysis of 2.5-year survival rates using Cox proportional hazard estimation methods. Chapter 8 analyses race/ethnic differences in the choice of hospital for first admissions and transfers with a focus on cardiac catheterization and revascularization.

For ease of reading, all tables discussed in the text appear at the end of each chapter. Supplemental tables also appear in appendices cross-referenced to each chapter.

2 Literature Review

Numerous studies have documented racial and ethnic differences in access to health care, utilization of diagnostic and therapeutic procedures, and levels of disease and disability. Barriers to medical care may be financial, organizational, or cultural. This literature review describes the major issues surrounding medical care for vulnerable populations and discusses findings from studies that lend support to the importance of investigating these disparities. The major issues include:

- Differential utilization of health care;
- Regional practice variation;
- Ability to pay;
- Provider discrimination; and
- Culturally determined differences in care-seeking behavior.

The majority of studies (especially for the elderly) have focused on white/black disparities. When possible, literature examining other racial/ethnic groups is cited.

2.1 Differential Utilization and Mortality of Health Care

Most of the studies examining racial/ethnic differences in access to care have focused on black versus white utilization comparisons. Fewer studies include disparities for other races/ethnicities. Gornick, *et al.* (1996) found higher mortality rates and hospital discharge rates for black Medicare patients compared to white Medicare patients and lower rates of physician visits for ambulatory care, fewer mammograms, and fewer influenza immunizations for blacks. It has been well documented that elderly whites have better access to procedures and other specialized or high-technology services than elderly blacks. For example, using Medicare claims, Lee, *et al.* (1997) examined aged white and black utilization rates for 80 services and procedures including physician visits, ambulatory procedures, oncology, diagnostic procedures, and minor and major general surgery. The researchers found that the white utilization rate exceeded the black use rate for the majority of the procedures and black utilization was weighted toward lower cost procedures and services. Whites have also been found to be approximately three times more likely to receive carotid endarterectomy than blacks (Escarce, *et al.*, 1993; Horner, *et al.*, 1995; Mitchell, *et al.*, 2000). Giacomini (1996) found significant differences in the use of hospital-based procedures among minorities in California – whites were significantly more likely than blacks, Latinos, and Asians to have angioplasty, more likely than blacks and Asians to have endarterectomy, more likely than blacks and Latinos to have kidney transplantation or coronary artery bypass graft (CABG), and more likely than blacks to have a defribrillator implant.

Evidence suggests that, compared to whites, blacks, Hispanics, and Native Americans have equivalent or higher rates of coronary heart disease (Gillum, 1982; American Heart Association, 2000). The American Heart Association reports that the age-adjusted prevalence rate of coronary heart disease is 7.1% for non-Hispanic black men and 9% for non-Hispanic black women and 7.2% and 6.8% for Mexican American men and women respectively. These rates are comparable to the rates reported by the

American Heart Association for non-Hispanic white men (6.9%) and higher than the rates for non-Hispanic white women (5.4%).

Numerous studies have reported racial differences in the use of cardiac procedures. Whites have been found to be significantly more likely than blacks to undergo cardiac catheterization or to receive a coronary revascularization procedure, with whites being more than three times as likely to receive a CABG and a percutaneous transluminal coronary angioplasty (PTCA) as blacks (Peterson, *et al.*, 1997; Escarce, 1993; Lee, 1997, Maynard, *et al.*, 1986; Boutwell and Mitchell, 1993; McBean *et al.*, 1994). Studies of patients that had undergone an angiography or cardiac catheterization confirm that these racial disparities continue despite the apparent need for these procedures (Ayanian, *et al.*, 1993; Mitchell and Khandker, 1995; Udvarhelyi, *et al.*, 1992). After adjusting for the severity of coronary disease and other characteristics, studies have shown that blacks are 22% less likely than whites to be recommended for surgery, 13% to 40% less likely to undergo angioplasty and 32 to 70 percent less likely to undergo bypass surgery (Maynard, *et al.*, 1986; Weitzman, *et al.*, 1997; Ford, *et al.*, 1989; Goldberg, *et al.*, 1992). In a study of patients admitted to California hospitals with acute myocardial infarction (AMI) that examined the many phases of care leading to the use of revascularization procedures, minorities (blacks and Hispanics) were found to be less likely to undergo revascularization at each of these steps (Blustein, *et al.*, 1995a,b). The greatest disparity in coronary revascularization utilization was found among the patients who stood to gain the most from the procedure suggesting underuse in blacks (Peterson, *et al.*, 1997). Blacks have also been found to be significantly less likely than whites to receive reperfusion therapy for AMI (Canto, *et al.*, 2000). According to a Kaiser report published in 1999, Hispanic Americans were equally as likely as non-Hispanic whites to undergo bypass surgery, but less likely to receive catheterization and angioplasty (Mayberry, *et al.*, 1999). Rates of coronary arteriography, revascularization procedures, and hospital mortality were not significantly different between Hispanics, Asian-Pacific Islanders, and Native Americans and their white counterparts (Canto, *et al.*, 1998). In a study of 1998 Medicare hospitalizations, black, Hispanic, and Native American aged beneficiaries had higher rates of hospitalization for heart disease compared to whites and lower rates of CABG and PTCA compared to whites (Eggers and Greenberg, 2000). Five-year survival rates are also found to be significantly lower in blacks than whites (Maynard, *et al.*, 1987).

Several studies have examined these differences by the urban versus rural location of the hospital. Ayanian, *et al* (1993) found consistent disparities by race across all types of hospitals. Rural blacks appear to experience disproportionate reductions in use compared with rural whites - urban whites are approximately 2.5 times as likely as urban blacks to receive a coronary angioplasty but rural whites were more than 20 times as likely as rural blacks to receive the procedure (Escarce, *et al.*, 1993).

Studies have shown that there may be differential access to newer– and higher-technology procedures and services for elderly whites compared to elderly blacks. Whites have been shown to be more likely than blacks to receive a Doppler echocardiogram, a colonoscopy, an upper GI endoscopy, and a magnetic resonance imaging scan of the brain (Escarce, *et al.*, 1993; Lee, *et al.*, 1997). Rates were not significantly different for the corresponding older technologies (two-dimensional or M-mode echocardiograph, barium enema, UGI series, and computerized tomographic scan). Blacks also have a higher incidence of stroke, which suggests that they have a greater need for diagnostic CT scans and MRIs (Horner, *et al.*, 1995; Kittner, *et al.*, 1990). However, despite blacks having greater utilization rates of CT scans, white Medicare patients are found to have greater access to the newer MRI procedure (Boutwell and Mitchell, 1993).

2.2 Regional Practice Variation

Researchers have documented racial differences in access to care between urban and rural localities and among the four census regions. This research has focused on white-black differences leaving a gap in the literature on regional disparities for other races/ethnicities. A wide range of medical procedures and diagnostic tests were examined and white/black disparities were found throughout the U.S. with the largest disparities in the South (Lee, *et al.*, 1997; Escarce, 1993; Goldberg, 1992). Whites were found to have 38% more procedures (e.g., CABG, angioplasty, hip fracture repair, hysterectomy, MRIs, and eye procedures) than blacks in the South (compared to 11% in the non-South), and they were four times more likely than blacks to have CABG surgery and coronary angioplasty in the South (compared to 2 times in non-Southern regions) (Lee, *et al.*, 1997).

When McClellan, *et al.*, (1994) control for distance to a hospital with cardiac catheterization and revascularization capabilities in explaining the use of the service and mortality for AMI patients, no effect is found for blacks, implying no lack of access due to greater distance; hence, all black-white use differences "occur within hospitals" (p. 863). The authors also find that the contribution of diagnostic angiography and revascularization are strongest on the first inpatient day with diminishing effects over time due to other risk factors.

2.3 Differences Based on Ability to Pay

Many studies have examined racial differences in access to care in the Medicare program based on differences in patients' ability to pay. Ability to pay in most cases is measure through supplemental insurance and income. Elderly Hispanics and blacks are more likely than whites to have limited income – one-third of elderly Hispanics and blacks compared to 16% of elderly whites depend on Social Security payments for 100 percent of their retirement income (Hendley and Mushinski, 2000). The primary focus of these studies has been on white and black differences and in some cases the study has been expanded to include Hispanics. Little or no literature exists on disparities among Medicare-eligible Asians and Native Americans based on their ability to pay. Ability to pay has been proxied using dual Medicaid coverage and income in the area of patients' residence. These studies have shown that racial differences in healthcare use persist even among patients who are of similar socioeconomic status and face very low out-of-pocket costs for medical care. Gornick, *et al.* (1996), also found that low-income Medicare beneficiaries (both white and black) received fewer services (e.g., office visits, mammograms, and influenza immunizations) and had higher hospitalization and mortality rates compared to more affluent Medicare beneficiaries.

One reason hypothesized for why minorities use fewer high-technology services is their lack of supplemental insurance. 87.3% of fee-for-service Medicare beneficiaries in 1996 had some form of supplemental insurance, of which 18 percent was joint Medicaid coverage for deductibles and copayments (Eppig and Chulis, 1997). Blacks tend to be 2 to 3 times less likely to have supplemental insurance versus whites (Chulis, *et al.*, 1993; Chulis, *et al.*, 1995; Short and Vistnes, 1992; Rice and McCall, 1985). And when blacks enjoy supplemental insurance, it is 3 times more likely to be Medicaid rather than private insurance (Chulis, 1993). The net result is that elderly blacks are more than twice as likely as elderly whites to have to pay Medicare's deductibles and copayments out of pocket (Rice and McCall, 1985). Even controlling for gender, age, education, income, health status, and other factors, blacks and Hispanics are 20-25% less likely to purchase private supplemental insurance or to have employer-sponsored retiree benefits (Short and Vistnes, 1992). Hence, strong evidence suggests that racial differences in ability to pay for care are important factors in explaining medical service utilization.

Researchers have shown that among Medicare dual Medicaid eligibles, whites are more likely than blacks to receive care from a physician, two to three times more likely to receive coronary angioplasty, Swan-Ganz catheterization, carotid endarterectomy, and total hip replacement, and more than 3 times as likely to receive coronary bypass surgery (Escarce, *et al.*, 1993). AMI patients who were Medicaid-eligible or lived in poverty areas were significantly less likely to undergo cardiac catheterization or to receive revascularization procedures compared to patients that were not Medicaid eligible or who were not living in poverty areas (Mitchell and Khandker, 1995). This suggests that even after controlling for differences in ability to pay by studying only Medicare/Medicaid eligibles with no out-of-pocket health costs, blacks still exhibit lower use of certain medical services than whites. In contrast, although elderly Alaskan Natives have been found to suffer from a greater variety of impairments compared to whites, these health differences disappeared after controlling for socioeconomic factors, suggesting that income and education are more important determinants of health status among the elderly than ethnicity (Seccombe, 1989).

2.4 Provider Discrimination

Studies suggest that race, like other social and cultural factors, may influence physicians' clinical decisions. There are relatively few studies that have examined provider discrimination, and these have looked at differences between blacks and whites. There is little or no literature examining the existence of these disparities for other races/ethnicities. Black and white elders receive different care even when they use the same physicians and facilities. Researchers have documented that, even after adjusting for differences in income and insurance coverage, nonelderly blacks and whites receiving care at the same hospital often are treated differently (Maynard, 1986; Yergan *et al.*, 1987). Schulman, *et al* (1999) found that black women were referred for cardiac catheterizations 60 percent less often than white women, white men, and black men despite having the same medical history, insurance coverage, and occupations. They concluded that physicians' decisions are affected by the combination of the patient's race and sex. Some of the treatment differences have been attributed to referral bias, that is, blacks are less likely to see a neurologist for TIA and may be less likely to be referred for diagnostic testing (Mitchell, *et al.*, 2000; Horner, *et al.*, 1995).

In a recent study by Chen, *et al.* (2001), rates of cardiac catheterization were examined for Medicare fee-for-service patients hospitalized in 1994 or 1995 with acute myocardial infarction (AMI). Regardless of the race of the physician, black patients were less likely than whites to undergo cardiac catheterization within 60 days of admission.

2.5 Health-Seeking Behavior

Studies suggest that there are racial and cultural differences in seeking care, that following physicians' recommendations is related to beliefs in the causes and symptoms of disease and the ability to be treated, and that perceived barriers to care are based either on prior experience or fears of financial burdens (Chen, *et al.*, 2001; Ell and Costaneda, 1998). Evidence indicates that Southeast Asians do not access health care appropriately due to cultural reasons including beliefs that suffering is inevitable and that one's life span is predetermined. This is compounded by apprehension about seeking treatment due to a lack of familiarity with U.S. diagnostic techniques and treatments and communication problems with their providers (Uba, 1992). Native American women have been found to have poorer health status than that reported for other women in the United States despite the availability of free health care available through the Indian Health Service (HIS). Many of these women are not accessing the health care system due to poor socioeconomic conditions, lack of education, and cultural barriers (Joe, 1996). Cultural barriers include a lack of provider understanding of cultural differences, language barriers, differences in interpersonal communication, historical antipathy/fear of exploitation on the part of Native Americans, and distrust (Cook and deMange, 1995).

Researchers have found that blacks were more likely than whites to disagree with physicians' recommendations that they undergo bypass surgery or cardiac catheterization (Maynard, *et al.*, 1986; Schecter, *et al.*, 1996). African American stroke and TIA patients expressed a greater degree of aversion to undergoing a carotid endarterectomy and a greater willingness to risk death to avoid surgery (Oddone, *et al.*, 1998). African American patients report lower levels of agreement during their physician visits than do white patients. However, when patients saw a physician of their own race, the patients reported higher levels of agreement during the visit (Cooper, *et al.*, 1999).

Whites and blacks have also been found to differ in their ability or desire to travel to hospitals offering high-technology cardiac care, with white patients being more likely than black patients to bypass their nearest hospital to receive care at high-technology hospitals (Blustein and Weitzman, 1995a). Cultural beliefs have also been found to directly affect mammography utilization among African American women (Bailey, *et al.*, 2000). Psychological barriers, especially concern about cost, are important predictors of mammography use among Hispanic women (Stein, *et al.*, 1999). Mammography rates for elderly black and Hispanic women were found to be significantly lower than for white women (Caplan, *et al.*, 1992). Based on a national survey of elderly white, Hispanic, and black women, the main reason black women gave for not having a mammogram was that their physician did not recommend it, while Hispanic women felt that it was not needed or necessary.

2.6 Unanswered Questions

Despite the extensive literature that exists concerning racial and ethnic disparities in health care, there are several important areas for further research. First, most of the research focuses on white versus black differences and does not address the aspects related to other races/ethnicities. Second, it has not been possible to investigate the relative contributions of financial barriers among Medicare beneficiaries because person-level supplemental insurance and income information are not available. Future studies should include more detailed patient-level measures of socioeconomic status (e.g., income, education, supplemental insurance) to more precisely measure whether these factors are the primary explanation for racial/ethnic differences in medical care. Third, further investigation into the relationship between physician and patient decision making and racial/ethnic differences in the use of medical services is needed since use of health care may be affected by cultural differences influencing the patient-physician relationship. Fourth, determining potential differences in the characteristics of physicians and hospitals (e.g., specialty, race and gender of physician, types of procedures performed in hospitals) who care for the elderly may be especially important to understand racial/ethnic differences in rates of referral to different types of specialists. Many of these unanswered questions related to racial differences in the utilization of health care services are very difficult to measure and will require in-depth surveys, interviews, and focus groups to get to the substance of these differences.

3 Model of Patient Health Care Utilization & Access

Measures of health care utilization such as hospital discharges, rates of CABG surgery, and special diagnostic tests should be analyzed within a complete structural model capturing both supply and demand factors. Absent a complete model, invalid conclusions can be reached linking one factor to another if another key variable that influences one or both factors is overlooked. Misinterpretation is especially likely for income effects as we discuss below.

Race is generally considered one of four dimensions of Socio-Economic Status (SES), along with income (and wealth), education level, and occupation. Sociologists and economists have used socioeconomic status in analyzing important class distinctions in terms of employment, type of job, access to power, etc. It is a multidimensional construct because no one of the four dimensions necessarily implies a particular class position in society. In health, SES has most often been used as a causal factor in explaining access to high quality services.

3.1 Schematic Overview of Model

What, exactly, is the purpose of controlling for SES in the analysis? Racial disparities, or any disparities by demographic characteristic for that matter, are of interest given that Medicare is a universal program for the elderly. As such, one would not expect significant differences in health care utilization because beneficiaries have roughly the same depth of insurance coverage. This should eliminate any financial barriers to care that might affect lower SES minority groups. That wide disparities in use among racial/ethnic groups exist suggest either that minority beneficiaries still vary from whites in depth of insurance coverage and/or other factors contribute to inequalities in utilization.

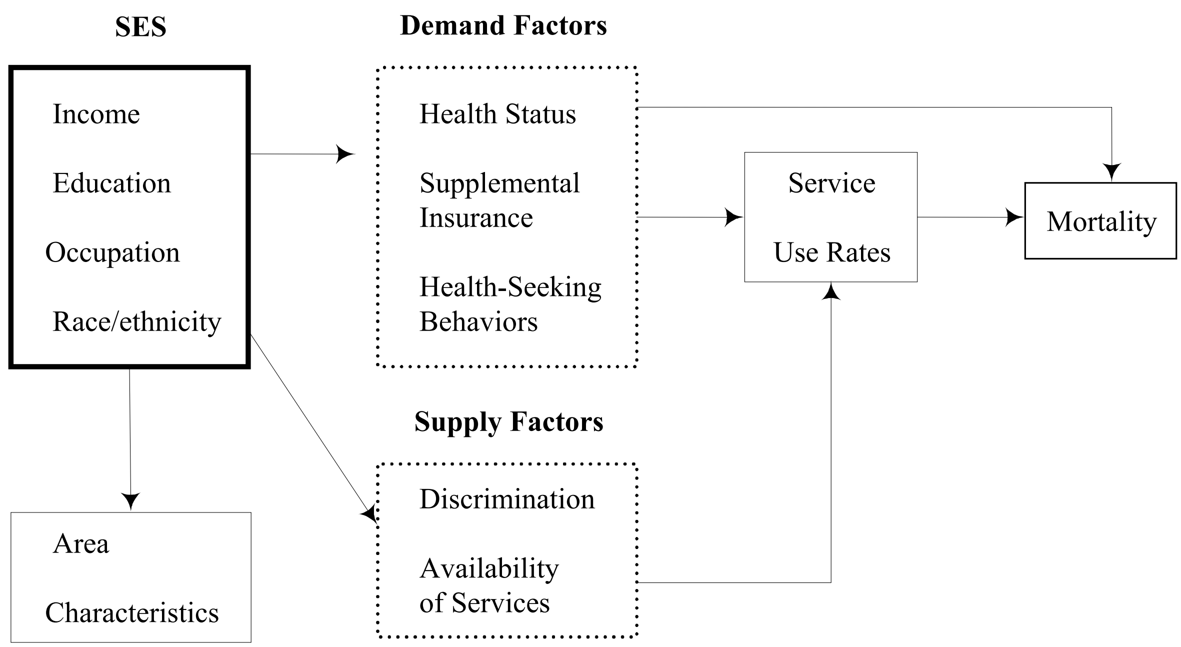
It is important to remember that SES characteristics, by themselves, generally do not directly determine use rates and mortality (see Figure 3-1). They work through at least five other, more immediate factors, grouped into demand versus supply-side factors. In the following three subsections, we examine the causal model of IHD utilization in more detail. First, we describe the links between SES and demand-side factors, including health status, supplemental insurance coverage, and health-seeking behaviors. Second, we draw out the links between SES and supply-side factors affecting utilization. Finally, we summarize the model in a set of hypotheses to be tested during the course of the study.

3.2 Demand-Side Effects

Let us begin the modeling by considering the standard model of patient demand for care. We will then incorporate SES effects to more fully explain variation in utilization among racial/ethnic groups. Patient demand for care is based on utility maximizing behavior under an income (I) constraint (e.g., Phelps, 1992, p. 86). Patient

Figure 3-1

Causal Model of IHD Service Use & Mortality of Medicare Beneficiaries



utility is posited as a function of a numeraire good, x, and health status, H. Health status in the utility function is linked to the income constraint through a medical production function, H = g(M, L), where M = quantity of health services consumed, and L = a vector of lifestyle and genetic factors. Given fixed prices and individual patient preferences for levels of health and other goods, patients choose utility maximizing quantities of x and M. The optimal level of M, M*, is the quantity of immediate interest and can be written as a function of medical out-of-pocket prices and personal gains in utility at the margin from using more health services. Because we assume that health status improves at a decreasing rate with more health services consumed, the optimum consumption of health services depends inversely on prices and positively on utility gains. Thus, higher out-of-pocket prices should reduce consumption of services while a higher marginal gain from a given level of medical service use should encourage more utilization. Note that utility gains are perceived, not actual, and are subject to interpersonal differences in the valuation and risk of medical interventions.

Let us now return to the causal model sketched in Figure 3-1. A single arrow is drawn from SES characteristics of beneficiaries to the three principal demand-side factors. Consider, first, the links with health status.

SES & Health Status. The underlying health status of low SES groups is likely to be lower as well. Lower income, less educated, blue collar minorities tend to report lower health status. Partly, this is due to lifestyle differences between minorities and whites (e.g., nutrition, physical requirements of their occupation). It may also be compounded by genetic differences (e.g., blacks are more prone to having sickle cell anemia). Of course, much of the observed differences in health status may be due to other confounding factors such as insurance coverage and availability of services. Nevertheless, lower health status may even be observed holding all other demand and supply factors constant.

SES & Supplemental Insurance. The vast majority of elderly persons undergoing bypass and other expensive heart interventions pay less than one percent of Medicare allowable payments; hence, price should play no role in deciding upon treatment modality. Supplemental insurance that covers Part A & B deductible and copays, however, is far from equally distributed across racial/ethnic groups. Due to unaffordable supplemental insurance premiums, lower SES elderly persons are much less likely to enjoy this additional financial protection. Consequently, net prices for IHD care will be much higher for low SES beneficiaries—particularly relative to their income.

The relation between income and affordability of supplemental insurance is not monotonic. Very poor, or disabled, Medicare beneficiaries may also be eligible for Medicaid. Thus, very low and most higher income beneficiaries are likely to enjoy supplemental coverage with no financial barriers to care. Only the "near poor" beneficiaries will not have supplemental insurance as often. To quantify the income-utilization dimension of demand, it is important to control for Medicaid eligibility of Medicare beneficiaries (Mitchell and Khandker, 1995).

SES & Health-seeking Behaviors. The literature on the demand for medical services by most minorities consistently cites cultural predilections against riskier, invasive procedures. Surgical therapy apparently is even less preferred for blacks. Other minority groups may prefer less invasive treatment modalities as well, including non-prescription drug therapy and changes in lifestyles. These preferences may be based on a lack of confidence in allopathic medicine to cure the underlying disease.

SES & Confounding Factors. So far, the causal modeling has been *ceteris paribus* in the sense that other variables are (logically) held constant. It is important to realize that both supplemental insurance coverage and health-seeking behaviors may, in turn, affect observed health status at any point in time. For example, minorities without supplemental insurance may not be able to afford needed care, thereby lowering their health status over and above any underlying genetic or lifestyle effects. Failure to seek critical surgical interventions in a timely manner may also reduce health status. To the extent health status is affected by supplemental insurance and health-seeking behaviors, one must be careful in controlling for health status in quantifying the SES effects of the other two variables on utilization. We propose to estimate models with and without health status to test the sensitivity of the other demand-side coefficients to health status.

3.3 Supply-Side Effects

Utilization of medical services is further constrained by their availability both in the general population and for minorities in particular. Important methodological differences exist between measuring income at the individual level versus the broader market level. Because this project will be using zip code income to proxy individual SES income, care should be taken in interpreting statistically significant effects. At the individual level, supply is generally taken as given while at the market (and small-area) level, market demand should determine supply in the long run. Wealthier communities should enjoy more hospitals, physicians, and other services. Individual versus market perspectives introduce subtle, but important, considerations. For example, poor beneficiaries living in Harlem may be geographically proximate to many of the finest hospitals and physicians in the world; yet, their access to these services could still be limited by ability to pay, travel costs, and, possibly even discrimination.[1] This may explain the provocative results of Lee, *et al.* (1997) who found large utilization differences between blacks and whites among Medicare beneficiaries matched by zip code as well as age and gender and Medicaid enrollment. Such differences cannot be attributed to raw differences in service availability in small areas as these were controlled for within zip code. Nor could large black/white differences in southern zip codes be attributed to wider income differences, as "income heterogeneity was greater in the non-South states" (Lee, *et al.*, 1997, p. 1188).

If, indeed, black/white use rates differ at least as much within as across zip codes, then simple measures of geographic proximity to medical services will exhibit low correlations with race/ethnic utilization. This would explain a lower correlation between SES/race/ethnicity with medical care utilization using small-area versus individual observations. *A form of measurement error occurs in assuming the entire local market is available to each and every beneficiary living in the market.*

Empirically, the relation between utilization and income controlling for race/ethnicity appears complex, as evidenced by results of Gornick, *et al.* (1996). These authors found that controlling for black/white income levels (as well as age and gender) narrowed the average black/white gap for ischemic heart discharges "relatively little" (p. 794) from 0.74 to only 0.78 (Gornick, *et al.*, 1996, Table 2). Yet, age-sex adjusted hospitalization rates differed markedly between blacks and whites depending upon zip

[1] Discrimination can take indirect forms. Poorer elderly may be forced to go to public hospitals with fewer, if any, high-tech services. This may be due, either, to a financial inability to purchase supplemental insurance and "buy in" to high-tech institutions or to direct discrimination regardless of ability-to-pay. Unequal abilities to purchase supplemental insurance, in turn, may be due to past discrimination in the workplace that results in lower wages.

code income class. The black-white admission ratio was .64 in the lowest income quartile compared to .95 in the highest quartile, suggesting that income should play a large role in explaining gaps in utilization. The reason why black-white zip code income has such limited effects on the average admission rate gap is that the income adjustment used by Gornick, *et al.* (1996) actually raises, slightly, the "expected" average white ischemic discharge rate when, in fact, it falls dramatically in higher income areas. This is due to placing more weight on the very high admission rate of whites living in low income zip codes. Because the effects of zip code income work in opposite directions on black versus white admission rates, the net effect of income on the average admission rate gap is minimized. The real paradox is why white use rates are so high in low income zip codes and fall sharply (22 percent) as income rises while the opposite occurs among blacks. One explanation for declining white ischemic admission rates in higher income areas is the impaired health status of whites living in low income areas. Improved access for blacks in more affluent areas apparently dominates improvements in black health status with higher income, leading to greater utilization.

3.4 Summary of Model's Hypotheses

The main conclusion to be drawn from the modeling and literature review is that the impact of SES on IHD utilization and mortality is indirect and complex, incorporating offsetting positive and negative effects. Based on the literature, most minorities are known to experience, on average (a) lower incomes, (b) lower educational attainment, (c) lower occupational status, and (d) live in less wealthy areas.

Let us state a few hypotheses that will help guide the empirical work, then conclude with the limitations to our proposed model testing.

Hypothesis #1: Lower minority SES results in lower rates of supplemental insurance thereby raising the net price of care to Medicare beneficiaries and reducing the demand and observed utilization of health care services (and especially expensive interventions);

- **Corollary Hypothesis #1a**: Dual Medicare/Medicaid eligibles with no out-of-pocket costs should not exhibit as large a gap in services.

Hypothesis #2: Lower minority SES is associated with living in poorer neighborhoods served by fewer hospitals offering expensive tertiary care services thereby reducing availability and utilization of health care services;

- **Corollary Hypothesis #2a**: Some minorities living in poorer neighborhoods may enjoy greater proximity to high-tech teaching facilities which should increase access and utilization of such services;

Hypothesis #3: Controlling for supplemental insurance and availability of services, minorities with low SES should not exhibit differences in utilization of high-tech, costly, invasive procedures;

- **Corollary Hypothesis #3a**: If lower SES minorities use fewer high-tech costly services, controlling for insurance coverage and service availability, then better health status (unlikely), aversion to risky invasive treatment (likely), and/or discrimination (possible) may explain the lower observed utilization rates.

3.5 Limitations of Analysis

In the proposed study, we will be able to proxy supplemental insurance coverage through median incomes of racial/ethnic groups within zip codes as in Gornick (1996). We will also directly measure the proximity of minorities to high-tech heart services using zip code geocoding indicators. Finally, we will be able to measure health status in a limited way using demographic (age, sex) and diagnostic (complicating admission diagnoses) information on individual patients. *We have no way of using the claims data, however, to measure either the independent influence of health-seeking behaviors of* *minorities versus whites or provider discrimination.* These become *residual effects* after controlling for the other principal factors. The strongest conclusion of our work will be that x% of the variation in, say, open heart surgery rates among racial/ethnic groups can be explained by supplemental insurance (and income), demographics, health status, and local availability of services. Any unexplained differences may be due, either to differences in health-seeking behaviors or discrimination by providers. This is unfortunate because they have very different policy implications. Aversion to invasive treatment suggests either a voluntary desire not to undergo certain kinds of care, in which case no policy intervention is obvious, or possibly to a lack of education about risks and rewards to intervention, in which case public education programs might close the treatment gaps and improve the long-run health status of minorities. Discrimination by providers has far more negative implications and would require very special studies in targeted geographical areas to verify. Because the literature does support the notion of risk-averse minority groups relative to whites, any analyses using claims data will never be able to isolate discriminatory practices as the ultimate cause of lower minority utilization rates; differences could always be attributed to voluntary choices made by minorities. Notwithstanding these limits, we can at least bound the possible effects of health-seeking behaviors and discrimination by carefully controlling for the SES variables and proximity of local resources.

4 Data and Analytic File Construction

This chapter summarizes the data used and the file construction steps taken to create the longitudinal Part A, B, and hospital outpatient (OPD) analytic file used for the analyses in this report. Section 4.3.6 also presents the zip code income distribution of patients by race. Section 4.5 presents counts of our IHD sample for 1997. All tables are provided at the end of the chapter. More detail on the source files and variable construction can be found in Appendix 4.

4.1 Data Sources

To construct the longitudinal Ischemic Heart Disease (IHD) file, we used the 1997-1999 Medicare short stay acute care hospital inpatient claims and enrollment files, the 1997-1999 Physician/Supplier Part B and OPD files, 1999 Census zipcode data on resident socio-economic characteristics, and AHA and Medicare Provider of Service (POS) hospital characteristics files. Inpatient admission information was from the 100 percent Medicare Provider Analysis and Review (MedPAR) files. Beneficiary enrollment and demographic information were obtained from HCFA's Denominator File. Physician/supplier Part B data obtained through a MANRLINE run. Procedures used during the IHD admission were constructed using the Part B and 100 percent OPD files. Health Economics Research purchased a zip code level population and income database from a commercial vendor, the Spatial Insights' Demographic Estimates and Projections (E & P) Database. This database, at the zip code level, consists of a wide range of demographic and economic attributes including population, households and household types, income, labor force, and population by gender, race, and age. All data were estimated by Spatial Insights for 1999. (See Appendix 4.A for details on imputing and merging SES characteristics onto the analytic file.) The American Hospital Association (AHA) annual file and CMS's Provider of Service (POS) File contain hospital identifying information (name, city, street address, zip code), ownership, level of teaching activity, number of beds, and provision of services (e.g., open heart surgery, ER). The AHA file contains more detailed information on hospital size, including admissions, Medicare days, Medicare discharges, ER visits and number of operations performed in addition to bedsize measures. The AHA also contains hospital longitude and latitude that was used to calculate distances between facilities. Since the POS file is maintained by CMS as an exhaustive listing of all Medicare participating hospitals, every facility serving Medicare beneficiaries had data present on the file. We were able to merge AHA data onto 96.2 percent of the claims in the analytic file. More than 99.9 percent of the claims in the analytic file matched to data in the POS.

4.2 Longitudinal File Construction

4.2.1 Identification of the IHD Sample and Index Admission

Our Medicare IHD sample was identified using the 1997 MedPAR files that include all admissions for Medicare patients discharged from a short stay acute care hospital in 1997. These IHD patients composed the finder file. Using the 1997 100 percent MedPAR File, we selected all Medicare beneficiaries that had an admission with a principal diagnosis of IHD (ICD-9-CM codes 410.0-414.9). We used a common definition of IHD, or Coronary Artery Disease (CAD), ICD-9-CM codes 410.0-414.9, that range from heart attack (AMIs) at one extreme to asymptomatic sclerosis (Braunwald, Mark, Jones, *et al.*, 1994). In this report we provide stratifications of results for AMI compared to "all other" IHD admissions for admission, readmission, and mortality rates. Procedure rates are reported using a more detailed breakdown – AMI, chronic IHD, subendocardial infarct, and unstable angina. We assigned patients based on the principal diagnosis on their index IHD admission.

For those patients that had a principal "index" diagnosis of IHD, we included all claims after their index admission with and without IHD as a principal diagnosis forward through the end of 1999. Admissions in 1997 prior to the IHD index admission with a secondary diagnosis of IHD were also included in the secondary IHD diagnosis file. Because the MedPAR file is an annual file based on the discharge date of the admission, the initial file included a few patients admitted in 1996, yet discharged in 1997. We do not have access to the 1996 Part B data under this contract. Therefore, we truncated the qualifying admission period to any IHD patient admitted by January 1, 1997, and discharged by December 31, 1997. This method undercounts the total number of IHD admissions in 1997, but does so equally regardless of race/ethnicity, gender, or age.

For data edits made to the final analytic file, see Appendix 4.B.

4.2.2 Merging on Eligibility and Demographic Information

Medicare enrollment information was obtained from HCFA's Denominator File for each of the years of data we analyzed (1997-1999). The Denominator File, an abbreviated version of the EDB, is an annual summary file of enrollment, eligibility, and demographic information such as state and county of residence, date of birth and death, gender, race, reasons for entitlement, and monthly indicators for different types of eligibility (Part A, Part B, HMO coverage, and Medicaid Buy-In). Unlike the EDB, it does not have information on enrollees ever enrolled in Medicare, just information on enrollees who were entitled to Medicare benefits during the calendar year of the Denominator File (e.g., 1999). The EDB is continuously updated, incorporating changes in fields such as enrollee residence throughout the year. Previously, the major limitation of the Denominator File had been the presence of multiple records as beneficiaries change HICNOs during the calendar year. However, the Denominator File now contains cross-referenced HICs, thereby allowing for easy identification of unique beneficiaries and linking of the file across years with the use of a cross-reference file.

We also merged the 1998 Denominator File information onto our 1998 and 1999 minority IHD patient files. We used the same selection criteria and weighting methodology discussed above. Cross-referencing of HICNOs was done to maximize the number of matches to the Denominator Files.

4.2.3 Accuracy of Race/Ethnicity Codes

CMS has been aware of major problems in its SSA data source for race/ethnicity for many years and has taken two steps to significantly improve accuracy of reporting since July, 1994 (Lauderdale & Goldberg, 1996). First, the agency transferred such data directly from the SS-5 file beginning in 1994. This avoided problems with previous files that assumed same races for couples and overcoding the "other" category. The results were that about three-quarters of those now classified as Asian American and slightly more than half of those now classified as Native Americans were previously classified as "other" (Lauderdale & Goldberg, 1996). Second, the agency has completed a survey of 2.1 million beneficiaries (of whom 858,520 responded) and assigned racial/ethnic indicators to many previously unknown individuals (Eggers & Greenberg, 2000). Despite these improvements to the race/ethnicity coding, a recent study showed that while the coding for whites and African Americans in the Medicare enrollment data was comparable to counts of elderly persons derived from the 1990 Census, counts of Hispanics, Asians, and Native Americans were much lower compared to what was expected based on the 1990 Census (Eggers & Greenberg, 2000). The likely effect of any remaining misclassification is that "observed" differences by race/ethnic group will understate true differences.

4.2.4 Sample Restrictions

Prior to beginning the analysis, there were several cleaning steps that were needed to delete beneficiaries for whom we would have incomplete claims. Specifically,

- IHD admissions that occurred when the beneficiary was under 65 years of age were deleted. (These claims were moved to a separate file to be available for future use.) Hence, this report focuses only on the Medicare elderly.
- IHD admissions that occur during the time that the beneficiary was enrolled in an HMO were deleted. (Some managed care plans submit dummy claims that have no charge or payment information and no corresponding Part B data.).
- Beneficiaries who did not live in the 50 states or Washington, DC were deleted.

Our sample selection strategy restricted our sample to patients for whom we would have full information at the time of admission.

4.2.5 Part A Fee-for-Service (FFS) Equivalents

Instead of deleting beneficiaries with truncated FFS eligibility due to death or enrollment in an HMO, we included beneficiaries with any FFS participation and created part-year equivalents. Counts of Medicare beneficiaries were weighted by the proportion of months in 1997 during which they were:

1. alive;
2. enrolled in fee-for-service Part A;
3. at least 65 years old (for those beneficiaries aging into the Medicare program).

This deflates our denominator counts for part-year beneficiaries to better reflect true admission and utilization measures.

For how we tracked patients who switched in and out of HMO's, see Appendix 4.C.

4.2.6 Merging on Post-Index Admission Inpatient Claims

All subsequent inpatient admissions through December 31, 1999, were merged onto our 1997 index admission file. We track subsequent admissions by time from the index discharge (e.g., 30 days, 90 days, one year) and by reason for admission (e.g., AMI, to IHD, stroke, other). In addition, we extracted all SNF, home health, and other SAF claims to describe treatment for the three-year period following an acute admission for IHD. Part B data was extracted from the date of the index admission forward to incorporate services provided by the physician during the index admission and all other physician treatment after the index admission.

4.2.7 Merging on 1998 and 1999 Eligibility Information

After creating a file beginning with the 1997 index IHD admission for each beneficiary and all their subsequent admissions through 1999, we merged on the 1998 and 1999 Denominator File information. This allowed us to identify beneficiaries who died in 1998 or 1999 or who enrolled in an HMO after 1997.

4.3 Variable Construction

Several variables were constructed for our analyses. Utilization measures include IHD admission rates, length of stay during the IHD index admission, and procedure use rates during the index admission. We also constructed two outcome measures – mortality rates and readmission rates. Weights were constructed to adjust for partial year FFS eligibility of beneficiaries for our admission rate analyses. A separate set of weights was created for the readmission analyses to account for deaths during the readmission periods. Descriptions of the weights are provided in the relevant sections below.

4.3.1 Admission Rates

After selecting admissions from the 1997 MedPAR file with an admission date of January 1, 1997, or later and a discharge date on or before December 31, 1997, we constructed three variants of admissions rates:

1. "Index" admission rates, defined as the first admission in 1997 with IHD as a principal diagnosis;
2. All admissions with IHD as a principal diagnosis (which would include "index" admissions); and
3. All admissions with IHD as a principal or secondary diagnosis.

Given the selection criteria for this study, the index admission rate is equivalent to a "unique beneficiary" admission rate or the probability that a Medicare beneficiary would be admitted with IHD as a principal diagnosis for most of the year since the admission and discharge both have to occur within the same year.

Beneficiaries and their IHD admissions were weighted (multiplied) by the proportion of months during the year that:

1. a beneficiary was alive (for those who died);
2. they were enrolled in fee-for-service Part A (for those with only partial year enrollment); and
3. the beneficiary was 65 (for those beneficiaries aging into the Medicare program).

4.3.2 Length of Stay

The length of stay analyses were conducted for the index IHD admission only. We examined the average length of stay by age, gender, and race/ethnicity using the length of stay variable reported on the 1997 MedPAR file.

4.3.3 Procedure Rates

A set of 16 diagnostic, 19 cardiac interventional, six severity indicator, and seven consult procedures were selected for study. These procedures represent both older and newer technologies and techniques for diagnosing and treating ischemic heart disease and related cardiac co-morbidities. Appendix 4.D describes how Part B CPT codes were collapsed into the broader set of procedures.

For the procedure rate analyses, we included only the first admission with a principal diagnosis of IHD beginning July 1, 1997 and ending with a discharge date no longer than December 31, 1997. Only index admissions plus any subsequent transfers for short stay acute care hospitals were retained. This sample was further restricted our sample to those beneficiaries that were enrolled in both Part A and Part B during the month of admission.

4.3.4 Mortality Rates

Mortality rates were calculated using the date of death variable from the 1997, 1998 and 1999 Medicare Denominator Files. Mortality rates are the number of IHD patients that died divided by the total number of IHD patients. These rates were constructed for 30-day, 90-day, and one-year intervals from the date of the index IHD admission. Rates are cumulative; that is, a patient that died within 30 days of admission is also counted as having died within 90 days and within one year. Since we have full information on date of death for the entire sample over the entire analytic period from the enrollment file, there was no need to weight the results by FFS eligibility.

4.3.5 Readmission Rates

Readmission rates, regardless of frequency within a given time period, were constructed for 30-day, 90-day, and one-year intervals after discharge from their index IHD admission. Calculating rates on an "ever readmitted" basis allows a straightforward interpretation of the rates as likelihoods of being readmitted, thereby avoiding "overcounting" multiple readmitters.

Patients who were discharged alive were weighted by the proportion of days in each of the windows following admission during which:

1. the beneficiary was alive (for those who died post-discharge);
2. they were enrolled in fee-for-service Part A (for those with only partial year enrollment); and
3. were not enrolled in an HMO.

We also excluded those admissions identified as transfers, based on discharge disposition, from counting as a readmission. Appendix 4.E characterizes patients who were eligible for the readmission analyses.

4.3.6 Standardization of Rates

Age, Gender, Race. Age, gender, and race adjustments were made for the admission, mortality, readmission, and procedure comparisons of sub-populations using the direct method of adjustment. Because the likelihood of developing cardiovascular problems increases with age, *inter alia*, a sub-population with a younger age distribution will have fewer IHD admissions compared to an older population. This is particularly important when examining differences by race because of unequal life spans. For our purposes, we used the age, gender, and race distribution of the total eligible Medicare population to adjust our IHD rates. For rates reported within age, gender, and race sub-population, no adjustment has been made as comparisons can be made directly. Rates reported by race/ethnicity were age/gender adjusted while age-adjusted rates are reported for gender/race sub-populations. For example, the overall rate for whites is age and gender adjusted and the overall rate for men is age and race adjusted.

Income. We also constructed admission, mortality, and readmission rate tables using income as a fourth adjustor within a particular sub-population. This allows us to test for differences in rates holding the income distribution constant. That is, what would the rates be if the income distribution of all races were equal? As with the age-sex adjustments, the overall Medicare beneficiary income quartile proportions are used to weight admission, mortality, and other important rates of the race/ethnic groups.

Table 4-1 displays the income distribution of IHD patients by gender and race. Because income is only calculated for the over-65 population, we will not be providing rate information (e.g., mortality rates, readmission rates) by age group. Median zip code incomes by race/ethnic group for the over-65 age group were merged onto the IHD claims by zip code at patient residence and race. Income quartiles were then created using all patients in our IHD sample. The bottom quartile lived in zip codes that had 1999 median household incomes of $21,073 or less. Median household income at the 50^{th} percentile (2^{nd} quartile) was $26,757. The third quartile income threshold was

$35,686, while the top zip code quartile included areas whose median incomes exceeded $35,686.

The distribution of income by gender did not differ greatly, but differences by race/ethnicity were striking. Nearly 60 percent of blacks admitted for IHD and over 80 percent of Native Americans lived in zip codes where the reported median income was below $21,074, the lowest quartile threshold. Conversely, less than 10 percent of Asians lived in zip codes where median elderly income was in the bottom quartile and nearly 60 percent of Asians lived in zip codes where the median income was in the top quartile (more than $35,687).

The type of adjustment (e.g., age/gender/race adjustment, age/gender adjustment, gender adjustment) is indicated on each of the tables.

4.4 Statistical Testing

Because we are using the 1997 100 percent MedPAR file to select our IHD patients, we have the universe of IHD admissions for the year. However, because IHD rates can vary from year to year based on service utilization and diagnostic coding. Thus, we believe we have a one-year sample out of many years, not a population. In this case, statistical testing is appropriate.

Even using the 100 percent MedPAR files to maximize sample size, some of the racial and ethnic groups are very small. With small samples, estimates can be unreliable. The reliability criterion we use to test whether our estimates are reliable is the relative standard error (RSE) used by the National Center for Health Statistics (NCHS). The relative standard error is the standard error of the estimate divided by the estimate (i.e., coefficient of variation) and is expressed as a percent:

$$RSE = 100 * \left(s_{\bar{p}} / \bar{p} \right)$$

Where $s_{\bar{p}} = \sqrt{\frac{\bar{p}(1-\bar{p})}{N}}$ and $\bar{p}$ = analytic rate.

NCHS uses the RSE criterion and defines "unreliable" to be any RSE over 30 percent (NCHS, 1999). This is the threshold we use as well. This criterion is generally more restrictive than just eliminating cells where the denominator has a sample size less than 30, which is another common threshold. We feel the RSE is a better criterion because it accounts for both the denominator and small numerators. The tables in Chapter 5 have NR for 'Not Reliable' where the estimate fails the RSE reliability test. If the estimate is unreliable, no further statistical testing is done.

For rates meeting the RSE test, we use a standard Z-test to compare the differences between two *unadjusted* rates (R_1 and R_2). When we examine how rates vary by race/ethnicity, whites are the reference group. We then test the relevant rates for each disadvantaged group versus the rate for whites in 2x2 contingency tables where there is enough sample to perform the test according to the RSE criteria discussed above.

Because we are doing multiple comparisons of a single rate (e.g., comparing black to white admission rates), we need to correct for the fact that a white versus black comparison is not the only possible comparison being made. We require a more stringent definition of significance, 1 percent, to account for this problem.

Statistical testing on adjusted rates is a bit more complicated. We used a methodology described in the Healthy People 2000 Statistical Notes from NCHS (Curtin and Klein, 1995). This methodology calculates variances and standard errors for each of the age/gender/race specific rate cells weighted by the proportion of eligibles in the cell to be tested. The variances and standard errors are used to calculate confidence intervals at the 99 percent confidence level (see example of method in Appendix 4.F).

4.5 Eligible and Admission Counts

4.5.1 All Beneficiaries

Tables 4-2A and 4-2B provide counts of the number of Medicare beneficiaries in 1997 by age, gender, and race/ethnicity that met our criteria for inclusion. Table 4-2A provides straight counts of beneficiaries while Table 4-2B adjusts the counts downwards by the proportion of months in 1997 the beneficiary was under age 65 and not enrolled in Part A FFS. Over one-half of the Medicare eligibles are ages 65-74, nearly 36 percent are ages 75-84, and about 13 percent are 85 years of age or older. The Medicare eligible population has a higher proportion of women than men (59% compared to 41%). Eighty-eight percent of eligibles are white, 8 percent are Black, Asians and Hispanics each make up about 1 percent of the Medicare elderly population, and less than 1 percent are Native Americans.

Adjusting for part-year eligibility, the eligible sample drops from 29.5 million to 27.5 million (a nearly 7% decrease). The age group 65-74 drops by 8 percent with the weighting, primarily due to aging into the program and enrollment in HMOs. The age 85+ number of eligibles also drops by 8 percent due mainly to increased numbers of deaths.

4.5.2 IHD Patients

Counts of the number of patients with at least one IHD admission in 1997 are found in Tables 4-3A and 4-3B. There are 700,682 beneficiaries that were admitted with a principal diagnosis of IHD in 1997. These counts decrease by 7 percent after being weighted (653,789). The decreases are again markedly higher among the 85 and older group of IHD patients (about 12%) due primarily to higher rates of death among this group. Patients with IHD are somewhat older than the Medicare eligible population: approximately 47 percent are ages 65-74, while over 40 percent are ages 75-84. Similar to the overall Medicare population, 90 percent of IHD patients are white, 6 percent are Black, Asians and Hispanics each make up about 1 percent of IHD patients, and Native Americans comprise less than 1 percent. However, unlike the Medicare eligible population, there is a higher proportion of men (52%) than women in the IHD sample.

Thirty-four percent of the IHD patients were admitted with a principal diagnosis of AMI (Tables 4-4A and 4-4B). There was a greater decrease in the number of beneficiaries after being weighted compared to all IHD patients: 9 percent decrease among those ages 65-74; 12 percent among the 75-84 year olds; and counts of those age 85 and older decreased nearly 20 percent. These decreases are primarily due to higher rates of mortality among AMI patients compared to all patients with the wide-ranging IHD diagnoses.

Similar decreases were found for those IHD patients that also had ESRD (Tables 4-5A and 4-5B). The IHD population with ESRD had higher proportions of Blacks (20%) and Hispanics (4%) compared to the overall IHD population, as well as men 54 percent, and patients ages 65-74 (57%). For more information on all Medicare beneficiaries with ESRD, see Appendix 4.G.

Table 4-1
Zip Code Income Distribution of Medicare IHD Patients by Gender and Race

	Total		Men		Women	
	Patients	%	Patients	%	Patients	%
Total	672,858		347,493		325,365	
Lowest quartile	168,191	25.0	81,851	23.6	86,340	26.5
2nd quartile	168,223	25.0	86,067	24.8	82,156	25.3
3rd quartile	168,265	25.0	87,989	25.3	80,276	24.7
Top quartile	168,179	25.0	91,586	26.4	76,593	23.5
White	616,160		323,854		292,306	
Lowest quartile	137,795	22.4	69,647	21.5	68,148	23.3
2nd quartile	158,568	25.7	82,074	25.3	76,494	26.2
3rd quartile	159,141	25.8	84,093	26.0	75,048	25.7
Top quartile	160,656	26.1	88,040	27.2	72,616	24.8
Black	42,633		16,554		26,079	
Lowest quartile	24,953	58.5	9,539	57.6	15,414	59.1
2nd quartile	7,335	17.2	2,862	17.3	4,473	17.2
3rd quartile	6,301	14.8	2,485	15.0	3,816	14.6
Top quartile	4,044	9.5	1,668	10.1	2,376	9.1
Asian	3,900		2,225		1,675	
Lowest quartile	370	9.5	210	9.4	160	9.6
2nd quartile	404	10.4	222	10.0	182	10.9
3rd quartile	836	21.4	478	21.5	358	21.4
Top quartile	2,290	58.7	1,315	59.1	975	58.2
Hispanic	9,415		4,484		4,931	
Lowest quartile	4,468	47.5	2,159	48.1	2,309	46.8
2nd quartile	1,837	19.5	871	19.4	966	19.6
3rd quartile	1,941	20.6	902	20.1	1,039	21.1
Top quartile	1,169	12.4	552	12.3	617	12.5
Native Americans	750		376		374	
Lowest quartile	605	80.7	296	78.7	309	82.6
2nd quartile	79	10.5	38	10.1	41	11.0
3rd quartile	46	6.1	31	8.2	15	4.0
Top quartile	20	2.7	11	2.9	9	2.4

NOTES:
1. Patients weighted by number of months enrolled in FFS Part A.
2. Components may not sum to totals due to rounding error.
Income distribution:
Lowest quartile - income <= $21,073.62; 2nd quartile - $21,073.62 < income <= $26,757.5;
3rd quartile - $26,757.5 < income <= $35,686.7; Top quartile - income > $35,686.7.

SOURCE: Developed from 1999 Spatial Insights Zip Code database, adjusted by Claritas 1999 Decennial Census data, merged onto Medicare IHD 1997 Longitudinal Admission File.

Table 4-2A

Distribution of Medicare Beneficiaries by Age, Gender, and Race/Ethnicity: 1997

		Race/Ethnicity					
	Total	White	Black	Asian	Hispanic	Native Americans	Other
Total	29,535,250	26,008,760	2,325,599	244,190	398,271	35,556	522,874
Ages 65-74[a]	15,273,406	13,286,782	1,263,751	138,710	246,408	21,640	316,115
Men	6,920,998	6,064,728	536,579	61,691	114,769	10,458	132,773
Women	8,352,408	7,222,054	727,172	77,019	131,639	11,182	183,342
Ages 75-84[a]	10,240,367	9,157,708	745,546	84,787	124,160	10,617	117,549
Men	4,016,320	3,613,299	269,632	39,406	52,012	4,543	37,428
Women	6,224,047	5,544,409	475,914	45,381	72,148	6,074	80,121
Ages 85+[a]	4,021,477	3,564,270	316,302	20,693	27,703	3,299	89,210
Men	1,126,240	996,971	85,876	8,784	8,907	1,226	24,476
Women	2,895,237	2,567,299	230,426	11,909	18,796	2,073	64,734

NOTES:
[a]Based on age as of December 31, 1997.
Includes all Medicare beneficiaries that were age 65 or older and enrolled in FFS Part A at some point in CY97 and lived in the 50 states or DC.

SOURCE: HER analysis of the 100% 1997 Denominator File.

Table 4-2B

Distribution of Medicare Beneficiaries Weighted by Months of Eligibility by Age, Gender, and Race/Ethnicity: 1997

		Race/Ethnicity					
	Total	White	Black	Asian	Hispanic	Native Americans	Other
Total	27,575,566	24,328,289	2,148,293	231,008	377,164	34,193	456,619
Ages 65-74[a]	14,075,956	12,277,502	1,149,548	131,645	233,936	20,949	262,376
Men	6,352,402	5,581,360	485,636	58,264	108,619	10,081	108,442
Women	7,723,555	6,696,143	663,912	73,382	125,317	10,868	153,934
Ages 75-84[a]	9,796,831	8,771,237	705,962	80,427	117,715	10,189	111,302
Men	3,813,347	3,435,085	252,913	37,209	48,959	4,322	34,860
Women	5,983,484	5,336,152	453,049	43,219	68,756	5,867	76,442
Ages 85+[a]	3,702,778	3,279,549	292,783	18,935	25,513	3,055	82,942
Men	1,023,253	905,293	78,432	7,970	8,069	1,127	22,362
Women	2,679,525	2,374,256	214,351	10,965	17,445	1,928	60,580

NOTES:
[a]Based on age as of December 31, 1997.
Components may not sum to totals due to rounding error.
Includes all Medicare beneficiaries that were age 65 or older and enrolled in FFS Part A at some point in CY97 and lived in the 50 states or DC.

SOURCE: HER analysis of the 100% 1997 Denominator File.

Table 4-3A

Distribution of Medicare Patients Admitted with IHD as a Principal Diagnosis by Age, Gender, and Race/Ethnicity: 1997

		Race/Ethnicity					
	Total	White	Black	Asian	Hispanic	Native Americans	Other
Total	700,682	633,609	44,235	4,015	9,868	847	8,108
Ages 65-74[a]	321,899	287,001	22,515	1,988	5,687	526	4,182
Men	190,237	173,819	9,696	1,152	2,939	285	2,346
Women	131,662	113,182	12,819	836	2,748	241	1,836
Ages 75-84[a]	281,625	257,956	15,995	1,619	3,484	248	2,323
Men	138,570	129,066	5,935	937	1,565	116	951
Women	143,055	128,890	10,060	682	1,919	132	1,372
Ages 85+[a]	97,158	88,652	5,725	408	697	73	1,603
Men	33,249	30,633	1,662	206	218	28	502
Women	63,909	58,019	4,063	202	479	45	1,101

NOTE:
[a]Based on age as of December 31, 1997.

SOURCE: HER analysis of the 1997 100% Denominator and MedPAR files.

Table 4-3B

Distribution of Medicare Patients Admitted with IHD as a Principal Diagnosis by Weighted by Months of Eligibility by Age, Gender, and Race/Ethnicity: 1997

		Race/Ethnicity					
	Total	White	Black	Asian	Hispanic	Native Americans	Other
Total	653,789	591,535	41,031	3,744	9,315	794	7,370
Ages 65-74[a]	305,520	272,787	21,099	1,890	5,415	495	3,833
Men	180,681	165,331	9,046	1,100	2,789	269	2,147
Women	124,839	107,456	12,054	791	2,626	226	1,686
Ages 75-84[a]	263,017	240,982	14,879	1,507	3,281	232	2,134
Men	129,177	120,380	5,486	871	1,470	106	865
Women	133,840	120,603	9,393	636	1,812	126	1,270
Ages 85+[a]	85,253	77,766	5,052	347	619	67	1,403
Men	28,787	26,515	1,450	173	189	25	435
Women	56,466	51,250	3,603	174	429	42	968

NOTES:
[a]Based on age as of December 31, 1997.
Components may not sum to totals due to rounding error.

SOURCE: HER analysis of the 1997 100% Denominator and MedPAR files.

Table 4-4A

Distribution of Medicare Patients Admitted with AMI as a Principal Diagnosis by Age, Gender, and Race/Ethnicity: 1997

		Race/Ethnicity					
	Total	White	Black	Asian	Hispanic	Native Americans	Other
Total	256,238	231,901	16,568	1,400	2,947	313	3,109
Ages 65-74[a]	99,343	88,241	7,463	581	1,545	184	1,329
Men	59,741	54,083	3,555	332	913	112	746
Women	39,602	34,158	3,908	249	632	72	583
Ages 75-84[a]	105,298	96,392	6,205	590	1,107	95	909
Men	51,887	48,029	2,525	340	558	54	381
Women	53,411	48,363	3,680	250	549	41	528
Ages 85+[a]	51,597	47,268	2,900	229	295	34	871
Men	18,310	16,892	889	119	108	16	286
Women	33,287	30,376	2,011	110	187	18	585

NOTE:
[a]Based on age as of December 31, 1997.

SOURCE: HER analysis of the 1997 100% Denominator and MedPAR files.

Table 4-4B

Distribution of Medicare Patients Admitted with AMI as a Principal Diagnosis Weighted by Months of Eligibility by Age, Gender, and Race/Ethnicity: 1997

		Race/Ethnicity					
	Total	White	Black	Asian	Hispanic	Native Americans	Other
Total	224,922	203,703	14,460	1,216	2,620	280	2,643
Ages 65-74[a]	90,527	80,615	6,665	518	1,403	165	1,162
Men	54,662	49,591	3,184	301	832	100	653
Women	35,865	31,023	3,481	217	571	65	509
Ages 75-84[a]	92,465	84,658	5,445	518	984	86	774
Men	45,598	42,207	2,223	299	501	47	321
Women	46,867	42,451	3,222	219	483	39	453
Ages 85+[a]	41,930	38,430	2,350	180	233	29	708
Men	14,732	13,592	715	93	86	13	234
Women	27,198	24,838	1,635	87	147	15	474

NOTES:
[a]Based on age as of December 31, 1997.
Components may not sum to totals due to rounding error.

SOURCE: HER analysis of the 1997 100% Denominator and MedPAR files.

Table 4-5A

Distribution of IHD Patients with ESRD by Age, Gender, and Race/Ethnicity: 1997

		Race/Ethnicity					
	Total	White	Black	Asian	Hispanic	Native Americans	Other
Total	10,345	7,503	2,059	146	370	36	231
Ages 65-74[a]	5,803	3,946	1,343	73	262	28	151
Men	3,060	2,320	488	33	131	13	75
Women	2,743	1,626	855	40	131	15	76
Ages 75-84[a]	3,928	3,079	621	60	100	7	61
Men	2,180	1,851	219	35	48	2	25
Women	1,748	1,228	402	25	52	5	36
Ages 85+[a]	614	478	95	13	8	1	19
Men	321	264	34	9	3	1	10
Women	293	214	61	4	5	0	9

NOTE:
[a]Based on age as of December 31, 1997.

SOURCE: HER analysis of the 1997 100% Denominator and MedPAR files.

Table 4-5B

Distribution of IHD Patients with ESRD Weighted by Months of Eligibility by Age, Gender, and Race/Ethnicity: 1997

		Race/Ethnicity					
	Total	White	Black	Asian	Hispanic	Native Americans	Other
Total	9,196	6,640	1,854	123	342	32	205
Ages 65-74[a]	5,221	3,535	1,221	61	245	25	134
Men	2,762	2,088	447	29	120	11	67
Women	2,459	1,447	774	32	125	14	67
Ages 75-84[a]	3,458	2,704	553	50	90	6	54
Men	1,923	1,635	192	28	43	1	23
Women	1,534	1,069	360	22	47	5	31
Ages 85+[a]	518	401	81	12	7	1	17
Men	270	219	29	8	3	1	9
Women	248	182	52	4	4	0	8

NOTES:
[a]Based on age as of December 31, 1997.
Components may not sum to totals due to rounding error.

SOURCE: HER analysis of the 1997 100% Denominator and MedPAR files.

5 IHD Index Admission & Readmission Rates and Length of Stay

5.1 Chapter Overview

This chapter presents rates of 1997 Medicare IHD admissions and readmissions and average length of stay during the index IHD admission. Admissions with a principal diagnosis of IHD, an admission date of January 1, 1997 or later, and a discharge date on or before December 31, 1997, were selected. The "index" admission is the first IHD admission for a beneficiary in 1997 and mirrors the number of unique beneficiaries with an IHD admission. This sample is used for all of the analyses in this chapter. Additionally, we provide counts of admissions (and beneficiaries admitted) with principal or secondary diagnoses of IHD using the same admission and discharge date criteria, replicating work conducted by CMS using 1998 data.

The readmission analyses use a different sample selection process. Readmission rates are calculated within 30 days, 90 days, and one year after the beneficiary was discharged from their index IHD admission. The beneficiary had to be discharged alive in order to be eligible for readmission. Secondly, the beneficiary could not enroll in an HMO within the time period of the readmission window (e.g., 90 days after discharge).

All rates are stratified by age, gender, and race/ethnicity. A few tables provide results further stratified by income. All rates except those in Tables 5-1 and 5-2 that replicate previous CMS tables are age, gender, race, and/or income adjusted (see

Chapter 4). Part of the scope of work for this project was to replicate a table included in the RFP providing counts and rates of *all* IHD admissions (Table 1 in the RFP). The table in the RFP provided counts of admissions in 1998 with a principal diagnosis or any (principal or secondary) diagnosis of IHD. These counts were also expressed on a per 1,000 eligibles basis without any age, gender, or race/ethnicity adjustments. Section 5.2 replicates CMS' Table 1 from the RFP using the 1997 MedPAR data.

Following the replication of CMS's work, age, gender, and race-adjusted admission rates are provided for IHD as a whole, as well as rates of AMI in the Medicare population and rates of IHD among Medicare eligibles with ESRD. Tables describing the length of stay during the index IHD admission by age, gender, and race are also presented.

Because the sample selection strategies differ based on the analysis being conducted and several adjustment methodologies are being used within the analyses, we have provided an exhibit to synthesize this information. Exhibit 5-1 summarizes the methodologies and samples used to construct the different tables in this chapter. Supplemental tables can be found in Appendix 5.

Exhibit 5-1

Explanation of Table Construction Methodologies

Table Number	All Admissions with Principal IHD Diagnosis	Index-only IHD Diagnosis Based	All Admissions with Principal and Secondary IHD Diagnosis	Rates Adjusted for Months of FFS Enrollment	Beneficiaries Enrolled in FFS Only	Rates Adjusted for Months Alive and Enrolled in Part A	Age, Gender, Race, Income Adjustment
Tables 5-1 and 5-2 Admission Rates	Y	N	N	Y	N	N	N
Tables 5-3 thru 5-6 Admission Rates	N	Y	N	Y	N	N	Y
Tables 5-7 thru 5-8 Readmission Rates	N	Y	N	N	Y	Y	Y
Tables 5-9 thru 5-10 Average LOS	N	Y	N	N	N	N	Y

5.2 Replication of CMS' Table 1

Table 5-1 provides counts of the number of admissions with a principal diagnosis of IHD (ICD-9 codes 410-414) in 1997 (all admissions), the admission rate per 1,000 Medicare eligibles (using all admissions as the numerator) and the percent of admissions that were transfers by age, gender, and race/ethnicity. (Appendix 5.A tables include all admissions with IHD diagnosis including IHD as principal diagnosis.) Note in Table 5-1 (and Table 5-2) that no age, gender, or race adjustment was done (or in Appendix Tables 5.A-1, 2) to keep the results comparable to CMS' work. We also did not conduct statistical testing on the results shown in Table 5-1 since these rates are not age, gender, or race adjusted. Testing was done in later tables on age, gender, and race adjusted rates.

In 1997, there were nearly 925,000 admissions with a principal diagnosis of IHD, a slightly lower number compared to the 928,145 admissions reported in 1998 in CMS' table. Some of this difference can be attributed to the truncated period of observation. Approximately 11 percent were transfers to another short-stay acute care hospital. There were over 31 IHD admissions per 1,000 Medicare eligibles, a rate that varied substantially by age, gender, and race/ethnicity. Whites, Hispanics, and Native Americans had the highest overall admission rates followed by blacks (24.5) and Asians (20.8). Similar results were reported by CMS using 1998 data.

Transfer rates also varied by race/ethnicity: 10.9 percent of all IHD admissions were transfers for whites; 11.5 percent for Native Americans; 8.4 percent for Asians and Hispanics and 7.6 percent for blacks. Low transfer rates reflect the fact that blacks, Asians, and Hispanics are more likely to live in the inner cities and be admitted directly to a teaching hospital with no need to be transferred to a higher tech or more specialized hospital (see Chapter 8). Whites and Native Americans are more likely to live in rural or suburban areas and be admitted to local hospitals where they are stabilized before being transferred to a hospital with the specialists and technology needed to treat these patients appropriately.

Table 5-1 also shows that men had far higher IHD admission rates compared to women. The overall rate for men was over 40 per 1,000 Medicare eligibles compared to about 25 per 1,000 for women. The disparities in rates by gender are greatest among whites and Asians. Relatively low admission rates for blacks and Hispanics are almost totally due to the disparity among men. The same could be said for Native Americans although the sample sizes are fairly small. Asians had uniformly low rates of admissions by gender and age compared to whites.

Admission rates by age were highest among the 75-84 age group overall and by gender and race/ethnicity. The lowest IHD admission rates were for Medicare eligibles 85 and older, presumably because they were less likely to survive to have multiple admissions during the year or were less prone to the disease. The transfer rate also declined with age, from 12 percent for IHD patients ages 65-74 to less than 5 percent for those 85 and older.

The number of Medicare unique eligibles with an admission with a principal diagnosis of IHD are shown by age, gender, and race/ethnicity in Table 5-2. There were 700,682 Medicare eligibles admitted with a principal diagnosis of IHD (about 9,000 less than reported by CMS using 1998 data), nearly 24 admissions per 1,000 unique Medicare eligibles. This rate is 75 percent of the all-admission rate in Table 5-1, implying that multiple IHD admissions for the same beneficiary account for one-quarter of annual IHD admissions (as a principal diagnosis). The highest rates were for whites (24.3 per 1,000 eligibles), Hispanics (24.7) and Native Americans (23.2). Asians and blacks had the lowest rates of admission – 16.2 and 19.1 per 1,000, respectively. Although our rates are lower than those reported by CMS for 1998, the relative rate results are similar. Nearly 7 percent of all Medicare eligibles had an admission with a principal or secondary diagnosis of IHD (see Appendix 5.A).

5.3 IHD Index Admissions by Age, Gender, and Race/Ethnicity

5.3.1 Overall Admission Rates

Table 5-3 provides age, gender, and race-adjusted rates of IHD admissions (based on the principal reason for admission) per 1,000 Medicare eligibles. Age, gender, and race adjustments vary by the stratification of the reported rates (e.g., white men, all men, etc.). For example, the overall rate for whites (24.2, col. 1) is both age and gender adjusted, while the overall rate for men is age and race adjusted. The overall admission rate was 23.7 IHD index admissions (or unique patients) per 1,000 Medicare eligibles, with higher rates for men (30.2) compared to women (19.0). These rates are conceptually equivalent to the rates shown in Table 5-2. Differences among genders are due to weighting by age. Rates for blacks (19.2) and Asians (16.1) were significantly lower than the rate for whites (24.2). Age-gender weighting narrows the white-black admission gap only slightly from 1.272 (Table 5-2) to 1.260 (=24.2/19.2; Table 5-3). Thus, the likelihood of a white beneficiary being admitted with a principal diagnosis of IHD is 26 percent greater than for blacks and 50 percent greater compared to Asians. Hispanics actually had a statistically greater likelihood of being admitted for IHD than whites (1.029 = 24.9/24.2; Table 5-3) while the likelihood ratio did not differ significantly between whites and Native Americans.

Among men, rates for whites (31.5) were higher than any other race/ethnicity (ranging from 19.7 to 26.9), while for women, only rates for blacks (18.9) or Asians

(12.8) were lower than the rate for whites (19.1). The admission likelihood ratios for men and women are almost identical for whites and Asians (although Asian rates are far lower) with men having over a 60 percent greater chance of admission than women. The gender gap is quite different, and much narrower, for blacks, Hispanics, and Native Americans.

Rates of IHD were the highest for beneficiaries aged 75-84 (27.0) compared to those ages 85 and older (24.0) and 65-74 (21.2). The differences in overall IHD rates by gender were consistent across all three age groups, but the male-female gap narrowed with increasing age.

5.3.2 AMI Admission Rates

Table 5-4 provides the rates of AMI index admissions per 1,000 Medicare eligibles. Nearly 1/3 of all index IHD admissions had a principal diagnosis of AMI, yielding an overall rate of 8.1 per 1,000 Medicare eligibles. Unlike with the overall IHD rates in Table 5-3, the AMI admission rates increased monotonically with age. Whites had higher rates compared to blacks, Asians, and Hispanics.

5.3.3 ESRD Admission Rates

IHD rates per 1,000 eligibles with ESRD are shown in Table 5-5. Admission Rates with IHD as a primary diagnosis were 4 times as great among the ESRD population compared to the general Medicare population rates: nearly 96 per 1,000 eligibles.

Whites and Hispanics had the highest rates of IHD with comorbid ESRD (99.4 and 95.2, respectively), followed by Asians (81.0), blacks (61.8) and Native Americans (59.7). The age/race-adjusted IHD rate for men with ESRD was 105.1 compared to 89.2 for women with these differences diminishing with age. Unlike the other race/ethnicities, black women had higher overall rates of IHD compared to black men (65.2 and 57.5, respectively). These differences by gender for blacks decreased with age and reversed for those ages 85 and older.

5.3.4 Admission Rates by Income Quartiles

Rates of IHD index admissions per 1,000 eligibles by gender, race/ethnicity, and zip code median income are shown in Table 5-6.[1] The income quartiles are based on the race/ethnic median income thresholds of the IHD patients as a whole (see notes to Table 5-6). Overall, Medicare beneficiaries living in zip codes in the lowest income quartile had statistically higher rates of IHD index admissions compared to the other beneficiaries living in higher income quartiles. This finding, however, is dominated by differences among whites. Blacks showed no admission differential regardless of zip code income,

[1] Income estimates were available only for the population ages 65 and older so a breakdown by age is not provided.

nor did Asians or Native Americans. (Black women in the top quartile do exhibit lower admission rates, but the effect of zip code is not consistent across zip code income quartiles.) Only Hispanics living in top quartile zip codes had lower IHD admissions rates relative to rates of Hispanics in the poorest (lowest) zip code quartile.

If zip code income is a proxy for ability to pay, these results are counterintuitive as high quartile beneficiaries should have higher use rates. Zip code income may be acting more as a proxy for health status with lowest quartile residents in poorest health. It was noted earlier (in Section 3.2) the elderly experience low out-of-pocket costs on average.

5.4 IHD Index Readmission Rates

We examined rates of readmission among our IHD patients 30 days, 90 days, and one year after the discharge date of their 1997 index IHD admission. Readmission rates were also calculated for our AMI and ESRD populations. Readmission rates reflect whether a patient who survived the post-discharge period (and remained in FFS) was ever readmitted during the period.

5.4.1 Overall Readmission Rates

Table 5-7 provides the overall readmission rates (in percentage terms) by age, gender, and race/ethnicity. Over 18 percent of IHD patients were readmitted within 30-days of discharge, increasing to 30.8 percent within 90 days and to over 50 percent within one year. These rates vary by race with blacks having higher and Asians having lower readmission rates for all three readmission periods compared to whites. Hispanics had higher readmission rates compared to whites in the 90-day and one-year readmission periods, and Native Americans were readmitted 62 percent of the time within one year compared to 52 percent for whites.

Women had significantly higher rates of readmission in all three readmission periods. This held true for women ages 65 to 74 and 75 to 84 compared to men in these same age groups, but the relationship reversed for the over-85 age group. Readmission rates increased with age.

5.4.2 AMI Readmission Rates

Table 5-8 provides the percent of AMI patients who were readmitted within 30 days, 90 days, and one year after being discharged from their index IHD admission. Readmission rates for this group of IHD patients was slightly higher than that for all IHD patients, especially in the 30 and 90 day periods. Blacks had higher rates of readmission in all three readmission periods. Hispanics had the highest rates of one-year readmission with 60 percent of Hispanic AMI patients being readmitted.

Women again had higher rates of readmission in all three readmission periods compared to men. White and black women also had statistically higher rates of readmission in all three periods compared to men of the same race.

5.4.3 ESRD Readmission Rates

Blacks have lower IHD readmission rates with comorbid ESRD compared to whites in all three readmission windows (see Appendix 5.B). Some gender differences were also found, with women having higher rates of readmission in the 90-day and one-year periods compared to men.

5.5 IHD Length of Index Admission

We examined the average length of stay (ALOS) during the index IHD admission for all IHD patients in our sample, as well as for those admitted for AMI with ESRD by age, gender, and race/ethnicity.

5.5.1 Overall Length of Stay

The ALOS during the index IHD admission was 5.1 days and was slightly higher for men (5.2) compared to women (5.0), Table 5-9. Blacks and Hispanics had average lengths of stay about one-half day longer compared to whites (5.0), a result explainable by their lower transfer rate (see Table 5-1).[2] Length of stay increased with age as

[2] Note that the index LOS rate does not include subsequent transfers.

expected: 4.9 for 65-74 year old IHD patients compared to 5.4 for IHD patients ages 85 and older.

5.5.2 AMI Length of Stay

The average length of stay for patients whose index admission was for AMI was 24 percent higher, 6.3 days, compared to all IHD index admissions (Table 5-10). Women had statistically higher AMI average lengths of stay compared to men, the reverse of all other admissions. Average LOS for blacks and Hispanics remained higher than that for whites.

5.5.3 ESRD Length of Stay

The average length of stay among ESRD patients was essentially equal to that for AMI patients (see Appendix 5.C). Because of small sample sizes, most of the estimates in this table are unreliable and could not be tested for statistical differences.

Table 5-1

Replication of CMS' Table 1
All Short-Stay Hospital Principal IHD Diagnosis Admissions for Medicare Aged Beneficiaries by Age, Sex, and Race/Ethnicity: 1997

	All Persons			Race/Ethnicity: White			Black			Asian			Hispanic			Native Americans			
	Count	Admission Rate[1,2]	Transfer Rate[3]	Count	Admission Rate[1,2]	Transfer Rate[3]	Count	Admission Rate[1,2]	Transfer Rate[3]	Count	Admission Rate[1,2]	Transfer Rate[3]	Count	Admission Rate[1,2]	Transfer Rate[3]	Count	Admission Rate[1,2]	Transfer Rate[3]	Count
All persons	924,885	31.5	10.6	838,726	32.4	10.9	56,393	24.5	7.6	5,132	20.8	8.4	12,926	32.5	8.5	1,150	31.8	11.5	10,558
65-74	432,598	29.3	12.0	386,937	30.1	12.3	29,290	24.0	8.8	2,564	18.6	9.0	7,546	30.8	9.2	710	32.0	11.7	5,551
75-84	372,392	35.7	10.8	342,115	36.6	11.0	20,295	26.9	7.5	2,081	24.1	8.7	4,520	36.3	8.3	343	31.8	12.0	3,038
85+	119,895	28.7	5.2	109,674	29.6	5.3	6,808	20.7	2.9	487	22.1	4.1	860	30.2	3.7	97	29.7	8.2	1,969
Men	478,993	40.2	11.0	442,211	41.9	11.2	22,189	25.2	8.4	2,915	26.4	8.3	6,119	35.0	9.1	591	35.8	12.4	4,968
65-74	254,513	38.2	11.9	233,113	39.9	12.1	12,619	24.4	9.2	1,460	24.0	8.3	3,846	33.7	9.7	379	35.6	11.9	3,096
75-84	182,874	44.9	10.9	170,662	46.6	11.1	7,564	27.8	8.2	1,207	30.2	9.3	2,017	38.9	8.5	172	37.0	13.4	1,252
85+	41,606	35.6	6.2	38,436	37.2	6.4	2,006	22.5	4.1	248	26.3	3.6	256	28.0	4.3	40	32.8	12.5	620
Women	445,892	25.5	10.2	396,515	25.8	10.5	34,204	24.0	7.1	2,217	16.3	8.6	6,807	30.5	8.0	559	28.4	10.6	5,590
65-74	178,085	21.9	12.1	153,824	21.9	12.6	16,671	23.7	8.6	1,104	14.3	9.9	3,700	28.3	8.6	331	28.7	11.5	2,455
75-84	189,518	29.8	10.6	171,453	30.2	11.0	12,731	26.3	7.0	874	18.9	8.0	2,503	34.5	8.2	171	28.0	10.5	1,786
85+	78,289	26.0	4.6	71,238	26.8	4.7	4,802	20.0	2.4	239	18.9	4.6	604	31.3	3.5	57	27.9	5.3	1,349

NOTES:
Admitted 1/1/97 or later and discharged on or before 12/31/97.
[1]Rates adjusted for part-year FFS eligibility.
[2]Rates per 1,000 Medicare eligibles.
[3]Percent of IHD admissions that were transfers to another short-stay acute care hospital.

SOURCE: HER analysis of 1997 100% Denominator and MedPAR files.

Table 5-2

Replication of CMS' Table 1
Number of Medicare Aged Beneficiaries with a Short-Stay Hospital Principal IHD Diagnosis Admission by Age, Sex, and Race/Ethnicity: 1997

	All Persons		Race/Ethnicity: White		Black		Asian		Hispanic		Native Americans		Other	
	Count	Rate[1,2]	Count	Rate[1,2]	Count	Rate[1,2]	Count	Rate[1,2]	Count	Rate[1,2]	Count	Rate[1,2]	Count	Rate[1,2]
All persons	700,682	23.7	633,609	24.3	56,393	19.1	5,132	16.2	12,926	24.7	1,150	23.2	10,558	16.1
65-74	321,899	21.7	287,001	22.2	22,515	18.4	1,988	14.4	5,687	23.1	526	23.6	4,182	14.6
75-84	281,625	26.8	257,956	27.5	15,995	21.1	1,619	18.7	3,484	27.9	248	22.8	2,323	19.2
85+	97,158	23.0	88,652	23.7	5,725	17.3	408	18.3	697	24.2	73	21.8	1,603	16.9
Men	362,056	30.3	333,518	31.5	17,293	19.6	2,295	20.7	4,722	26.9	429	25.8	3,799	20.8
65-74	190,237	28.4	173,819	29.6	9,696	18.6	1,152	18.9	2,939	25.7	285	26.7	2,346	19.8
75-84	138,570	33.9	129,066	35.0	5,935	21.7	937	23.4	1,565	30.0	116	24.4	951	24.8
85+	33,249	28.1	30,633	29.3	1,662	18.5	206	21.7	218	23.5	28	22.2	502	19.4
Women	338,626	19.2	300,091	19.4	26,942	18.8	1,720	12.5	5,146	23.0	418	21.1	4,309	13.5
65-74	131,662	16.2	113,182	16.0	12,819	18.2	836	10.8	2,748	21.0	241	20.8	1,836	11.0
75-84	143,055	22.4	128,890	22.6	10,060	20.7	682	14.7	1,919	26.3	132	21.5	1,372	16.6
85+	63,909	21.1	58,019	21.6	4,063	16.8	202	15.8	479	24.6	45	21.6	1,101	16.0

NOTES:
Admitted 1/1/97 or later and discharged on or before 12/31/97.
[1]Rates adjusted for part-year FFS eligibility.
[2]Rates per 1,000 Medicare eligibles.

SOURCE: HER analysis of 1997 100% Denominator and MedPAR files.

Table 5-3

Rates[1] of IHD Index Admissions per 1,000 Eligibles Adjusted for Months of Eligibility by Age, Gender, and Race/Ethnicity: 1997

	All Ages			Ages 65-74[a]		
Race/Ethnicity	Total[2]	Men[3]	Women[3]	Total[4]	Men	Women
Total (race adjusted)	23.7	30.2	19.0 †	21.2	28.4	16.2 †
White	24.2	31.5	19.1 †	21.6	29.6	16.0 †
Black	19.2 *	19.7 *	18.9 * †	18.3 *	18.6 *	18.2 *
Asian	16.1 *	20.8 *	12.8 * †	14.1 *	18.9 *	10.8 * †
Hispanic	24.9 *	26.9 *	23.3 * †	22.9 *	25.7 *	21.0 * †
Native Americans	23.0	25.3 *	21.2 *	23.2	26.7	20.8 * †
Other	16.9 *	21.5 *	13.6 *	14.6 *	19.8 *	11.0 * †

	Ages 75-84[a]			Ages 85+[a]		
Race/Ethnicity	Total[4]	Men	Women	Total[4]	Men	Women
Total (race adjusted)	27.0	33.6	22.3 †	24.0	28.1	21.1 †
White	27.7	35.0	22.6 †	24.7	29.3	21.6 †
Black	21.1 *	21.7 *	20.7 * †	17.5 *	18.5 *	16.8 * †
Asian	18.3 *	23.4 *	14.7 * †	18.3 *	21.7 *	15.8 * †
Hispanic	27.8	30.0 *	26.3 * †	24.1	23.5 *	24.6 *
Native Americans	22.7	24.4 *	21.5	21.9	22.2	21.6
Other	20.0 *	24.8 *	16.6 * †	17.4 *	19.4 *	16.0 * †

NOTES:
[a]Based on age as of December 31, 1997.
[1]Rates adjusted for part-year FFS eligibility.
[2]Age/sex adjusted.
[3]Age adjusted.
[4]Sex adjusted.
* Statistically significant difference at the .01 level compared to whites.
† Statistically significant difference at the .01 level compared to men.
SOURCE: HER analysis of 1997 100% Denominator and MedPAR files.

Table 5-4

Rates[1] of AMI Index Admissions per 1,000 Eligibles Adjusted for Months of Eligibility by Age, Gender, and Race/Ethnicity: 1997

	All Ages			Ages 65-74[a]		
Race/Ethnicity	Total[2]	Men[3]	Women[3]	Total[4]	Men	Women
Total (race adjusted)	8.1	10.5	6.5 †	6.3	8.6	4.6 †
White	8.3	10.9	6.6 †	6.4	8.9	4.6 †
Black	6.8 *	7.7 *	6.2 * †	5.8 *	6.6 *	5.2 * †
Asian	5.4 *	7.0 *	4.4 * †	3.9 *	5.2 *	3.0 * †
Hispanic	7.2 *	9.0 *	5.9 * †	5.8 *	7.7 *	4.6 †
Native Americans	8.1	10.5	6.5 †	7.6 *	9.9	6.0 †
Other	6.0 *	7.7 *	4.8 * †	4.4 *	6.0 *	3.3 * †

	Ages 75-84[a]			Ages 85+[a]		
Race/Ethnicity	Total[4]	Men	Women	Total[4]	Men	Women
Total (race adjusted)	9.5	11.9	7.8 †	11.9	14.4	10.1 †
White	9.7	12.3	8.0 †	12.3	15.0	10.5 †
Black	7.8 *	8.8 *	7.1 * †	8.2 *	9.1 *	7.6 * †
Asian	6.3 *	8.0 *	5.1 * †	9.4 *	11.6 *	7.9 * †
Hispanic	8.3 *	10.2 *	7.0 * †	9.3 *	10.6 *	8.5 *
Native Americans	8.4	10.9	6.7	9.5	11.7	8.0
Other	7.3 *	9.2 *	5.9 * †	8.9 *	10.4 *	7.8 * †

NOTES:
[a]Based on age as of December 31, 1997.
[1]Rates adjusted for part-year FFS eligibility.
[2]Age/sex adjusted.
[3]Age adjusted.
[4]Sex adjusted.
* Statistically significant difference at the .01 level compared to whites.
† Statistically significant difference at the .01 level compared to men.

SOURCE: HER analysis of 1997 100% Denominator and MedPAR files.

Table 5-5

Rates[1] of IHD Index Admissions per 1,000 Eligibles with ESRD Adjusted for Months of Eligibility by Age, Gender, and Race/Ethnicity: 1997

	All Ages			Ages 65-74[a]		
Race/Ethnicity	Total[2]	Men[3]	Women[3]	Total[4]	Men	Women
Total (race adjusted)	95.9	105.1	89.2 †	96.5	106.6	89.5 †
White	99.4	109.8	91.7 †	99.8	111.6	91.7 †
Black	61.8 *	57.5 *	65.2 * †	65.4 *	58.7 *	70.1 * †
Asian	81.0 *	91.2 *	77.1 * †	69.4 *	66.0 *	71.7
Hispanic	95.2 *	98.4 *	93.5 * †	100.6	102.0	99.6
Native Americans	59.7 *	75.0 *	54.0 * †	67.3 *	72.2	63.8
Other	80.5 *	92.5 *	71.9 * †	80.4 *	98.2	68.2 *

	Ages 75-84[a]			Ages 85+[a]		
Race/Ethnicity	Total[4]	Men	Women	Total[4]	Men	Women
Total (race adjusted)	98.6	109.1	91.2 †	85.2	88.4	82.9 †
White	102.6 *	114.8	94.1 †	87.7 *	90.2	86.0
Black	60.8 *	56.9 *	63.5 *	52.4 *	54.2 *	51.2 *
Asian	86.0 *	93.1	81.1	126.0 *	182.2	87.3 NR
Hispanic	99.1 *	101.3	97.5	67.2 *	77.3 NR	60.3 NR
Native Americans	50.4 *	36.0 NR	60.4 NR	75.6	185.2 NR	0.0 NR
Other	72.8 *	75.7 *	70.7	99.1 *	114.1	88.8

NOTES:
[a]Based on age as of December 31, 1997.
[1]Rates adjusted for part-year FFS eligibility.
[2]Age/sex adjusted.
[3]Age adjusted.
[4]Sex adjusted.
NR = not statistically reliable.
* Statistically significant difference at the .01 level compared to whites.
† Statistically significant difference at the .01 level compared to men.

SOURCE: HER analysis of 1997 100% Denominator and MedPAR files.

Table 5-6

Rates[1] of IHD Index Admissions per 1,000 Eligibles Adjusted for Months of Eligibility by Gender, Race/Ethnicity, and Median Income: 1997

	Men					
	Total[2]	White	Black	Asian	Hispanic	Native Americans
Total (income adjusted)	30.4	31.6	19.6	21.0	26.3	29.3
Income Groups[3]						
Lowest Quartile	32.7	34.0	19.6	21.5	28.4	25.4
2nd Quartile	31.2 *	32.4 *	19.2	21.7	27.2	25.7
3rd Quartile	30.2 *	31.3 *	19.9	20.6	26.6	35.9
Top Quartile	28.4 *	29.3 *	19.5	20.4	23.4 *	29.7
	Women					
	Total[2]	White	Black	Asian	Hispanic	Native Americans
Total (income adjusted)	19.3	19.6	18.7	12.6	22.1	19.8
Income Groups[3]						
Lowest Quartile	22.7	23.1	19.1	12.3	24.7	22.2
2nd Quartile	20.2 *	20.4 *	18.4	13.2	23.3	22.6
3rd Quartile	18.8 *	18.8 *	19.3	12.1	22.4 *	13.1
Top Quartile	16.7 *	16.5 *	18.0 *	12.6	18.7 *	21.6

NOTES:
[1]Rates adjusted for part-year FFS eligibility.
[2]Race adjusted.
[3]Income distribution:
Bottom quartile - income <= $21,073.62; 2nd quartile - $21,073.62 < income <= $26,757.5;
3rd quartile - $26,757.5 < income <= $35,686.7; Top quartile - income > $35,686.7.
* Statistically significant difference at the .01 level compared to the lowest quartile.

SOURCE: HER analysis of 100% 1997 Denominator and MedPAR files.

Table 5-7

Readmission Rates (in percent) of IHD Patients for any Reason by Age, Gender, and Race/Ethnicity: 1997

	All Ages								
	Total (age/sex adjusted)			Men (age adjusted)			Women (age adjusted)		
Race/Ethnicity	30-day	90-day	One-Year	30-day	90-day	One-Year	30-day	90-day	One-Year
Total (race adjusted)	18.0	30.8	52.6	17.8	30.0	50.5	18.3 †	31.5 †	54.2 †
White	18.0	30.7	52.1	17.8	29.8	50.0	18.3 †	31.4 †	53.7 †
Black	18.2 *	32.5 *	57.4 *	18.2 *	32.7 *	56.1 *	18.2	32.6 *	58.4 * †
Asian	16.7 *	28.7 *	48.2 *	16.0 *	28.0	47.4	17.4	29.5	49.2 *
Hispanic	18.2	32.8 *	57.0 *	18.3	31.5 *	53.4 *	18.2	33.9 *	59.5 * †
Native Americans	21.8	34.3	61.9 *	20.7	32.5	59.3	23.2	35.9	64.0
Other	18.1	30.5	51.9	16.8	29.5	49.7	19.1	31.5	53.5 †

	Ages 65-74								
	Total (sex adjusted)			Men			Women		
Race/Ethnicity	30-day	90-day	One-Year	30-day	90-day	One-Year	30-day	90-day	One-Year
Total (race adjusted)	17.0	29.1	49.2	16.4	27.5	46.1	17.5 †	30.1 †	51.4 †
White	17.0	28.9	48.7	16.3	27.3	45.5	17.4 †	29.9 †	50.9 †
Black	17.4 *	31.1 *	55.0 *	16.9	30.2 *	52.8 *	17.7	31.6 *	56.5 * †
Asian	15.7	27.9	45.8	13.4 *	24.8	41.8	17.2	30.0	48.6 †
Hispanic	17.4	31.5 *	54.3 *	17.4	29.7 *	50.7 *	17.4	32.7 *	56.8 * †
Native Americans	23.8	35.6	61.5	19.1	30.9	55.2 *	27.0 *	38.8 *	65.8 *
Other	17.0	28.4	48.0	15.2	25.9	44.9	18.2	30.2	50.1 †

Table 5-7 (Continued)

Readmission Rates (in percent) of IHD Patients for any Reason by Age, Gender, and Race/Ethnicity: 1997

	Total (sex adjusted)			**Men**			**Women**		
Race/Ethnicity	30-day	90-day	One-Year	30-day	90-day	One-Year	30-day	90-day	One-Year
Ages 75-84									
Total (race adjusted)	19.0	32.2	54.8	18.9	31.9	53.2	19.0 †	32.4 †	55.8 †
White	19.0	32.1	54.4	18.9	31.7	52.8	19.0	32.4 †	55.5 †
Black	19.1	33.5 *	58.8 *	19.5	34.3 *	57.6 *	18.8	33.0	59.6 *
Asian	17.5	29.0	49.0 *	18.0	29.9	50.6	17.2	28.3	47.9 *
Hispanic	19.8	34.4	59.3 *	19.5	33.0	55.5	20.1	35.4 *	61.8 * †
American Indian/Alaska Native	19.9	32.6	60.5	20.1	33.1	62.7	19.9	32.2	59.0
Other	18.9	32.6	54.9	17.7	32.0	52.9	19.8	33.1	56.3
Ages 85+									
Race/Ethnicity	30-day	90-day	One-Year	30-day	90-day	One-Year	30-day	90-day	One-Year
Total (race adjusted)	19.8	34.5	60.2	20.5	35.0	60.1	19.3 †	34.2 †	60.4
White	19.8	34.4	59.9	20.5	34.7	59.6	19.4 †	34.2	60.2
Black	19.3	36.3 *	63.6 *	20.0	37.9	65.1 *	18.9	35.2	62.5 *
Asian	19.5	32.3	57.3	20.9	35.1	60.6	18.6	30.4	55.0
Hispanic	17.6	34.4	61.7	18.8	34.8	58.3	16.8	34.1	64.0
Native Americans	21.6	35.6	68.6	28.0 NR	37.1	66.4	17.1 NR	34.6	70.1
Other	20.9	34.2	59.6	21.0	36.9	59.9	20.8	32.4	59.3

NOTES:
Based on age as of December 31, 1997.
Adjusted by the number of days alive in readmission period.
Intervals based on days after discharge from the index admission.
NR = Not statistically reliable.
* Statistically significant difference at the .01 level compared to whites.
† Statistically significant difference at the .01 level compared to men.

SOURCE: 100% 1997 Denominator File and 100% MedPAR file.

Table 5-8

Readmission Rates (in percent) of AMI Patients by Age, Gender, and Race/Ethnicity: 1997

All Ages

	Total (age/sex adjusted)			**Men (age adjusted)**			**Women (age adjusted)**		
Race/Ethnicity	30-day	90-day	One-Year	30-day	90-day	One-Year	30-day	90-day	One-Year
Total (race adjusted)	20.3	33.9	53.7	19.2	32.2	51.3	21.1 †	35.3 †	55.6 †
White	20.1	33.6	53.1	19.2	31.9	50.7	20.9 †	34.9 †	55.0 †
Black	21.2 *	36.8 *	59.2 *	19.9	34.9 *	56.8 *	22.2 * †	38.3 * †	61.1 * †
Asian	20.6	34.5	53.2	17.2	29.7	47.7	23.2	38.3	57.3
Hispanic	21.8	38.0 *	60.1 *	20.2	35.8	55.6	22.8	39.7	63.4 *
Native Americans	23.8	34.2	56.9	22.9	32.1	57.5	24.7	35.6	57.3
Other	21.6	35.1	53.4	18.9	33.2	50.4	23.6	36.7	55.5

Ages 65-74

	Total (sex adjusted)			**Men**			**Women**		
Race/Ethnicity	30-day	90-day	One-Year	30-day	90-day	One-Year	30-day	90-day	One-Year
Total (race adjusted)	19.2	32.4	50.9	17.8	29.7	47.3	20.2 †	34.2 †	53.4 †
White	19.1	32.0	50.2	17.8	29.5	46.7	20.0 †	33.8 †	52.6 †
Black	19.8	34.7 *	56.7 *	18.3	31.7 *	52.6 *	20.8 †	36.8 * †	59.6 * †
Asian	19.8	35.6	51.2	16.1	27.8	44.3	22.3	41.0 †	56.0 †
Hispanic	21.4	37.7 *	58.8 *	20.1	34.9 *	53.6 *	22.3	39.7 *	62.5 * †
Native Americans	26.1	36.4	57.1	24.8	33.4	52.7	27.0	38.4	60.2
Other	19.6	33.7	51.3	17.5	30.5	48.9	21.1	36.0	53.1

Table 5-8 (Continued)

Readmission Rates (in percent) of AMI Patients by Age, Gender, and Race/Ethnicity: 1997

	Ages 75-84								
	Total (sex adjusted)			**Men**			**Women**		
Race/Ethnicity	30-day	90-day	One-Year	30-day	90-day	One-Year	30-day	90-day	One-Year
Total (race adjusted)	21.3	35.4	56.0	20.2	34.1	54.1	22.0 †	36.3 †	57.3 †
White	21.1	35.0	55.4	20.2	33.8	53.6	21.7 †	35.9 †	56.7 †
Black	22.5 *	38.9 *	61.5 *	20.8	37.6 *	60.2 *	23.6	39.8 *	62.4 *
Asian	21.0	33.4	53.0	15.7	29.1	48.3	24.7	36.4	56.2
Hispanic	22.5	39.3	63.0 *	20.9	36.0	57.9	23.6	41.5	66.6 * †
Native Americans	23.4	32.4	56.0	20.1	33.6	59.1	25.6	31.6	53.8
Other	24.2	37.4	55.5	19.5	35.1	50.9	27.4 * †	39.0	58.6
	Ages 85+								
	Total (sex adjusted)			**Men**			**Women**		
Race/Ethnicity	30-day	90-day	One-Year	30-day	90-day	One-Year	30-day	90-day	One-Year
Total (race adjusted)	22.1	36.7	59.5	22.0	36.4	59.2	22.1	37.0	59.8
White	21.9	36.5	59.2	21.9	35.9	58.8	21.9	36.8	59.4
Black	23.8	40.2 *	63.9 *	23.5	40.2	64.2 *	24.1	40.1 *	63.8 *
Asian	23.8	35.4	62.2	25.4	38.6	58.8	22.7	33.2	64.5
Hispanic	21.2	36.6	58.1	18.8	39.2	57.1	22.9	34.9	58.9
Native Americans	17.4 [NR]	30.1	61.9	23.1 [NR]	23.5 [NR]	71.4	13.5 [NR]	34.7 [NR]	55.3
Other	22.9	35.9	56.2	22.6	38.5	55.1	23.1	34.1	56.9

NOTES:
Based on age as of December 31, 1997.
Adjusted by the number of days alive in readmission period.
Intervals based on days after discharge from the index admission.
NR = Not statistically reliable.
* Statistically significant difference at the .01 level compared to whites.
† Statistically significant difference at the .01 level compared to men.

SOURCE: 100% 1997 Denominator File and 100% MedPAR file.

Table 5-9

Average Length of Stay (in days) During the Index IHD Admission by Age, Gender, and Race/Ethnicity: 1997

	All Ages			**Ages 65-74[a]**		
Race/Ethnicity	Total[1]	Men[2]	Women[2]	Total[4]	Men	Women
Total (race adjusted)	5.1	5.2	5.0 †	4.9	4.9	4.8 †
White	5.0	5.1	5.0 †	4.8	4.8	4.8 †
Black	5.6 *	5.7 *	5.6 *	5.5 *	5.5 *	5.5 *
Asian	5.3	5.3	5.3	5.2	5.1	5.3
Hispanic	5.5 *	5.6 *	5.4 *	5.4 *	5.3 *	5.4 *
Native Americans	4.7	4.6	4.8	4.5	4.3	4.7
Other	5.2	5.3	5.1	4.9	4.9	4.9
	Ages 75-84[a]			**Ages 85+[a]**		
Race/Ethnicity	Total[3]	Men	Women	Total[3]	Men	Women
Total (race adjusted)	5.3	5.4	5.2 †	5.4	5.5	5.3 †
White	5.3	5.4	5.2 †	5.3	5.4	5.3 †
Black	5.8 *	5.9 *	5.7 *	5.8 *	5.8 *	5.8 *
Asian	5.2	5.3	5.0	6.1	5.8	6.3 *
Hispanic	5.6	5.8 *	5.4	5.8	6.1	5.6
Native Americans	4.9	5.2	4.7	4.9 NR	4.7	5.1
Other	5.5	5.8	5.3	5.6	5.7	5.5

NOTES:
[a]Based on age as of December 31, 1997.
[1]Age/sex adjusted.
[2]Age adjusted.
[3]Sex adjusted.
NR = Not statistically reliable.
* Statistically significant difference at the .01 level compared to whites.
† Statistically significant difference at the .01 level compared to men.

SOURCE: HER analysis of 1997 100% Denominator and MedPAR files.

Table 5-10

Average Length of Stay (in days) During the Index IHD Admission - AMI Patients by Age, Gender, and Race/Ethnicity: 1997

	All Ages			Ages 65-74[a]		
Race/Ethnicity	Total[1]	Men[2]	Women[2]	Total[4]	Men	Women
Total (race adjusted)	6.3	6.1	6.4 †	6.1	5.9	6.2 †
White	6.2	6.0	6.2 †	5.9	5.8	6.0 †
Black	7.2 *	7.0 *	7.3 *	7.1 *	6.9 *	7.3 * †
Asian	7.1	6.8	7.4	7.3	6.9 *	7.6 *
Hispanic	7.1 *	6.9	7.3	7.2	6.7 *	7.5 *
Native Americans	5.8	5.6 NR	5.9 NR	5.8 NR	5.3	6.1
Other	6.6	6.6	6.6	6.4	6.1	6.6

	Ages 75-84[a]			Ages 85+[a]		
Race/Ethnicity	Total[3]	Men	Women	Total[3]	Men	Women
Total (race adjusted)	6.5	6.4	6.5 †	6.5	6.5	6.5
White	6.4	6.3	6.5 †	6.4	6.4	6.4
Black	7.3 *	7.3 *	7.2 *	7.2 *	7.0 *	7.3 *
Asian	6.8	6.6	6.9	7.4	6.9	7.7
Hispanic	7.1	7.2 *	7.0	7.1	7.1	7.1
Native Americans	6.0 NR	6.2	5.9	5.2 NR	5.5	4.9
Other	6.9	7.3	6.6	6.6	6.6	6.6

NOTES:
[a]Based on age as of December 31, 1997.
[1]Age/sex adjusted.
[2]Age adjusted.
[3]Sex adjusted.
NR = Not statistically reliable.
* Statistically significant difference at the .01 level compared to whites.
† Statistically significant difference at the .01 level compared to men.

SOURCE: HER analysis of 1997 100% Denominator and MedPAR files.

6 IHD Rates of Diagnostic and Interventional Procedures

Numerous research studies have reported racial differences in the use of cardiac procedures. Whites have been found to be significantly more likely than blacks to undergo cardiac catheterization or to receive a coronary revascularization procedure, with whites being more than three times as likely to receive a CABG and a percutaneous transluminal coronary angioplasty (PTCA) as blacks (Peterson, *et al.*, 1997; Escarce, *et al.*, 1993; Lee, *et al.*, 1997; Maynard, *et al.*, 1986; Boutwell and Mitchell, 1993; McBean, *et al.*, 1994). Studies of patients that had undergone an angiography or cardiac catheterization confirm that these racial disparities continue despite the apparent need for these procedures (Ayanian, *et al.*, 1993; Mitchell and Khandker, 1995; Udvarhelyi, *et al.*, 1992). A recent study by Thomas LaVeist and colleagues (LaVeist, *et al.*, 2002) showed that racial differences in utilization of cardiac angiography occurred during the process of determining treatment; blacks are less likely than whites to be referred for angiography. However, once a referral was obtained, blacks were no less likely than whites to undergo the diagnostic procedure.

In this chapter, we report the results of a series of exploratory descriptive analyses of the rate of selective diagnostic and interventional procedures for Medicare FFS beneficiaries admitted with ischemic heart disease, followed by a multivariate analysis of likelihood of revascularization. We consider the descriptive analyses exploratory for two primary reasons. First, we are not controlling for any underlying differences in the severity of ischemic heart disease across different sub-populations. And, second, we are not controlling for differences in the prevalence of co-existing morbidities, e.g., cardiac arrhythmias, diseases of cardiac valves, diabetes, etc. that affect the rate of procedures. These issues are addressed more directly in the multivariate analysis

The analyses reported in this chapter build on an earlier study in which we evaluated the rate of diagnostic and interventional procedures using hospital billing data from the MedPAR file and ICD-9 coding of procedures (Cromwell, *et al.*, 2002). The results of the earlier study are summarized in Section 6.1.2. We start by analyzing age-sex-race adjusted rates of diagnostic and interventional procedures *during* the hospital phase of treatment for ischemic heart disease stratified by three age groups, gender, and six race/ethnicity categories using Medicare Part B billing data for physician services and Medicare outpatient hospital billing records. In Section 6.1.3, we report the rates of sixteen major diagnostic procedures and eighteen major interventional procedures commonly associated with diagnosis and treatment of ischemic heart disease. We also report use rates during the admission for services that we consider severity proxies, e.g., number of ICU visits, cardiovascular hemodynamic support, ventilation support, etc., as well as rates of consults during the admission. In Section 6.1.4, we report the four sets of use rates by four clinical strata: acute myocardial infarction, subendocardial infarction, unstable angina, and chronic stable angina. This allows us to control directly for differential prevalence rates across sub-populations of interest that could influence the observed rates across all IHD patients.

To the extent that practice patterns or service availability differ across hospital type or across geographic regions, differences in observed rates of procedures could be reflective of the differences in the proportion that are provided in-patient versus out-patient. Thus, we expand our analyses and report in Section 6.1.5 rates of service provision across all settings within a six-month episode of care that spans the index admission and a six-month window prior to admission. We report rates for all IHD patients as well as for the three clinical strata of acute myocardial infarction, including subendocardial infarction, and unstable and chronic stable angina.

In 1994, the Agency for Health Care Policy and Research (1994) released a clinical practice guideline for diagnosis and management of unstable angina. Selecting a subset of patients admitted with a principal diagnosis of unstable angina, we more closely examine the diagnostic service patterns during the six-month period prior to admission. In Section 6.1.6, we report rates of recommended diagnostic tests by age, gender, and race/ethnicity.

In our earlier study, we observed age, gender, and racial variation in the use of coronary revascularization procedures as well as coronary angiography procedures during the index admission (Cromwell, *et al.*, 2002). In section 6.2, we present the results of our evaluation of diagnostic procedures during the six months prior to admission for either coronary artery bypass surgery (CABG) or angioplasty with or without stents (PTCA). We examine rates of services for major categories of invasive and non-invasive diagnostic procedures and examine rates of referral to cardiologists and cardiothoracic surgeons. In addition, we examine whether the time between angiography and revascularization varies by age, gender, and race/ethnicity. Variation in time could signal differential levels of surgical aggressiveness or differential preferences for surgical intervention.

We conclude Chapter 6 with a multivariate analysis of the likelihood of undergoing coronary revascularization, CABG or PTCA, during the index admission. We examine the influence of age, gender, race/ethnicity, and socioeconomic status on the likelihood of having a CABG or PTCA controlling for clinical comorbidity and IHD diagnostic and interventional treatments during the six-month period prior to admission and patient severity and complications during the admission. A novel feature of our multivariate evaluation is the examination of ICD-9 supplementary V codes that "describe circumstances or problems that are present and that may influence a person's health status but is not in itself a current illness or injury. Examples of V codes are family history of housing, household, economic or psychosocial circumstances and preadmission history of surgical or other procedure not carried out because of patient's decision. The results of the multivariate modeling are in Section 6.3.

All tables appear at end of chapter.

6.1 Rates of Diagnostic and Interventional Procedures

6.1.1 Background

In our earlier report, we noted two limitations to using the MedPAR data. Namely, the ICD-9 coding system for diagnostic procedures is not as detailed as the CPT coding system, thereby limiting the evaluation of diagnostic tests. And, second, diagnostic tests are under-reported on MedPAR. Jencks, *et al.*, (1988) found that the limited number of diagnoses allowed on Medicare claims decreased the ability to report comorbidities or led to the exclusion of chronic conditions not directly related to the admission from the diagnosis list. With a limited number of procedures that can be reported on the MedPAR claim, the more invasive, higher-tech procedures will be reported first and, if there is room, the diagnostic tests will follow.

We conducted a more comprehensive evaluation using Medicare Part B physician data and the Medicare Outpatient Department (OPD) file to allow for a richer set of procedures to be identified using CPT codes and to provide a better evaluation of the presence of indicators of severity of illness or aggressiveness of medical management during the hospitalization[1]. We include claims from the OPD file to ensure that we capture services provided to patients who are hospitalized on the same day as the OPD service. We expand our previous analyses by identifying a greater number of diagnostic and interventional procedures as well as reporting on use of physician consults during the index admission and on the provision of hemodynamic, cardiovascular, or respiratory support services that we view as proxies for severity of illness or for aggressiveness of medical management. For example, we report on the rate of Medicare beneficiaries that received a cardiac assist device or ventilation support during the index admission.

[1] It is important to note that we did not combine the Part A and Part B (plus OPD) data for this analysis. Rather, we report only the Part B (plus OPD) data to allow for a more detailed evaluation of services provided during the index admission. As there are few direct crosswalks between the CPT procedure variables created and those that were created using the Part A ICD-9 codes, reporting both would have required the creation of fairly high levels of aggregation of procedures, thereby defeating the purpose of using Part B data to more thoroughly explore services during the Index admission.

Further, we disaggregate patients into four clinical strata by principal diagnosis to further evaluate whether rates of diagnostic or interventional procedures are influenced by differences in type or severity of ischemic heart disease. We create four disease categories to reflect varying degrees of severity or acuity of ischemic heart disease:

- acute myocardial infarction (AMI) to reflect patients who have had a major myocardial infarction, e.g., transmural infarction;
- subendocardial infarction to reflect patients who have had a less serious type of myocardial infarction than those in the AMI category;
- unstable angina to reflect patients who have a serious form of ischemic heart disease for which they are at high risk of an AMI or sudden death; and
- chronic stable angina to reflect patients with known ischemic heart disease that are not considered unstable.

Third, we expand our focus to include diagnostic and interventional procedures provided prior to the hospital phase of treatment for ischemic heart disease. To the extent that practice patterns or service availability differ across hospital type or across geographic regions, differences in observed rates of procedures during hospitalization may be reflective of the differences in the proportion that are provided in-patient versus out-patient. Thus, we report the total rate of service provision across all settings within a six month episode of care that encompasses the index admission.

6.1.2 Summary of Findings of Service Use Using Hospital Billing Data

In our earlier report, we presented rates of selected diagnostic and interventional procedures during the index 1997 IHD admission. The key findings from the earlier report using only inpatient hospital billing data are as follows:

- Approximately 42 percent of IHD patients received a diagnostic cardiac catheterization and/or angiocardiography with contrast material during their index hospitalization. These rates decreased substantially with age, and women were less likely than men to receive these procedures. Blacks and Native Americans were less likely than whites to receive diagnostic catheterization and/or angiocardiography procedures; while Asians and Hispanics were more likely than whites to receive these procedures.
- Women had a higher rate of thallium stress testing than men, but no difference in the rate of standard stress testing was observed. Compared to whites, Asians and Native Americans had higher rates of standard stress testing performed during their IHD hospitalization, and all minorities except Native Americans had higher rates of thallium stress testing.
- Medicare beneficiaries age 75 years and older, female beneficiaries, and all racial minority groups had higher rates of three types of diagnostic imaging tests of varying degrees of cost and sophistication when compared to Medicare beneficiaries under age 75, males, and whites, respectively.
- With few exceptions, Medicare beneficiaries age 75 years and older and women had lower rates for all types of coronary artery invasive procedures when compared to Medicare beneficiaries under age 75 and men. Across the racial groups, we observed for blacks and Native Americans a pattern similar to that observed for the eldest Medicare beneficiaries: consistently lower rates of procedures when compared to whites across all procedures. Asians tended to have higher rates of all types of procedures than whites. There was no discernible pattern of substitution of older procedures for newer procedures for older beneficiaries, women, or racial minorities.
- Women and blacks received the less sophisticated single chamber pacemakers at the same rate as men but they were significantly less likely to receive the more sophisticated automatic cardioverter/ defibrillator.
- Females and Medicare beneficiaries who were 75 years and older were far less likely than males and beneficiaries 74 years of age and younger to have received electrophysiologic (EP) testing, respectively. At the same time, females and older beneficiaries were more likely than males and younger beneficiaries to have received standard electrocardiograms, 24 hour Holter monitor devices and telemetry. There were no differences in the rate of EP testing among the major racial groups. However, racial minorities tended to have higher rates

of the standard electrocardiographic technologies as compared to whites.

6.1.3 Rates of Service Use Using Physician Billing Data

We now present use rates for four types of services provided during an inpatient stay with a primary diagnosis of ischemic heart disease: (1) cardiovascular diagnostic procedures; (2) cardiovascular intervention procedures; (3) hemodynamic and respiratory monitoring or support services; and (4) specialty consultations. Table 6-1 displays rates per 100 Medicare beneficiaries admitted with IHD, thus they are directly interpretable as percentages. Data are displayed in total and by three age groups, two sex groups, and six racial/ethnic classes. The rates have been age/sex/race adjusted, as appropriate. When conducting the two-way comparisons, age 65-74, men, and whites are the respective reference groups. The methodology for standardization and statistical testing was discussed in detail in Chapter 4.

We evaluated the use rates of roughly seventy cardiovascular diagnostic and interventional procedures that vary in degree of invasiveness, level of sophistication, and costs. Note that the many of the diagnostic tests are done on an outpatient basis. Any diagnostic testing conducted prior to the index admission is not reflected here and could explain some of the racial differences. However, many of the procedures occurred with such infrequency it was not possible to conduct statistically reliable comparisons across different sub-populations. Further, the low rates of occurrence prevented any policy-relevant analyses with respect to racial/ethnic disparities in total use of services and differential rates of use of older versus newer technologies. Thus, we report the more frequently occurring services as well as reporting rates for larger groups of services.

Rates of Diagnostic Procedures for All IHD Admissions. Across all IHD admissions, approximately half of all beneficiaries received an invasive right or left heart catheterization and/or angiography. Heart catheterizations and angiography are used to directly assess hemodynamic functioning of the heart and examine the structural patency of cardiac vessels and valves. These two procedures often provide the definitive diagnostic information upon which surgical and/or medical intervention decisions are made.

Only 13 percent of beneficiaries underwent a bicycle, treadmill, or pharmacologically provoked stress test. These tests are used to determine if ischemia is induced with exertion. Pharmacological provocation is generally used when patients have limited physical exercise capacity, e.g., arthritis or age, or when ST segment analysis with exercise stress testing cannot be performed because the patient is taking digitalis or they have a cardiac arrhythmia such as a bundle branch block.

The vast majority of beneficiaries, 87 percent, received a resting electrocardiogram (ECG). This is a commonly performed procedure for patients with IHD. However, less than 2 percent of all beneficiaries received any of the other types of longer-term ECG monitoring procedures, and less than 1 percent underwent an intracardiac electrophysiological mapping procedure. This latter procedure is used to evaluate the degree and origin of heart beat irregularities, or arrhythmias, and as such is a fairly invasive newer technology.

Three different types of echocardiography were evaluated. Echocardiography is an ultrasound technique used to diagnose a range of cardiac disorders. Their individual usefulness varies across type of cardiac disorders. Roughly 40 percent of all beneficiaries admitted for IHD received a 2-D or M-mode electrocardiogram. 2-D is the dominant echocardiographic technique in current practice and is used to evaluate a broad spectrum of diseases; ranging from valvular disease to CAD to pericardial and aortic diseases (Merck Manual). About one-third received a standard doppler echo and less than a third received doppler color velocity flow mapping. This latter procedure is essentially a 2-D mode echo with the cardiac blood flow mapped in color.

Only about one-eighth of all patients underwent any form of myocardial perfusion imaging during their stay. These procedures are typically performed to evaluate the significance of coronary artery stenosis or to evaluate the extent of scarring following an AMI. Only 1 percent of all IHD patients received evaluation of ventricular function and wall motion through a variety of different ventriculography services, e.g. gated equilibrium pool imaging studies. And, only 2 percent received a CT of the thorax. This procedure may be used to assess cardiac anatomy or pulmonary functioning.

Rates of Cardiovascular Intervention Procedures for All IHD Admissions. About 40 percent of all beneficiaries admitted with IHD underwent one or more major cardiovascular procedures during their index admission. Across all IHD admissions, about 18 percent underwent coronary artery bypass graft (CABG) surgery during admission. The majority of beneficiaries undergoing a CABG, 68 percent, received a combination of arterial and venous grafts, which has become the dominant form of

CABG surgery for graft patency reasons. The second most common type of CABG was two or three venous grafts; 16 percent of beneficiaries undergoing a CABG received these. Just over 1 percent of all beneficiaries admitted for IHD received thrombolysis either by intracoronary infusion or intravenous infusion during the admission. Intravenous thrombolysis administered outside of the hospital or ER setting on the day of admission, i.e., by an EMT prior to transport to the hospital, would not be reflected in these estimates.

Roughly one-quarter of all IHD beneficiaries underwent some form of percutaneous balloon angioplasty and/or stent insertion. Single vessel stent and/or angioplasty was the most common form of intervention. And, just under 1 percent underwent valvular surgery and just over 1 percent underwent permanent pacemaker or implantable cardioverter-defibrillator surgery during the IHD admission.

Rates of Severity Indicator Procedures for All IHD Admissions. We selected for evaluation six hemodynamic, cardiovascular, and respiratory support services that we view as proxies for severity of illness or for aggressiveness of medical management. About one-quarter of all beneficiaries received some form of hemodynamic monitoring during their IHD admission. However, relatively few beneficiaries received any other significant form of life support. Less than 5 percent received ventilatory support during their admission, 3 percent received prolonged ventricular mechanical assistance, 2 percent received temporary cardiac pacing assistance, 1 percent received cardiopulmonary resuscitation, and just under 1 percent underwent cardioversion for arrhythmias.

Rates of Consultations for All IHD Admissions. Lastly, we examined the rates at which beneficiaries were hospitalized in intensive care units and received consults from a variety of specialists. Consultations may be viewed also as a severity proxy, or more importantly, may be an important indicator of the types of medical or surgical treatments that are being considered during the hospitalization, even if the treatment were not provided, i.e., cardiothoracic surgical consult without a resulting CABG. Across all IHD admissions, 15 percent of beneficiaries were hospitalized at least one day in an ICU. Not surprisingly, 71 percent of beneficiaries received a cardiology consult during the admission. Only 7 percent received a cardiothoracic surgical consult, although 17 percent of beneficiaries underwent a CABG during the admission. Presumably the difference reflects those that are admitted for the sole purpose of surgery. The thoracic surgeon would bill the appropriate surgical code, rather than a consult code. Many fewer beneficiaries received other types of consultations: 8 percent received a pulmonary consult, 4 percent received renal or neurology consults, and less than 2 percent received an infectious disease consult.

Rates of Procedures by Age Group. Evaluation of the rates of diagnostic and interventional procedures as well as the provision of life support services and consultation services by age group reveals a stark contrast in patterns of diagnostic and interventional treatment for those age 65 to 74 versus those 75 years and older. The observed systematic differences suggest less aggressive surgical and medical management of beneficiaries age 75 and older. Beneficiaries age 75 and older have lower rates of invasive diagnostic procedures, e.g., cardiac catheterization with or without angiography and stress testing, than those age 74 and younger. In contrast, beneficiaries age 75 and older have significantly higher rates of all types of echocardiograms and doppler color velocity flow mapping. At the same time, the oldest old had a significantly lower rate of myocardial perfusion studies. There were no differences in the rates at which patients received evaluation of ventricular function and wall motion through a variety of different ventriculography services, e.g. gated equilibrium pool imaging studies. And, patients age 75 to 84 received a CT of the thorax more often than those age 65 to 74.

Older beneficiaries also have lower rates of stress testing during the admission. In contrast, the elderly age 75 to 84 have higher rates of standard ECG testing, and beneficiaries age 75 and older have higher rates of 24 hour ECG monitoring. The oldest old also have lower rates of more sophisticated ECG monitoring, i.e., telephonic transmission of post-system ECG strips and signal averaged ECG. Further, beneficiaries age 85 and older have considerably lower rates of intracardiac electrophysiological procedures than those 65 to 74 years of age. Interestingly, beneficiaries age 75 and older have a higher rate of permanent pacemaker insertion than those under age 75.

As observed in the earlier report, beneficiaries age 75 to 84 have significantly lower rates of all types of cardiovascular (CV) intervention procedures and beneficiaries age 85 and older have even lower rates of intervention procedures. Twenty-two percent of beneficiaries age 65 to 74 received some form of a coronary artery bypass graft (CABG) procedure, while only 16 percent age 75 to 84 received a CABG and less than 4 percent age 85 and older underwent a CABG. The same pattern holds for less invasive cardiac intervention procedures, i.e., thrombolysis and percutaneous angioplasties with or without stents. Further, the ratios of rates for those 75 to 84 relative to 65 to 74 are very similar across all types of CV intervention procedures suggesting no pattern of substitution of newer, more sophisticated procedures for older or less sophisticated types of procedures. In contrast, beneficiaries age 85 and older appear to be more likely to have the less invasive, newer types of CV intervention procedures, PTCA, stents, etc., as compared to CABGs, albeit the rates for the oldest old are substantially lower than rates for beneficiaries age 65 to 74. Consistent with CABGs, the oldest old also have lower rates of all types of valvular surgeries than those age 65 to 74. In contrast, beneficiaries age 75 and older have higher rates of permanent pacemaker insertions. This would be consistent with their higher rates of 24 hour ECG monitoring.

Beneficiaries age 75 and older have lower rates of hemodynamic and respiratory monitoring and life support services than those who are age 65 to 74 years. The noted exception is for cardiopulmonary resuscitation. Beneficiaries age 75 to 84 years of age have higher rates of cardiopulmonary resuscitation than those age 65 to 74. Thus, it would appear that the older beneficiaries are not less severely ill than 65 to 74 years of age, but rather they appear to be less aggressively monitored and supported. Interestingly, even though beneficiaries age 85 and older have higher rates of permanent pacemaker insertions than younger beneficiaries and 24 hour ECG monitoring, they do not have higher rates of temporary pacemaker insertions or cardioversion. In fact, beneficiaries age 85 and older have significantly lower rates of temporary pacing and cardioversion. The difference in rates for these technologies would suggest that pacemaker insertions for older beneficiaries are more likely to be scheduled, as opposed to be inserted following an acute event that triggers the need for temporary pacer insertion and/or cardioversion.

Given the lower level of cardiovascular and respiratory support services and CV intervention procedures provided to beneficiaries age 75 and older, it is not surprising to see that they are less likely to be admitted to the ICU, and have fewer cardiology and cardiothoracic surgical consults. Beneficiaries age 85 and older also have fewer pulmonary and renal consults. But, beneficiaries age 75 to 84 have more neurology consults. Once again, the observed consult patterns suggest less aggressive cardiovascular medical management of older beneficiaries.

Rates of Procedures by Gender. Evaluation of the rates of diagnostic and interventional procedures as well as the provision of life support services and consultation services by sex reveals a similar contrast in patterns of diagnostic and interventional treatment as was observed between beneficiaries age 65 to 74 and those age 75 and older. Women, like Medicare beneficiaries age 75 and older, appear to be less aggressively treated, both surgically and medically, than men. Like the oldest old, women receive fewer invasive diagnostic catheterizations and/or angiographies but more doppler echocardiograms. Women also receive more myocardial perfusion imaging than men as well as more routine ECG monitoring and stress testing during the index admission. However, women have lower use rates for the more sophisticated procedures, e.g., signal averaged ECGs and intracardiac electrophysiological mapping.

Women have significantly lower rates of all types of cardiovascular (CV) interventional procedures. Twenty-two percent of men received some form of a coronary artery bypass graft (CABG) procedure, while only 14 percent of women received a CABG. The same pattern holds for less invasive cardiac intervention procedures, i.e., thrombolysis and percutaneous angioplasties with or without stents. However, like the oldest old, women appear to be more likely to have the less invasive, newer types of CV intervention procedures, PTCA, stents, etc., as compared to CABGs, albeit the rates for women remain substantially lower than rates for men. Women also have lower rates of valvular procedures and insertion of permanent pacemakers. Like the oldest old, women have lower rates of hemodynamic and respiratory monitoring and life support services than men, and lower rates of all types of consults. In spite of lower levels of life support, invasive monitoring, and consults, women are as likely to spend at least one day during their index admission in an ICU as men.

Rates of Procedures by Race/Ethnicity. The pattern of service use for blacks as compared to whites is very similar to that which was observed for women as compared to men. Although many of the rates are considered statistically non-reliable due to very small numbers, Native Americans have service use patterns very similar to blacks. Interestingly, Asians and those with Unknown or Other as a Race/Ethnicity categorization tend to resemble whites in their service use pattern more than they do other racial/ethnic minorities. Beneficiaries of Hispanic origin tend to have procedure rates that are typically higher than those observed for blacks and Native Americans, but lower than those observed for Asian and Other/Unknown racial/ethnic classes.

Almost half of white beneficiaries underwent a right or left heart catheterization and/or coronary angiography during their hospital stay. Although all racial/ethnic groups had statistically significant lower rates of catheterization and/or angiography, three minority groups, Asians, Hispanics, and those with a racial assignment of Other/Unknown had less than a five percentage point difference when compared with whites. Blacks and Native Americans had a 10 percentage point difference. Like women and the beneficiaries age 75 and older, blacks were more likely to get non-invasive diagnostic testing through the use of echocardiograms, myocardial perfusion imaging, or CT of the thorax. Hispanics were also more likely to get a 2-D or M-mode echocardiogram and have myocardial perfusion imaging. All other racial groups had rates of non-invasive imaging and echocardiograms similar to whites.

Blacks were more likely than whites to undergo stress testing during the index admission and to have 24 hour ECG monitoring and telephonic transmission of post-syndrome ECG strips. However, blacks have lower rates of cardiac interventional procedures that would be follow-on procedures for the types of diagnostic testing just discussed. Blacks, for example, underwent CABG surgery 10-in-100 admissions versus 18-in-100 for whites and balloon PCTA 7.2 percent versus 9.6 percent for whites. In contrast, Hispanics and beneficiaries with race as Other/Unknown had significantly lower rates of telephonic transmission of post-syndrome ECG strips and intracardiac electrophysiological procedures than whites.

Other than for blacks, there is no clear-cut pattern of service provision for cardiac interventional procedures among minority populations. Asians and beneficiaries with

Other or Unknown racial designation had similar rates as whites for most of the cardiac interventional procedures; while Hispanics and Native Americans had lower rates than whites for only a few selected cardiovascular procedures, e.g., CABG, percutaneous single vessel stent and balloon angioplasty. Many of the Native Americans/Alaska Natives had rates that were not statistically reliable due to small numbers.

Blacks also consistently received fewer hemodynamic and respiratory life support services than whites, but had a higher rate of cardiopulmonary resuscitation than whites; a similar pattern that was observed for beneficiaries age 75 to 84. Asians and beneficiaries with a racial designation of Other or Unknown had rates of life support similar to that of whites. Hispanics and Native Americans received fewer non-imaging CV hemodynamic services than whites, and Hispanics had lower rates of cardioversion. All other rates were either non-reliable or the same as whites.

As with women, blacks had the same rate of admission to an ICU as whites in spite of having significantly fewer cardiovascular procedures and life support services. They also had lower rates of cardiology and cardiovascular surgical consults as well. However, blacks did have higher rates of renal and neurology consults. The pattern is less clear for the remaining minority populations. Asian, Hispanic, and Other/Unknown beneficiaries had significantly higher rates of admission to an ICU and renal consults than whites. All minorities except Asians had lower rates of cardiology consults than whites, and Hispanic beneficiaries also had lower rates of cardiothoracic surgical and infectious disease consults than whites.

6.1.4 Rates of Service Use by Type of Principal Diagnosis

Differential rates of diagnostic or interventional procedures observed across all IHD patients could be influenced by differences in type or severity of ischemic heart disease among the sub-populations of interest. Thus, we created four disease categories to reflect varying degrees of severity or acuity of ischemic heart disease and assigned patients to the disease category based upon their principal diagnosis. Table 6-2 displays the proportion of all IHD admissions by principal diagnosis class, in total, and by age, sex, and racial/ethnicity categories. Across all IHD admissions, 17 percent were assigned to acute myocardial infarction (AMI), 19 percent were assigned to subendocardial infarction, 11 percent were assigned to unstable angina, and 53 percent were assigned to chronic stable angina.

There are considerable differences in the distribution of principal diagnoses between the youngest and oldest beneficiaries. We observe that 60 percent of patients age 65-74 are admitted with a principal diagnosis of chronic stable angina, in contrast to only 34 percent for beneficiaries 85 and older. Half as many patients age 65-74, or 30 percent, are admitted for some form of a myocardial infarction. However, over 50 percent of the oldest old are admitted with a principal diagnosis of myocardial infarction. Unstable angina represents the smallest proportion of IHD admissions across all age groups.

There is considerably less variation in the distribution of diagnoses between males and females and across the racial/ethnic classes.

Table 6-3 provides procedure and service rates by the four disease categories. Appendix 6.A contains four sets of tables that display rates of service use by the same age, sex, and racial/ethnic groups as previously evaluated. Comparing the rates on Table 6-3 for the two types of myocardial infarction, one observes similar levels of diagnostic and CV interventional procedures with only a few noted exceptions. The rates of patients receiving heart catheterization with angiography, percutaneous single vessel balloon angioplasty, and percutaneous single vessel stent were considerably lower for those admitted with a subendocardial infarction as compared to those admitted for a more significant myocardial infarction. A greater distinction in rates is observed between the two types of infarctions when evaluating the provision of hemodynamic and respiratory monitoring and life support services and number of ICU visits. Not unexpectedly, those admitted with a subendocardial infarction were less likely to receive these types of services and have ICU visits than those with more significant myocardial damage. There is relatively little distinction among rates of consults between the two types of infarctions.

Patients admitted with either unstable or chronic stable angina differ considerably in the rates at which they receive diagnostic and CV interventional services, both between themselves and with beneficiaries admitted for an AMI. Medicare beneficiaries admitted with unstable angina had considerably lower rates of invasive diagnostic testing and cardiac interventional procedures than those admitted with chronic stable angina as well as beneficiaries admitted with a myocardial infarction. Both chronic stable and unstable angina patients had similarly lower rates of doppler echocardiograms than myocardial infarction patients did, but higher rates of myocardial perfusion imaging testing.

Chronic stable angina patients had the highest rate of CABG, 22 percent, of all four diagnostic categories. They also exhibited relatively high rates for percutaneous single vessel stent, 17 percent, and percutaneous single vessel balloon angioplasty, 11 percent. In contrast, the rate of CABG for patients with unstable angina was only 7 percent, and the rates of the same percutaneous procedures were 6 and 3 percent, respectively.

Unstable angina patients had very low rates of hemodynamic and respiratory monitoring and life support services relative to all other diagnostic categories. Given the clinical nature of unstable angina, it is peculiar that they do not exhibit higher rates of usage than those with chronic angina do. Chronic angina patients had rate of service use more similar to the myocardial infarction patients. Both sets of angina patients had very low rates of ICU visits. However, it should be noted that chronic stable angina patients had the highest CABG rate, thus it is likely that the number of ICU visits by their attending physician is not captured in this estimate as surgeons bill a global fee for the surgery and do not bill for visits within a 90 window of surgery. The rates of consults for both sets of angina patients is generally lower than rates observed for both sets of patients admitted with myocardial infarction.

Irrespective of similarities or differences in levels of procedure rates across the four IHD disease categories, the previously observed patterns of disparities for those 75 years of age and old, women, blacks, and Hispanics are observed within each of the four disease categories (see Appendix Tables 6.A-1, 4). Because of the small numbers of other minorities, many of their rates are not statistically reliable, thereby precluding a more detailed analysis at the racial/ethnic level. For the noted demographic populations, one continues to observe lower rates of invasive diagnostic and CV interventional procedures, higher rates of doppler echocardiograms, lower rates of acute hemodynamic and respiratory monitoring and life support services, and lower rates of ICU visits and consults.

6.1.5 Rates of Service Use Six Months Prior to and During an Admission

The finding that there are differential rates of inpatient procedure use for patients with ischemic heart disease by age, gender, and race is not surprising given the large body of literature reviewed earlier in this report. However, the analyses so far have focused strictly upon the rate of diagnostic and interventional procedures during the hospital phase of treatment for ischemic heart disease. To the extent that practice patterns or service availability differ across hospital type or across geographic regions, differences in observed rates of procedures may be reflective of the differences in the proportion that are provided in-patient versus out-patient. Thus, we expand our focus to include diagnostic and interventional procedures provided in any setting during a six-month window prior to an IHD admission with the procedures that are provided during the admission.

This more comprehensive evaluation uses Medicare Part B physician data and the Medicare Outpatient Department (OPD) file to identify services prior to admission. Further, we collapse a large number of procedures into a smaller number of diagnostic and interventional procedures for ease of comparison. For example, we aggregate nine CABG procedure rates into one CABG procedure rate. We also create aggregate categories of physician consults, e.g., cardiology consult, cardiothoracic consult, and all other types of consult, and aggregate categories of hemodynamic, cardiovascular, or respiratory support services that we view as proxies for severity of illness or for aggressiveness of medical management.

Table 6-4 displays the age-sex-race adjusted rates that cover the period of hospitalization for the index admission and the six-month period prior to the admission. Appendix 6.B contains an accompanying set of tables that displays the age-sex-race adjusted rates of services during just the pre-admission period (Appendix Table 6.B-1) and during just the index admission (Appendix Table 6.B-2). This allows one to directly examine the influence of the pre-admission service provision patterns on the observed index admission service provision patterns as only the combined rates are displayed in text Table 6-4.

Rates of Procedures for All IHD Admissions. There is a marked increase in the proportion of Medicare FFS beneficiaries receiving diagnostic services, when services provided during the six months prior to the IHD admission are combined with index admission services. The rate per 100 IHD Medicare FFS beneficiaries of right or left heart catheterizations and/or angiography increases by 10 percentage points, the rate of echocardiogram/doppler flow mapping increases almost 20 percentage points, the rate of diagnostic imaging more than doubles, the rate of stress testing almost triples, and the rate of 24 hour electrocardiogram monitoring nearly triples. Excluding pre-admission testing during the six months prior to admission underestimates the level of activity associated with evaluation of ischemic heart disease during a relevant window of treatment.

Not surprising, there is relatively little increase in the rates for CV interventional procedures. This suggests that few older persons are getting multiple major CV procedures within a six-month window. The observed rates of the severity indicators also show only modest increases. For example, the six-month pre-admission period only increases the proportion of Medicare beneficiaries receiving CV hemodynamic monitoring by 2 percentage points. ICU visits increase by 3 percentage points, and the rate of beneficiaries receiving ventilator support increases by 2 percentage points.

Further, there are modest increases in the total proportion of patients receiving consults when expanding the window period. This is relatively surprising, but may reflect the fact that CPT consultation codes, rather than the evaluation and management (E&M) codes were used to define consults. This would imply that many of the patients admitted for IHD have established relationships with cardiologists and/or cardiothoracic surgeons, and these physicians would presumably bill using E&M codes, rather than consult codes.

Rates of Procedures by Age Group. Inclusion of pre-admission diagnostic testing procedures changes the prior observed pattern of disparities in rates between beneficiaries age 75 and older and beneficiaries age 65 to 74 because of differentially higher rates of outpatient diagnostic testing for the 65 to 74 age group prior to admission. The comparative rates of heart catheterization and/or angiography and echocardiograms/doppler flow mapping remain relatively stable. Beneficiaries age 75 and older continue to receive fewer heart catheterizations and/or angiographies and a greater number of echocardiograms than younger Medicare beneficiaries. When the preadmission period is considered, the higher rate of standard electrocardiograms among 75 to 84 year olds during hospitalization disappears, and the rate of ECGs for those age 85 years of age and older actually falls below the rate of ECGs for those age 65 to 74. Older beneficiaries continue to have a higher rate of 24-hour electrocardiographic monitoring than beneficiaries age 65 to 74; however, one no longer observes a statistical difference between the oldest old and young age groups. In sharp contrast, however, beneficiaries age 75 to 84 have significantly lower rates of diagnostic imaging than their younger counterparts when incorporating the diagnostic imaging that occurs in the six-month period prior to admission. Beneficiaries age 75 to 84 and age 65 to 74 had very similar rates of diagnostic imaging during the hospitalization period.[2] The disparity in rates between beneficiaries age 85 and older and beneficiaries age 65 to 74 remains.

There is virtually no change in rates of interventional procedures when considering the six month period prior to admission. These are major cardiac interventions and the likelihood of multiple procedures within a relatively small window of time is quite low. Nor are there any significant changes in the rates of services that we consider proxies for severity. Beneficiaries age 75 to 84 have lower rates of hemodynamic monitoring and ventilator support than beneficiaries age 65 to 74 and this

[2] It should be noted that there were statistically significant differences in rates of diagnostic imaging between the two age groups during the hospitalization period when evaluating individual diagnostic imaging procedures. Aggregation across all diagnostic imaging removes the observed disparities.

gap widens when comparing beneficiaries age 85 and older with the youngest age group. In contrast, beneficiaries age 75 and older continue to have more ICU visits than younger beneficiaries do even though they continue to receive fewer interventional services and fewer life support services.

The pattern of differences in rates of consultations among the three age groups remains constant as well although the overall levels increase for all age groups.

Rates of Procedures by Gender. The patterns of disparities between rates of services for men and women remain fairly stable with the addition of pre-admission services for interventional procedures, severity proxies, and consultations. Women continue to receive far fewer of these types of services than men do. While women have a 10 percent higher rate of diagnostic imaging during hospitalization than men, when the full episode of care is considered, one observes that men actually have a 6 percent higher rate of diagnostic imaging than women.

Rates of Procedures by Race/Ethnicity. Evaluation of rates of diagnostic and interventional procedures as well as the provision of life support and consultation services by the six race/ethnicity classes continues to reveal significant disparities for some but not all minorities, and the levels of disparity remain fairly constant. Blacks continue to receive fewer invasive diagnostic procedures than whites, but more non-invasive echocardiograms, 24 hour ECG monitoring, and diagnostic imaging than whites. Blacks continue to receive significantly fewer cardiac interventional procedures, life support services, and cardiology and cardiothoracic consults than whites, but continue to higher rates of consults for co-morbid conditions than whites. Not surprising blacks also have a significantly lower rate of cardiac rehabilitation services prior to admission than whites.

Native Americans/Alaska Natives (NA/ANs) continue to exhibit disparities compared to whites. Asians continue to resemble whites in their service use pattern. The previously observed lower rate of catheterization and/or angiography no longer exists between Asians and whites when the observation period is expanded to include the six months prior to admission. Beneficiaries of Hispanic origin continue to have diagnostic and interventional procedure rates that are often higher than those observed for blacks and Native Americans, but lower than those observed for Asians and whites. Hispanics continue to resemble blacks in relative rates of cardiology and other consultations as compared to whites.

Rates of Procedures by Type or Principal Diagnosis. An earlier analysis of rates of hospital service use stratified by four principal diagnostic categories within IHD (AMI, subendocardial infarction, unstable angina and chronic stable angina) revealed considerable variation in the levels of service use across the four disease categories but similar patterns of disparities across all four diagnosis categories. Appendix Tables 6.B-3 to 6.B-6 display the total age-sex-race adjusted rates of services for Medicare FFS beneficiaries with a principal diagnosis of AMI (including subendocardial infarction), unstable angina and chronic stable angina for the admission period as well as the six month period prior to admission. Adding pre-admission service use to the hospital service rates did not change the previously observed patterns of disparities for beneficiaries age 75 and older, women, blacks, and Hispanics within each principal diagnostic category for the majority of services. The noted exception is non-invasive diagnostic imaging. For each type of IHD diseases, the rates of diagnostic testing that had generally been higher for women than men, higher for beneficiaries age 75 to 84 than for beneficiaries age 65 to 74, and higher for blacks than whites became more similar or, in fact, became significantly lower. The only exception to this general pattern is rate of non-invasive diagnostic imaging for blacks with Unstable Angina. The addition of pre-admission non-invasive diagnostic imaging did not change the relative rate at which blacks received these services as compared to whites. With all services included within the six-month window, the age-sex adjusted non-invasive imaging rate was 33.3 per 100 blacks with unstable angina as opposed to 29.1 per 100 whites with unstable angina.

Summary. These findings suggest that the provision of IHD diagnostic and therapeutic interventions do not appear to vary between inpatient and outpatient settings systematically with age, gender, or race/ethnicity with a few noted exceptions. There is considerable diagnostic activity during the six-month period prior to admission for IHD for many Medicare beneficiaries.

In particular,

- men and beneficiaries age 65 to 74 have substantially higher rates of non-invasive imaging than women and beneficiaries 75 years of age and older, respectively
- no readily apparent differentially rate of pre-admission diagnostic testing is observed when comparing across the race/ethnicity classes.

Further,

- the overall proportion of Medicare beneficiaries receiving major cardiac interventions, consults, or intensive life support services during the six-month period prior to admission for IHD is small.

And,

- in general, the patterns of disparity among the age groups and race/ethnicity classes and between men and women remain constant across these types of services.

6.1.6 Pre-admission Diagnostic Treatment Patterns for Unstable Angina

In 1994, the Agency for Health Care Policy and Research (1994) released a clinical practice guideline for diagnosis and management of unstable angina. Selecting a subset of patients admitted with a principal diagnosis of unstable angina, we more closely examine the diagnostic service patterns during the six-month period prior to admission with respect to the guidelines. The guideline specifies alternative sets of diagnostic and therapeutic interventions that vary by severity of unstable angina symptoms. Given that we have only claims data to use in our evaluation, we are limited to evaluating the rates of all unstable angina patients, not stratified by severity. To the extent that there are systematic differences in severity across sub-populations of interest, the reported rates may reflect underlying severity and not treatment pattern variation. Nor can all of the recommended diagnostic and therapeutic interventions be evaluated. For example, we cannot monitor the use of aspirin, heparin, beta blockers, nitrates or calcium channel blocking agents. These are not captured in Medicare claims.

We focus upon a set of diagnostic and therapeutic services that we have previously evaluated, and that are contained in the guidelines, and add diagnostic procedures from the guidelines not previously evaluated, such as cardiac laboratory tests and oxygen saturation through pulse oximetry. The cardiac laboratory test category contains a mixture of laboratory tests that are used to monitor heparin administration (PT/PTT), red blood cell count and oxygen saturation (Hematocrit and Hemoglobin), digoxin administration (digoxin levels), and possible myocardial damage (CPK levels). Although not diagnostic, rates of referral for physical therapy are also evaluated as this is a recommended service for nonintensive medical management, i.e., encouraging the patient to progress to a level of activity that is required to perform activities of daily living.

Severity indicators are also evaluated for this subset of patients that would indicate a higher level of patient severity: preadmission physician direction of EMS or ER usage, observation bed admission, and office services after hours.

When analyzing rates of pre-admission diagnostic testing, CV interventions, and physician consultations and referral services for only unstable angina patients, one observes an overall reduction in the level of disparities previously observed in the inpatient setting. One continues to observe lower rates of invasive diagnostic testing among beneficiaries age 75 and older as compared to those age 65 to 74, and among women as compared to men, and blacks as compared to whites. Diagnostic imaging and stress testing are also lower for the older beneficiaries and women as compared to beneficiaries age 65 to 74 and men. Blacks have lower rates of stress testing than whites, but there is no disparity in rates for diagnostic imaging. Beneficiaries age 75 to 84, blacks, and Hispanics have higher rates of service provision prior to admission than beneficiaries age 65 to 74 and whites, respectively. There is very little disparity in the rate of cardiac laboratory testing or in rate of pulse oximetry among the sub-populations of interest. In fact, beneficiaries age 75 to 84 have a rate of cardiac laboratory testing that is higher than beneficiaries age 65 to 74, and Hispanics have a rate of pulse oximetry that is higher than whites.

Revascularization is a recommended therapeutic intervention for patients deemed to be at high risk of death or a myocardial infarction. As observed during the hospitalization phase, beneficiaries age 75 and older have lower rates of angioplasty than beneficiaries age 65 to 74 do, and blacks have lower rates than whites. These differences could be a reflection of differences in rate of patients considered appropriate candidates for reperfusion. However, there are only modest differences across all of the severity indicators. The single most noted difference is in the higher rates of preadmission physician direction of EMS or ER usage that one observes for beneficiaries age 75 and older, women, and blacks and Hispanics as compared to beneficiaries age 65 to 74, men, and whites. Blacks also have twice the rate of whites in the use of office services after hours. Asians have a significantly lower rate of preadmission physician direction of EMS or ER usage than whites.

There are also relatively modest differences in the rate of cardiology consults among age groups, and no difference in the rate of cardiothoracic surgery consults among any of the sub-populations. Blacks and beneficiaries age 75 to 84 continue to demonstrate higher referral rates to physicians specializing in renal, neurology, respiratory, and infectious diseases when compared to whites and beneficiaries age 65 to 74. Nor is there much variation in the rate of physical therapy provided during the six-month period before admission. The only statistically significant difference observed is between the oldest old (85 years and older) and the youngest (65 to 74). This disparity is also observed in cardiac rehabilitation physician services as well, and probably reflects a greater level of activity limitations in the population of beneficiaries age 85 and older. Although there is a lower rate of cardiac rehabilitation physician services for blacks as compared to whites, this disparity dose not exist for physical therapy.

Summary.

- there is a noticeable reduction in use rate disparities for patients with a principal diagnosis of unstable angina when the pre-admission period is examined distinct from the hospitalization period.

This would suggest that outpatient medical management may have been influenced by the development and dissemination of the AHRQ practice guideline almost a decade ago. Further evaluation controlling for degree of severity of the unstable angina and other clinical factors that affect clinical decision making could reduce the observed disparities even further.

6.2 Diagnostic and Therapeutic Treatment Patterns Prior to Revascularization Among Medicare FFS Beneficiaries Admitted with Ischemic Heart Disease

The last descriptive analysis that we present is the evaluation of variation in diagnostic and therapeutic treatment patterns prior to revascularization among Medicare FFS beneficiaries admitted with ischemic heart disease. We present age-sex-race adjusted rates of diagnostic and CV interventional procedures provided during a six-month period leading up to the index admission for IHD for revascularization either with coronary artery bypass graft (CABG) or angioplasty, including stents. We also present rates of procedures that are proxies for poor health status, i.e., ventilator support, as well as a set of four variables that reflect patient and sociological factors that could affect the rate at which Medicare beneficiaries undergo revascularization: unavailability of other medical facilities for care, preadmission history of surgical or other procedure not carried out because of a contraindication, preadmission history of surgical or other procedure not carried out because of patient decision, and family history of housing, household, economic or psychosocial circumstances. Lastly, we create a variable, angiography more than sixty days prior to revascularization, to identify the rate at which different sub-populations may experience delays in care for whatever reasons.

Diagnostic and Therapeutic Treatment Patterns Prior to CABG. Seventeen percent of all Medicare FFS beneficiaries admitted for treatment of ischemic heart disease received a CABG (see Table 6-1). The rate at which beneficiaries received a CABG declined significantly with age and was significantly lower for women as compared to men and for Blacks, Hispanics, and Native Americans/Alaska Natives as compared to whites. There was a similar pattern observed for the rate of right and/or left heart catheterization with angiography, a diagnostic test usually performed within a fairly close period to revascularization.

Table 6-6 displays the age-sex-race adjusted rates per 100 Medicare beneficiaries admitted for a CABG of procedures received during the six-month period prior to admission. The prior observed lower rates of heart catheterization and/or angiography continue to be observed for beneficiaries age 75 and older and women as compared to rates for beneficiaries age 65 to 74 and men. This would suggest that these populations are most likely undergoing angiography during the CABG hospitalization. There are no observed statistically significant differences among any of the populations in the rate of beneficiaries that have an angiography performed more than 60 days prior to the index admission during which a CABG is performed.

There is no longer any observed racial disparity in the rate of catheterization and/or angiography. In fact, there are very few statistically significant differences in the rates of all types of diagnostic testing across the six racial/ethnic groups implying that racial/ethnic minorities that undergo a CABG have similar diagnostic work-ups as whites. With the exception of echocardiograms/Doppler flow imaging studies and 24 hour ECG monitoring, beneficiaries age 75 and older and women continue to receive fewer pre-CABG diagnostic services than beneficiaries under the age 75 and men.

Disparities in rates of CV interventional procedures observed among all IHD patients during an index admission and the six-month period prior to admission are not apparent for CABG patients during the six-month preadmission period. The only statistically significant difference observed is the lower rate that beneficiaries age 75 to 84 receive angioplasty during the pre-admission period relative to beneficiaries age 65 to 74. Further, the majority of statistically significant differences in procedures that we view as severity proxies also substantially decline. Pre-admission uses of physician direction of EMS or ER and to a lesser extent ICU admissions are the only two severity indicators for which age, sex, and racial variation continue to be observed. Beneficiaries age 75 and older, women, and blacks and Hispanics tend to have higher rates of these services than their respective comparison group. This suggests that beneficiaries undergoing CABG may be more similar, in terms of severity, than the general IHD population.

Lastly, much of the observed variation in rates of consults and use of physician cardiac rehabilitation and physical therapy services during the hospital and six-month preadmission period for all IHD patients is not observed for CABG patients. The noted exception remains cardiothoracic surgical consults. Beneficiaries age 75 and older continue to demonstrate lower rates than beneficiaries age 65 to 74. Interestingly, beneficiaries age 85 and older are significantly more likely than beneficiaries age 65 to 74 to have a cardiology consult during the six-month preadmission period. This could reflect a more aggressive attempt at medical management for the older higher surgical risk population.

Evaluation of the rates at which patient and or sociological factors are present in this population shows relatively few physicians coding these patient or social factors on Medicare billing claims during the preadmission period. Less than 1 percent had a preadmission history of another surgical procedure not being performed because of a contraindication. Due to smallness of numbers there are no statistically significant variations observed across the age groups, between men and women, and among the race/ethnic classes.

Diagnostic and Therapeutic Treatment Patterns Prior to Angioplasty. Almost twenty-five percent of all Medicare FFS beneficiaries admitted for treatment of ischemic heart disease underwent angioplasty during admission (see Table 6-1). The rate at which beneficiaries underwent angioplasty declined significantly with age and was significantly lower for women as compared to men and for blacks, Hispanics, Native Americans/Alaska Natives, and those with other types of race or unknown race as compared to whites.

The prior observed lower rates of heart catheterization and/or angiography for all IHD patients as well as those receiving a CABG continue to be observed for beneficiaries age 75 and older and women as compared to rates for beneficiaries age 65 to 74 and men. Once again this would suggest that these populations are most likely undergoing angiography during the angioplasty hospitalization. As with CABG, there are no observed statistically significant differences among any of the populations in the rate of beneficiaries that have an angiography performed more than 60 days prior to the index admission during which angioplasty is performed.

There is no longer any observed racial disparity in the rate of catheterization and/or angiography with one noted exception. Asians have a rate of catheterization and/or angiography that is 10 percentage points higher than whites. Asians also have significantly higher rates of echocardiograms and stress tests than did whites. Asians admitted with IHD tend to have similar rates of all three diagnostic tests as Whites during the admission phase as well the six-month period prior to admission. There is no observed difference between Asians and whites undergoing angioplasty in the rate of angiography, stress testing, or echocardiograms. This implies that Asians who undergo angioplasty appear to have a greater level of outpatient services than Whites and other racial minorities prior to admission for angioplasty.

Unlike what was observed for CABG patients, the patterns of diagnostic testing shows considerably more variation and the patterns are more consistent with what was observed for all IHD patients either during just the admission period or during the admission and six-month preadmission period. Older beneficiaries tend to have higher rates than beneficiaries age 65 to 74 of echocardiograms, electrocardiograms and 24 hour monitoring but lower rates of diagnostic imaging and stress testing. The oldest old also have a considerably lower rate of cardiac laboratory tests. Women also had higher rates of echocardiograms and cardiac laboratory tests than men, but lower rates than men of diagnostic imaging and stress testing. Blacks, Asians, and Hispanics had higher rates of echocardiograms than whites but blacks had a lower rate of stress testing. It is a bit surprising that the previously observed variation in rates across the sub-populations for a very broadly defined clinical group of patients remains for a more homogenous group of patients all undergoing angioplasty. The continuing variation could signal considerable co-morbid diversity across these patients or more complex and difficult cases to definitively diagnosis.

As with CABG patients, the disparities in rates of CV interventional procedures observed among all IHD patients during an index admission and the six-month period prior to admission are not apparent for angioplasty patients during the six-month preadmission period. The only statistically significant difference observed is a higher rate of arrhythmia procedures for older beneficiaries. Women have a lower rate of arrhythmia procedures than men. This pattern was observed during the hospitalization period as well and likely reflects differences in prevalence of arrhythmias.

Medicare beneficiaries undergoing angioplasty tend to resemble the general IHD population more than beneficiaries undergoing a CABG in terms of severity of illness. The very old, women, and Blacks tend to have higher rates of procedures that we view as severity proxies than their comparison counterpart. Pre-admission use of physician direction of EMS or ER and to a lesser extent ICU admissions and CV hemodynamic monitoring are more likely in these sub-populations. Interestingly, blacks and Asians have lower rates of observation bed usage than Whites, but blacks have a higher rate than whites of ER use or physician direction of EMS. These seem like contradictory patterns.

Lastly, much of the prior variation in rates of consultations during the hospital and six-month preadmission period for all IHD patients is observed, but to a lesser extent, for angioplasty patients. However, unlike the general IHD population, beneficiaries age 75 and older and blacks are more likely to have a cardiology consult than beneficiaries age 65 to 74 and whites, respectively. The opposite was previously observed for the hospitalization period, and no variation was observed for CABG patients. There is no difference in the rate at which patients undergoing angioplasty have cardiothoracic surgical consults, but beneficiaries age 75-84, women, blacks and Hispanics continue to have higher rates of consultations with other types of physicians than their comparison group. This likely reflects a higher level of co-morbidity.

Evaluation of the rates at which patient and or sociological factors are present in this population shows once again relatively few physicians coding these patient or social factors on Medicare billing claims during the preadmission period. Less than one-quarter of one percent have a pre-admission history of another surgical procedure not being performed because of a contraindication. As with the CABG population, there are no statistically significant variations observed across the age groups, between men and women, and among the race/ethnic classes.

Summary. There is observed variation in the diagnostic and therapeutic intervention patterns between Medicare FFS beneficiaries undergoing CABG and angioplasty, but the patterns of age, sex, and racial/ethnic disparities in service use rates are considerably less for CABG patients than for angioplasty patients. The finding that diagnostic practices of physicians appear to be more uniform for patients who undergo CABG may reflect a number of physician and patient factors. First, the level of severity of the CABG patients may be more similar and higher than the severity of patients undergoing angioplasty. This could lead to greater physician attention for all sub-populations as the consequences of ignoring symptoms of significant coronary stenosis can lead to myocardial infarction or death. Similarly, patients of all age, sex, and racial/ethnic classes might be more likely to respond more similarly if symptoms of significant coronary artery disease are present, or if there are significant debilitating sequelae.

In contrast, patients undergoing angioplasty or those admitted with a principal diagnosis within the broad classification of ischemic heart disease may present as diagnostic challenges to physicians resulting in greater variation and disparity in diagnostic evaluations. Or, these patients may have less compelling reasons to comply with prescribed testing.

The descriptive analyses conducted to this point do not allow us to draw more definitive explanations as to the reasons for the observed disparities. It is likely that variation in underlying CV severity of illness, differences in prevalence of co-morbid conditions, geographic variation in practice patterns, and patient preferences are contributing to the observed diagnostic patterns are to the subsequent observed differences in rates of revascularization among Medicare beneficiaries with IHD. In Section 6.3, we conduct a multivariate analysis of the likelihood of undergoing revascularization during an IHD admission to more directly examine the influence of these types of factors on the treatment decisions.

6.3 Multivariate Analysis of Likelihood of Revascularization Among Medicare FFS Beneficiaries Admitted with IHD

The descriptive analyses presented in Section 6.2 confirm what other researchers have previously documented, namely, that whites are significantly more likely than blacks to receive a coronary revascularization procedure (Peterson, *et al.*, 1997; Escare, *et al.*, 1993; Lee, *et al.*, 1997; Maynard, *et al.*, 1986; Boutwell and Mitchell, 1993; McBean, *et al.*, 1994). These racial differences tended to remain even after controlling for factors that were shown to be correlated with revascularization.[3] Further, studies of patients that have undergone an angiography or cardiac catheterization confirm that racial disparities in subsequent revascularization continue despite the apparent need for these procedures (Ayanian, *et al.*, 1993; Mitchell and Khandker, 1995; Udvarhelyi, *et al.*, 1992). A recent study by Thomas LaViest and colleagues (LaViest, *et al.*, 2002) showed that racial differences in utilization of cardiac angiography occurred during the process of determining treatment; blacks are less likely than whites to be referred for angiography. However, once a referral was obtained, blacks were no less likely than whites to undergo the diagnostic procedure. The researchers found that the odds of referral for coronary angiography was only 0.34 for blacks as compared to whites. However, the odds of coronary angiography after referral was 0.70 for blacks as compared to whites. This odds ratio was not statistically different from one.

Whether or not patients are referred for angiography may be more of a function of where they select treatment rather than physician prescribing bias. In a study conducted by Mark McClellan and colleagues (McClellan, *et al.*, 1994) on Medicare beneficiaries admitted with an acute myocardial infarction, they demonstrate that self-selection problems in observational data is likely to produce biased research results. They note that differences in outcomes among patients who receive different services are likely to

[3] For example, Peterson and colleagues found that the likelihood of angioplasty declined and the likelihood of CABG increased as the degree of coronary heart disease (CHD) increased. Further, males and patients with diabetes are less likely to undergo angioplasty relative to CABG. Controlling for these and a host of clinical factors, such as ejection fraction and type of underlying CHD, blacks were still less likely than whites to undergo angioplasty (odds ratio, 0.87), and CABG (odds ratio, 0.68).

be attributable to factors that go unobserved. Using an instrumental variable estimation approach, they show that there are virtually no incremental benefits of catheterization and revascularization on mortality after an AMI. Rather, treatment during the first hours of care (and prior to revascularization) has the greatest impact on long-term mortality. Beneficiaries who live near hospitals or select hospitals that have excellent cardiac care units are likely to have the best long-term mortality results.

In this section of the report, we provide the results of our multivariate analysis of the likelihood of undergoing coronary revascularization, CABG or angioplasty, during an index admission for ischemic heart disease. We examine the influence of race/ethnicity on the likelihood of having revascularization controlling for age, sex, socioeconomic status, clinical comorbidity and IHD diagnostic and interventional procedures during the six-month period prior to admission and patient severity and complications during the admission. A novel feature of our multivariate evaluation is the examination of ICD-9 supplementary V codes that "describe circumstances or problems that are present and that may influence a person's health status but not in itself a current illness or injury." Previous research of the Medicare population has not explicitly included these measures in their evaluations of likelihood of revascularization.

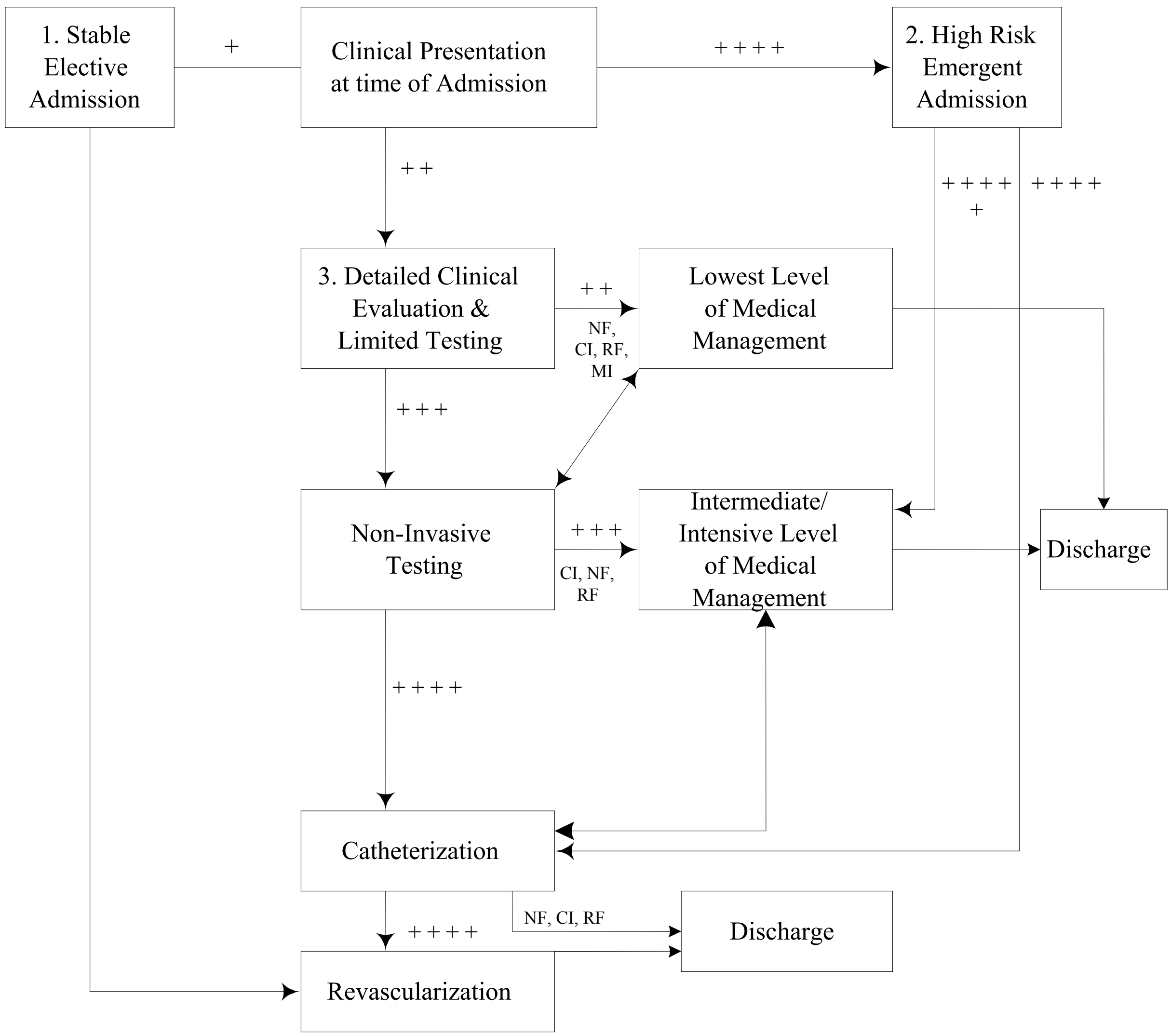
6.3.1 Model of Process Leading to Revascularization or Medical Management

The clinical practice guide developed by the Agency of Healthcare Research and Quality (AHRQ) for diagnosing and managing unstable angina provides an overarching framework for our model of the clinical decision making process leading to revascularization or medical management of Medicare beneficiaries with ischemic heart disease. Unstable angina is a clinical condition that falls between stable angina and acute myocardial infarction within the spectrum of patients with ischemic heart disease. Like patients with unstable angina, the clinical goal of treatment for patients with IHD is to lower the risk of death or nonfatal myocardial infarction. This may be accomplished through increasing levels of intensity of medical management or through invasive intervention either through angioplasty or coronary artery bypass graft.

Figure 6-1 displays a generalized model of the clinical decision making process for patients admitted to a hospital with ischemic heart disease. It is a modification of ARHQ's recommended path for diagnosing and treating patients with ischemic heart disease. The key goal of the model for clinicians is to identify the risk of an adverse event and triage patients based upon this risk to appropriate medical or surgical therapy. The model also provides a blueprint in explaining the level and direction of effects in the multivariate analysis to follow.

Figure 6-1

Model of Clinical Pathway Leading to Revascularization or Medical Management



NOTES: + = Risk level lowest; +++++ = risk level highest
NF = negative findings; RF = refused revascularization; CI = contraindications; MI = myocardial infarction

SOURCE: ARHQ angina treatment guidelines (1994) as modified by authors.

The unstable angina guideline identifies five types of patients that are candidates for cardiac catheterization and revascularization: (A) patients failing to stabilize with medical therapy; (B) patients with significant congestive heart failure or left ventricular dysfunction; (C) patients with high-risk clinical findings or non-invasive test results; (D) patients with prior angioplasty, bypass surgery, or myocardial infarction; and (E) patients opting for an early invasive strategy. The clinical decision pathway leading to revascularization or medical management begins in the model in Figure 6-1 at the point of admission. The level of risk of either death or serious myocardial infarction is denoted in Figure 6-1 by the number of plus (+) signs. One plus sign (+) denotes stable IHD patients while five plus signs (+++++) denote highly unstable, critically ill patients. The model flows from top to bottom with increasing levels of patient severity and treatment intensity. At point of admission, patients are stratified into three risk categories. Category 1 contains stable IHD patients admitted for purpose of revascularization (left side of figure). These patients, having been diagnosed in an earlier admission, are admitted and usually go directly to revascularization (shown at the bottom of the figure). They tend to have "prior histories" and tests indicating revascularization (e.g., stable angina) but are not an "emergency" case (e.g., heart attack in progress).

The second risk category contains high-risk, unstable patients admitted on an emergency basis (far right side of figure). This category contains extremely ill patients who are triaged to (a) intensive medical management/palliative care and are viewed as too ill to undergo revascularization, or to (b) emergency catheterization and then to either revascularization or back to intensive medical management.

The third category of patients includes those considered relatively lower risk than the high risk emergent admissions but who are not always as stable as the elective patients. These patients are admitted for medical management and/or additional diagnostic testing in a more controlled environment (center of figure). Patients in this category triaged to the lowest level of medical management are those with (a) negative clinical findings (NF) upon examination or history, or (b) those with significant clinical comorbidities and other contraindications (CI) that would preclude revascularization, (c) patients whose preference is not to undergo revascularization (RF), or (d) patients admitted with a myocardial infarction (MI) that has already evolved and are in stable medical condition but not immediately suitable for revascularization.

Those category 3 patients determined by limited testing to be at higher risk of an adverse event and do not have any contraindications to revascularization are likely to undergo additional, more complicated, non-invasive testing, e.g., myocardial perfusion imaging or stress testing. Based upon the results, these patients are then referred for intermediate or intensive levels of medical management or for cardiac catheterization. Patients triaged to intermediate/intensive medical management are those with (a) negative clinical findings upon testing, (b) with contraindications or too medically unstable to undergo revascularization upon further non-invasive testing, or (c) with an aversion to revascularization. Category 3 patients willing and at a sufficiently high risk of an adverse event based upon non-invasive testing are triaged to cardiac catheterization and then to revascularization. Patients may also fail intensive medical management and, if willing, undergo catheterization and revascularization during the admission.

The clinical pathway model, besides highlighting the importance of clinical risk factors, has implications for how to interpret the multivariate results that explain catheterization and revascularization. First, severity upon admission is likely not to be monotonically related to the likelihood of catheterization and revascularization. Patients who are admitted too sick to undergo such procedures, plus healthier patients determined not to require revascularization, should be less likely to have invasive treatment compared to those patients in the "middle severity" group. Second, the level of complexity of non-invasive testing should be positively correlated with the likelihood of undergoing catheterization and subsequent revascularization. After all, clinicians will recommend more complicated tests when they suspect the need for invasive treatment. However, certain positive test results can lead the clinician to recommend medical management over revascularization, at least during the current IHD episode. Third, it is quite possible that *when* the patient undergoes a diagnostic procedure, well before or during the admission, affects how that test predicts the likelihood of catheterization/revascularization. A test result well *before* the index admission may result in a stabilized patient who is being referred electively for invasive care in our data base. A test *during* admission, conversely, may confirm the clinician's suspicion that a candidate is unprepared to undergo revascularization during the index admission. Consequently, we may observe the same diagnostic or test variable having opposite signs in the revascularization model depending upon when the test was performed.

Regarding the model's implications for race/ethnic differences, much depends upon whether, compared to whites, any of the minority groups are more inclined to present in category 1, 2, or 3, as well as how their test results turn out. However, by controlling for the complexity of diagnostic testing both before and during the index admission, as well as for comorbid conditions and admission risk factors, we should be able to narrow our explanations of any remaining race/ethnic differences in revascularization rates considerably.

6.3.2 Methods

Estimation Method. The standard method for modeling a binary outcome (0,1) such as CABG versus medical treatment is logistic regression. However, when the outcome can take on more than two values and the outcome data are nominally scaled, then multinomial or polytomous logistic regression is more appropriate (Hosmer and Lemeshow, 1989). In our case, patients have three treatment options for their IHD: medical treatment, angioplasty, or CABG.

The logistic regression model for a binary outcome variable produces an odds ratio that allows one to assess the effects of the presence or absence of a particular characteristic, e.g., age $\geq$ 85, on the likelihood of receiving a CABG. The odds ratio approximates relative risk, or how much more likely (less likely) is a CABG given the presence of advanced age. An odds ratio of 1.35, for example, would indicate that an elderly patient is thirty-five percent more likely to undergo a CABG as compared to someone under age 85; while an odds ratio of .50 indicates the patient is only half as likely to undergo a CABG compared to someone under age 85.

In multinomial logistic regression with three possible outcomes (0, 1, 2), two logit functions are estimated, one for angioplasty and another for CABG. Medical management serves as the reference group, or "left-out equation," when comparing the influence of selected characteristics on the likelihood of receiving revascularization versus medical treatment.

Interpretation of the relative risk ratios from a multinomial logistic regression model is not as straightforward as the interpretation of a binary logistic regression model. Building on the earlier example, assume that the modeling of angioplasty and CABG versus medical management yields odds ratios of 1.25 and 1.35, respectively. Thus, the relative odds of undergoing angioplasty rather than medical management is 1.25 for patients 85 years of age and older relative to patients under age 85. Likewise, the relative odds of undergoing CABG rather than medical management is 1.35 for patients 85 years of age and older relative to patients under age 85. The relative odds of undergoing *CABG rather than angioplasty* for patients age 85 and older versus those under age 85 is 1.08. This is obtained by exponentiating the *difference* between the two logit coefficients from the models, i.e., $1.08 = e^{0.30 - 0.223}$. Thus, patients age 85 and older are 8 percent more likely than patients under age 85 to receive a CABG rather than an angioplasty.

Equation Specification. Multinomial logistic regression was performed using STATA software to model three possible outcomes: medical treatment, angioplasty, or CABG. The general specification of the multinomial logistic model was as follows:

(6.2) $P[O_i = 1|X_i] = f\,[RACE_i;\ DEMOSES_i;\ SEVERITY_i;\ PROC_i]$

where the dependent variable is the probability, P, of an outcome $O_i = 1, 2$ if angioplasty or CABG occurs for the *i*-th patient, given the set, X_i, of patient characteristics. For purposes of this study, the relevant set of independent variables includes a vector of dummy variables for the race/ethnicity of the patient ($RACE_i$); a vector of sociodemographic and socioeconomic characteristics of the *i*-th patient ($DEMOSES_i$); a vector of severity indicators ($SEVERITY_i$) separated into prior versus upon admission; and a vector of procedures prior to and during the index IHD admission.

Specification of Treatment Models. Because the longitudinal database contains a very large number of clinical variables, we employed a variation of a model-building strategy recommended by Hosmer and Lemeshow (1989). Because of the sheer number of clinical variables in our database, we estimated separate models for each vector of variables of interest. We assessed the level of association between each independent variable and the two revascularization treatment outcomes relative to medical management, uncontrolled for differences in severity. A 10 percent confidence level was then used as the standard for assessing association and including risk factors in our model building strategy. We also created a few composite variables to further reduce the number of variables included in the model by combining variables that had coefficients of the same magnitude and direction.

The next step was the estimation of seven multinomial logistic models, starting with a set of dummy variables for our key variable of interest, race, and stepping in six other vectors of independent variables. This allowed us to assess the overall explanatory power of each vector of variables as they are stepped into the previous model and to evaluate the relative changes in the odds ratios as a function of the stepped in variables.

The second model steps in sociodemographic (e.g., age categories) and socioeconomic variables (e.g., Medicare/Medicaid dual eligibility). Stepping these variables into the model is analogous to adjusting for such variables in descriptive comparison of revascularization rates. If none of the racial/ethnicity odds ratios change as the other variables are stepped into the regression, we conclude that these factors are uncorrelated with race/ethnicity. By controlling for these factors that affect revascularization rates, we “remove” their effects from the race/ethnic odds ratios and they can be compared on an “adjusted” basis. Again, this model does not control for differences across the races in comorbidity. The third and fourth models step in two vectors of severity. In Model 3, comorbidity, as reflected by the Charlson index and severity at the time of admission proxied by emergency (ER) admission, are added. In Model 4, variables representing proxies for clinical severity prior to admission are added. Model 5 steps in pre-admission testing variables that are likely to be correlated with medical treatment decisions that are made prior to admission. The last two models contain variables that also proxy for severity. Principal diagnosis of AMI and unstable angina are added to directly test their effects on revascularization. Two additional variables are included that capture the presence of severe clinical conditions during the hospitalization, cardiac arrest and cardiogenic shock. Also, in Model 7, we step in two variables representing diagnostic testing received during the index admission likely to reflect greater co-morbidity.

6.3.3 Results

Table 6-8 contains the multinomial logistic regression results of two possible revascularization treatments for ischemic heart disease relative to medical management. Only results of the full Model 7 are shown. Appendix 6-C.1 contains all seven stepwise multinomial logistic regression models. The first column presents odds ratios comparing the likelihood of a patient receiving angioplasty relative to medical management. The second column contains the odds ratios comparing the likelihood of the patient receiving CABG relative to medical management. Stars are included next to the odds ratios to indicate statistical significance.

Controlling for sociodemographic, socioeconomic, pre-admission and admission diagnostic testing, and severity differences across the races, the relative odds of undergoing angioplasty rather than medical management is 0.69 for blacks relative to whites. The relative odds for receiving a CABG rather than medical management is even lower for blacks as compared to whites, 0.56. Exponentiating the difference in the two logit coefficients reveals that blacks are 21 percent less likely than whites to receive a CABG as compared to an angioplasty. Among the other races, only Native Americans are less likely than whites to receive angioplasty as compared to medical treatment, *ceteris paribus*.

Not surprising, the likelihood of receiving angioplasty or CABG as compared to medical treatment declines significantly with age. Beneficiaries age 85 and older are roughly 80-90 percent less likely to receive an angioplasty and CABG versus medical treatment when compared to beneficiaries age 65 to 74. Males are more likely to receive either angioplasty or CABG than women, and are 45 percent more likely than women to receive a CABG as compared to angioplasty.

Living in rural areas, being dually enrolled in both Medicare and Medicaid, and living in very low income zip codes all reduce the likelihood of revascularization relative to medical treatment.

Two variables intended to capture psychosocial factors and patient preferences that might influence the likelihood of undergoing an invasive procedure have odds ratios less than one but were not statistically significant—possibly because they are not frequently reported. Interestingly, patients that have a physician claim indicating unavailability of other medical facilities for care have significantly lower odds of receiving angioplasty than those without such a secondary diagnosis.

The next set of variables characterizing pre-admission co-morbidity captures both patient severity prior to admission as well as pre-admission history of medical conditions that increase the risk of an AMI. Severity determined prior to admission, as assessed using the Charlson co-morbidity index or ER admission, reduces the odds of receiving either form of revascularization. The presence of fluid, electrolyte and acid-base imbalances or a history of anemias and other blood diseases further lowers the odds of revascularization. These variables presumably reflect surgical risk severity not captured in the Charlson co-morbidity index. Referring back to the model in Figure 6-1, admission through the ER plus those with high Charlson scores reflect patients in the high risk cohort on the far right side of the figure. Relative to the stable patients, many of whom go on to revascularization, these high risk patients are less likely to go to revascularization during the admission—partly due to a higher death rate.

The next set of pre-admission variables are risk factors for AMI. They all raise the likelihood of either CABG or angioplasty relative to medical treatment; only the magnitudes differ. A history of a surgical procedures not carried out because of a contraindication, which increases the likelihood of revascularization as well, likely reflects a subset of patients previously determined to be too ill for revascularization and have been treated medically for an extended period of time. They may now be ready for revascularization and fall into the larger set of Category 1 patients.

The timing of when a patient receives a diagnosis of unstable angina or undergoes non-invasive cardiovascular diagnostic testing greatly affects the likelihood of revascularization. A previous history of unstable angina increases the likelihood of revascularization over medical treatment. Beneficiaries with (versus without) a prior history of unstable angina are 20 percent more likely to receive an angioplasty and nearly 40 percent more likely to receive a CABG than to receive medical treatment These patients represent another subset of Category 1 patients being admitted in a stable medical condition for revascularization. In sharp contrast, diagnosis of unstable angina *during* admission significantly lowers the odds of revascularization; odds ratios of roughly 0.20 for both CABG and angioplasty. This variable is reflecting a subset of sicker Category 2 patients who are simply too ill for revascularization and are referred to intensive medical management during the admission.

Beneficiaries who have pre-admission non-invasive diagnostic testing are far more likely to undergo revascularization rather than medical treatment during the index admission. For example, the odds of either form of revascularization versus medical treatment are twice as high for beneficiaries who have a pre-admission stress test as compared to those who do not. Stress testing is often conducted prior to referral for catheterization and revascularization. This variable is another proxy for Category 1 patients. The significantly *lower* odds of revascularization stress testing during the index admission is also not surprising. The AHRQ clinical guidelines suggest that patients admitted with unstable angina should only undergo stress testing if they are low risk patients likely to receive medical treatment. At some later time, however, the results of the stress test, coupled with deteriorating health, can lead to a revascularization admission.

The AHRQ unstable angina clinical guidelines suggest that patients with a prior history of angioplasty or CABG are one class of candidates for revascularization. Yet, our results show that Medicare beneficiaries with a previous CABG are less likely to receive either angioplasty or another CABG compared to those without any previous revascularization—even holding age constant. And when undergoing revascularization, they are roughly 2.8 times more likely to switch to angioplasty rather than a second CABG. The AHRQ guidelines that place beneficiaries had a higher risk of ischemic heart problems do not necessarily lead to more extensive revascularization over time.

Beneficiaries who have a prior history of angioplasty present a different picture. Those with a prior history of angioplasty are 91 percent more likely to receive another angioplasty than medical treatment during the index admission as compared to beneficiaries who have not had any prior angioplasty. This is consistent with the AHRQ guidelines. In contrast, beneficiaries with a prior angioplasty are about 20 percent less likely to undergo a CABG. Hence, beneficiaries who have had previous angioplasty are almost 2.5 times more likely to have another angioplasty rather than a CABG during their index admission as compared to beneficiaries who have not had prior angioplasty—an odds ratio not too different for CABG patients.

What could explain this unexpected pattern of results? From the AHRQ guidelines, one might have expected patients with prior revascularization to be more likely to be admitted for further revascularization. One possibility is that second CABGs involve much greater surgical risks and are to be avoided in favor of angioplasty if possible. Even angioplasty is less likely for previous CABG patients, however, possibly because of long-standing contraindications. Considered from the opposite perspective, newly admitted IHD patients without any previous revascularization are far better surgical candidates for CABG. Patients with a prior angioplasty may continue with another such procedure because they (a) remain poor candidates for major surgery, (b) have had stents inserted that make bypassing arteries more difficult, (c) have less advanced or serious (e.g., no left main occlusion) disease, or (d) continue to reject major heart surgery. What does seem clear is that CABG and angioplasty revascularization reflect, not only the presence of IHD, but also surgical risks, anatomical characteristics, and patient preferences for one approach over another.

Most admission severity/complication variables reduce the likelihood of revascularization relative to medical treatment. Not surprising, beneficiaries admitted with a principal diagnosis of acute myocardial infarction receive less revascularization than those that have chronic stable angina as their principal diagnosis. Revascularization is designed to prevent an AMI from occurring. Once the myocardium is damaged, watchful waiting and medical support for complications arising from the AMI is the usual form of treatment. Cardiac arrest also significantly reduces the likelihood of revascularization. Patients who experience cardiac arrest have very high odds of dying. Thus, there is limited opportunity to revascularize these patients. Survivors of cardiac arrest are very ill patients, and thus, not good surgical candidates.

The significantly higher odds of patients undergoing revascularization with the presence of cardiogenic shock is that myocardial ischemia is a direct cause of impaired myocardial contractility and functioning. The primary treatment for cardiogenic shock, if performed within a few hours of onset of a myocardial infarction, is the restoration of cardiac functioning through revascularization.

To aid in interpretation of the previous results and to more directly and easily understand the influence of race, we estimate the overall probability of receiving medical management, angioplasty, or CABG, holding all factors constant except race. We do this by first assuming that all beneficiaries are white, holding all other factors constant, and then calculating the probabilities of each treatment approach. We then assume that all beneficiaries are black, holding all other factors constant, and then calculating the probabilities of each outcome, and so forth. The difference in the sets of probabilities is the difference due to race, holding all other characteristics constant.

Table 6-9 displays the overall probabilities of Medicare FFS beneficiaries admitted with ischemic heart disease receiving medical management, angioplasty, or CABG by race. Probabilities across each row add (approximately) to 1.0. Pair-wise statistical comparisons are made relative to whites using z tests of differences in sample proportions. Because of the large number of cases, over 300,000, virtually all differences are statistically significant.

Holding all factors other than race constant, blacks are significantly less likely than whites to undergo either angioplasty or CABG during an index admission for ischemic heart disease. Sixty-seven percent of blacks are predicted to follow medical management during hospitalization as compared to 59 percent of whites. Twenty percent of blacks are predicted to undergo angioplasty as compared to 23 percent for whites. The more notable difference is for CABG. Only 13 percent of blacks are predicted to undergo CABG surgery in comparison to 18 percent whites. Similar disparities are noted for Native Americans.

Interestingly, Asians and Hispanics are essentially as likely as whites to receive both angioplasty and CABG, after controlling for differences in characteristics of these two populations. Bivariate statistics showed Hispanics receiving revascularization procedures at lower rates than whites.

6.3.4 Summary of Multinomial Results

In summary, the results from the multinomial logistic regression modeling show blacks are far less likely than whites to receive either angioplasty or CABG. Disparities in revascularization rates between whites and black remained in spite of the large number of covariates included in our model. There is considerably less difference in the likelihood of revascularization among the other minorities as compared to whites once demographic and clinical characteristics are included as adjusters. Factors that have been previously shown to affect the rate of revascularization generally performed in expected ways.

One clear limitation of our analysis is the absence of detailed clinical data on the severity of ischemic heart disease. This could narrow black-white differences if we were able to more directly control for underlying disease severity, although other research (Peterson, *et al*., 1997) still finds gaps in the use of these procedures. Further, we had limited information on the role of patient preferences and compliance in the observed rates of revascularization. Our use of an ICD-9 “V” code regarding patients’ previous preferences for surgical intervention did not affect the observed rate of revascularization. These types of supplementary codes appear very infrequently on Medicare claims data.

And, third, we were unable to control fully for patient selection bias. It may be that patients are self-selecting to hospitals that influence their likely treatment far more than their underlying medical conditions. Clearly, further research is warranted to understand more fully the factors underlying the observed disparities in treatment of ischemic heart disease.

Table 6-1

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native Americans	Other/ Unknown
Diagnostic Procedures												
Right or Left Heart Catheterization, with angiography	47.7	57.1	45.8 *	17.5 *	50.2	46.0 *	48.6	38.2 *	45.3 *	44.2 *	39.1 *	46.0 *
Right or Left Heart Catheterization, without angiography	0.4	0.5	0.4 *	0.2 *	0.5	0.4 *	0.4	0.5	0.3 NR	0.7	0.3 NR	0.5
Selective venous and/or arterial angiography without cardiac catheterization	1.9	2.2	1.9 *	0.6 *	2.1	1.8 *	2.0	1.2 *	1.5	1.7	0.7 NR	1.6
Treadmill or Bicycle Stress Test or pharmacological stress/Ergonovine Provocation Test	13.0	14.1	13.5 *	7.9 *	12.3	13.6 *	12.8	15.6 *	13.0	13.2	12.0	12.7
ECG -- resting	87.1	86.8	87.7 *	87.0	86.6	87.6 *	87.4	85.3 *	84.7 *	87.2	73.0 *	83.0 *
Telephonic transmission of post-symptom ECG strips	1.3	1.3	1.2	1.1 *	1.3	1.3	1.2	1.9 *	0.8	0.6 *	0.8 NR	0.8 *
Signal averaged ECG	0.4	0.4	0.4	0.3 *	0.5	0.3 *	0.4	0.3	0.5	0.4	0.0 NR	0.4
ECG Monitoring for 24 hours	1.8	1.5	1.9 *	2.2 *	1.7	1.8	1.6	3.4 *	1.4	2.1	0.6 NR	1.5
Intracardiac Electrophysiological Procedures	0.7	0.8	0.7	0.2 *	1.1	0.4 *	0.7	0.7	0.2 NR	0.3 *	0.0 NR	0.4 *
2D or M-mode echocardiogram	38.6	35.1	41.3 *	45.2 *	37.0	39.8 *	38.1	43.1 *	38.1	40.7 *	35.7	39.4
Doppler echocardiogram	33.8	30.1	36.5 *	41.4 *	32.1	35.1 *	33.4	38.3 *	33.4	33.7	32.2	34.9
Doppler color velocity flow mapping	28.4	25.4	30.7 *	34.7 *	27.0	29.5 *	28.0	32.6 *	28.1	27.6	28.0	29.7

Table 6-1 (continued)

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native Americans	Other/ Unknown
Myocardial Perfusion	11.8	12.5	12.6	7.6 *	10.8	12.6 *	11.4	15.6 *	11.9	13.2 *	12.6	11.3
Myocardial Imaging	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3 NR	0.4	0.0 NR	0.4
Cardiac blood pool imaging, rest or stress, gated equilibrium or planar, single or multiple, including MUGA	1.0	1.1	1.1	0.9	1.1	1.0	1.0	1.2	0.8 NR	0.9	1.5 NR	0.9
CT of Thorax	2.2	2.1	2.4 *	1.9	2.4	2.0 *	2.1	2.6 *	1.7	1.8	2.3 NR	2.2
Intervention Procedures												
Coronary Artery Bypass Graft	17.4	21.7	16.1 *	3.6 *	21.6	14.4 *	18.1	10.2 *	16.7	15.3 *	11.3 *	16.8
CABG: Single Vein Graft	0.4	0.4	0.3 *	0.1 *	0.3	0.4	0.4	0.2 *	0.3 NR	0.4	0.0 NR	0.4
CABG: 2 or 3 Vein Grafts	2.8	3.0	3.4 *	1.2 *	2.9	2.8	2.9	1.8 *	3.1	2.5	1.4 NR	3.2
CABG: 4, 5 or 6 or More Vein Grafts	1.6	1.6	2.0 *	0.6 *	2.0	1.4 *	1.7	1.3 *	2.2	1.8	2.0 NR	1.8
CABG: Single Arterial Graft	0.5	0.7	0.4 *	0.1 *	0.6	0.5	0.5	0.3 *	0.4 NR	0.4	0.5 NR	0.5
CABG: 2 or More Arterial Grafts	0.3	0.5	0.3 *	0.0 *	0.4	0.3 *	0.4	0.2 *	0.1 NR	0.2 NR	0.0 NR	0.2 NR
CABG: 1 Arterial Graft and 1 Vein Graft	1.4	1.9	1.1 *	0.2 *	1.5	1.3 *	1.5	0.8 *	0.5 NR	1.2	0.6 NR	1.2
CABG, One or More Arterial Grafts and any number of Venous Grafts	11.9	15.9	9.9 *	1.5 *	15.6	9.2 *	12.5	6.5 *	10.9	10.4 *	7.5 *	11.1 *
CABG or Valve Reoperation more than 1 month after original procedure	1.3	1.7	1.2 *	0.2 *	2.1	0.8 *	1.4	0.4 *	1.1	0.8 *	0.3 NR	1.2

Table 6-1 (continued)

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native Americans	Other/ Unknown
Coronary Endarterectomy	0.3	0.4	0.3 *	0.1 *	0.5	0.2 *	0.3	0.3	0.3 NR	0.4	0.9 NR	0.3
Thrombolysis by intracoronary infusion	0.4	0.4	0.3 *	0.1 *	0.4	0.3 *	0.4	0.2 *	0.4 NR	0.3	0.0 NR	0.3 NR
Thrombolysis by intravenous infusion	0.9	1.1	0.9 *	0.5 *	1.0	0.8 *	0.9	0.5 *	1.0	0.7	0.4 NR	1.4
Percutaneous Single Vessel Stent	14.7	18.3	13.2 *	5.1 *	15.8	13.9 *	15.4	8.9 *	13.1 *	10.6 *	9.1 *	13.3 *
Percutaneous Multiple Vessel Stent	1.2	1.4	1.0 *	0.5 *	1.3	1.1 *	1.2	0.7 *	0.5 *	1.0	0.5 NR	1.2
Percutaneous Single Vessel Balloon Angioplasty	9.4	11.3	8.9 *	3.9 *	9.9	9.1 *	9.6	7.2 *	11.2	10.9 *	6.3 *	9.1
Percutaneous Multiple Vessel Balloon Angioplasty	1.0	1.1	0.9 *	0.5 *	1.1	0.9 *	1.0	0.8	1.5	1.3	0.3 NR	1.0
Percutaneous Single or Multiple Vessel Atherectomy, Mechanical or other method, with or without balloon angioplasty	1.4	1.7	1.3 *	0.6 *	1.5	1.4	1.5	0.9 *	2.0	1.1	1.1 NR	1.5
Aortic, Mitral, Triscuspid, Pulmonary Valvuloplasty, Valvectomy, Valvotomy, and other valvular-related repairs/Aortic, mitral, pulmonary valve percutaneous balloon valvulplasty	1.0	1.0	1.1	0.4 *	1.1	0.9 *	1.0	0.6 *	0.8	0.7	0.2 NR	0.9
Permanent Pacemaker or Implantable Cardioverter-defibrillator	1.3	1.1	1.6 *	1.5 *	1.7	1.1 *	1.4	1.1 *	1.0	1.0	1.0 NR	1.1

Table 6-1 (continued)

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Severity Indicators	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native Americans	Other/ Unknown
Non-imaging CV Hemodynamics: Arterial or Venous Central Line for Pressure Monitoring, including Swan-Ganz and ej with probe technique	19.8	23.9	18.9 *	6.4 *	23.7	17.0 *	20.4	13.7 *	19.3	17.9 *	14.0 *	19.6
Ventilation Support, including CPAP and CNP	4.0	4.6	4.0 *	1.7 *	4.7	3.5 *	4.1	2.7 *	3.5	4.7	3.5	3.6
Cardiac Assist Device -- prolonged extracorporeal, intra-aortic balloon (open or percutaneous insertion), ventricular assist device	2.9	3.4	3.0 *	1.1 *	3.4	2.7 *	3.1	1.5 *	2.3	3.2	1.8 NR	3.2
Insertion of Temporary Pacing Wires or Temp. Transcutanous Pacing	1.9	2.0	2.0	1.3 *	2.0	1.9	2.0	1.6 *	2.6	2.2	1.3 NR	2.1
Cardiopulmonary Resuscitation	1.0	0.9	1.1 *	1.0	1.1	1.0	1.0	1.2 *	1.5	1.1	1.9 NR	1.3
Cardioversion	0.9	0.9	1.0	0.6 *	1.2	0.7 *	0.9	0.5 *	0.8	0.5 *	0.6 NR	0.7
ICU	14.8	14.2	15.5 *	15.7 *	15.0	14.7	14.6	14.6	18.0 *	20.0 *	12.7	18.5 *

Table 6-1 (continued)

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native Americans	Other/ Unknown
Consults During Admission												
Cardiology	71.3	74.3	71.7 *	59.5 *	72.8	70.4 *	71.9	65.8 *	73.5	69.2 *	55.5 *	69.3 *
Cardiothoracic surgeon	6.9	8.0	6.9 *	2.4 *	7.9	6.1 *	7.0	4.4 *	8.7	9.6 *	4.5	8.2
Pulmonary consult	7.8	7.9	8.2	6.6 *	8.4	7.4 *	7.8	7.3	7.8	8.6	5.6	8.4
Neurology consult	4.5	4.2	5.2 *	4.0	4.7	4.4 *	4.4	5.3 *	5.0	4.8	3.2	4.8
Renal consult	4.4	4.4	4.6	3.7 *	4.8	4.1 *	3.9	8.1 *	6.7 *	6.5 *	4.7	5.8 *
Infectious diseases consult	1.6	1.6	1.7	1.4	1.8	1.5 *	1.6	1.8	2.1	2.3 *	0.8 NR	1.7

NOTES:
* = Significant at the .01 level.
NR = Not statistically reliable.
n = 350,704
[1]Age, Sex, and Race Adjusted; [2]Sex and Race Adjusted; [3]Age and Race Adjusted; [4]Age and Sex Adjusted

Significance tests were conducted:
a. by age using the 65-74 age group as the reference group; b. by gender using males as the reference group; c. by race using whites as the reference group.

SOURCE: HER analysis of 100% 1997 Denominator, MedPAR, Physician/Supplier, and OPD files.

Table 6-2

Proportion of All Medicare FFS Beneficiaries Admitted with Ischemic Heart Disease by Principal Diagnosis

		Age Group			Sex		Race					
	Total	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native Americans	Other/ Unknown
Acute Myocardial Infarction												
Number of Admissions	58,444	24,992	23,478	9,974	29,419	29,025	53,527	3,143	289	692	77	716
Proportion of all IHD Admissions	17	15	17	21	16	17	17	14	14	14	18	17
Subendocardial Myocardial Infarction												
Number of Admissions	66,551	23,729	28,050	14,772	33,085	33,466	59,521	4,990	358	728	79	875
Proportion of all IHD Admissions	19	15	20	31	19	19	19	23	18	15	18	21
Unstable Angina												
Number of Admissions	39,301	16,659	15,919	6,723	15,289	24,012	34,218	3,411	258	795	82	537
Proportion of all IHD Admissions	11	10	11	14	9	14	11	15	13	16	19	13
Chronic Stable Angina												
Number of Admissions	186,287	97,319	72,802	16,166	100,974	85,313	169,599	10,504	1,090	2,774	190	2,130
Proportion of all IHD Admissions	53	60	52	34	56	50	54	48	55	56	44	50
Total	350,704	162,775	140,292	47,637	178,827	171,877	316,971	22,057	1,995	4,992	428	4,261

NOTES:

(1) Analysis of 1997 Medicare MedPAR, Physician, and Outpatient Department Claims Files by Health Economics Research, Inc.

(2) 121 Medicare Beneficiaries were admitted with a principal diagnosis of aneurysm. These cases are not reported as a separate analytic group; however, the are in the total number of reported IHD admisssions.

Table 6-3

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients with a Principal Diagnosis of AMI, Subendocardial Infarction, Unstable Angina or Chronic Stable Angina

Diagnostic Procedures	Acute Myocardial Infarction	Subendocardial Infarction	Unstable Angina	Chronic Stable Angina
Right or Left Heart Catheterization, with angiography	54.3	44.4	29.1	51.8
Right or Left Heart Catheterization, without angiography	0.4	0.3	0.3	0.5
Selective venous and/or arterial angiography without cardiac catheterization	1.7	1.5	0.8	2.3
Treadmill or Bicycle Stress Test or pharmacological stress/Ergonovine Provocation Test	10.6	10.2	20.4	13.4
ECG -- resting	91.7	90.2	85.9	85.3
Telephonic transmission of post-symptom ECG strips	1.8	1.4	1.1	1.1
Signal averaged ECG	0.8	0.4	0.2	0.3
ECG Monitoring for 24 hours	1.7	1.9	1.8	1.7
Intracardiac Electrophysiological Procedures	0.9	0.9	0.3	0.7
2D or M-mode echocardiogram	59.9	56.3	33.2	27.2
Doppler echocardiogram	54.2	50.9	29.0	22.8
Doppler color velocity flow mapping	45.7	43.0	24.1	19.2
Myocardial Perfusion	9.2	9.4	17.6	12.5
Myocardial Imaging	0.2	0.2	0.2	0.1
Cardiac blood pool imaging, rest or stress, gated equilibrium or planar, single or multiple, including MUGA	1.4	1.4	0.9	0.8
CT of Thorax	2.7	2.9	2.0	1.8

Table 6-3 (continued)

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients with a Principal Diagnosis of AMI, Subendocardial Infarction, Unstable Angina or Chronic Stable Angina

Intervention Procedures	Acute Myocardial Infarction	Subendocardial Infarction	Unstable Angina	Chronic Stable Angina
Coronary Artery Bypass Graft				
CABG: Single Vein Graft	0.3	0.2	0.1	0.4
CABG: 2 or 3 Vein Grafts	2.8	2.3	1.0	3.5
CABG: 4, 5 or 6 or More Vein Grafts	1.7	1.5	0.6	2.0
CABG: Single Arterial Graft	0.3	0.2	0.2	0.7
CABG: 2 or More Arterial Grafts	0.2	0.2	0.1	0.5
CABG: 1 Arterial Graft and 1 Vein Graft	0.9	0.8	0.6	1.9
CABG, One or More Arterial Grafts and any number of Venous Grafts	8.8	8.7	4.7	15.3
CABG or Valve Reoperation more than 1 month after original procedure	0.7	0.9	0.5	1.8
Coronary Endarterectomy	0.3	0.3	0.1	0.4
Thrombolysis by intracoronary infusion	1.1	0.2	0.1	0.2
Thrombolysis by intravenous infusion	4.6	0.4	0.1	0.2
Percutaneous Single Vessel Stent	18.7	10.0	5.9	17.1
Percutaneous Multiple Vessel Stent	1.1	0.8	0.4	1.5
Percutaneous Single Vessel Balloon Angioplasty	13.2	6.6	3.3	10.7
Percutaneous Multiple Vessel Balloon Angioplasty	0.9	0.6	0.4	1.2
Percutaneous Single or Multiple Vessel Atherectomy, Mechanical or other method, with or without balloon angioplasty	0.7	0.6	0.5	2.1
Aortic, Mitral, Triscuspid, Pulmonary Valvuloplasty, Valvectomy, Valvotomy, and other valvular-related repairs/Aortic, mitral, pulmonary valve percutaneous balloon valvulplasty	0.8	1.0	0.3	1.2
Permanent Pacemaker or Implantable Cardioverter-defibrillator	1.8	1.8	0.7	1.2

Table 6-3 (continued)

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients with a Principal Diagnosis of AMI, Subendocardial Infarction, Unstable Angina or Chronic Stable Angina

Severity Indicators	Acute Myocardial Infarction	Subendocardial Infarction	Unstable Angina	Chronic Stable Angina
Non-imaging CV Hemodynamics:	21.0	17.8	7.2	22.7
Ventilation Support, including CPAP and CNP	5.3	4.5	1.3	4.0
Cardiac Assist Device -- prolonged extracorporeal, intra-aortic balloon (open or percutaneous insertion), ventricular assist device	7.7	3.1	1.0	2.0
Insertion of Temporary Pacing Wires or Temp. Transcutanous Pacing	4.4	1.7	0.6	1.6
Cardiopulmonary Resuscitation	3.3	1.7	0.2	0.3
Cardioversion	1.8	1.1	0.3	0.7
ICU Admission	33.4	22.1	8.9	8.0
Consults During Admission				
Cardiology	77.7	73.6	57.7	72.0
Cardiothoracic surgeon	7.4	6.8	3.4	7.6
Pulmonary	11.4	12.1	4.1	6.0
Neurology	6.7	6.5	2.4	3.6
Renal	5.4	7.1	2.7	3.5
Infectious diseases	2.5	2.6	0.8	1.2

NOTES:

n = 350,583

All rates are age-sex-race adjustd.

SOURCE: HER analysis of 100% 1997 Denominator, MedPAR, Physician/Supplier, and OPD files.

Table 6-4

Rates of Cardiac Procedures and Diagnostic Tests During Hospitalization and the 6 Month Period Prior to Admission Per 100 Medicare FFS Beneficiaries Admitted with a Principal Diagnosis of Ischemic Heart Disease by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Procedure	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native Americans	Other/ Unknown
Diagnostic Procedures												
Right or Left Heart Catheterization and/or Angiography	58.83	70.95	55.84 *	20.88 *	63.49	55.69 *	60.08	46.58 *	58.01	54.32 *	45.86 *	55.93 *
Echocardiogram/Doppler Flow Mapping	55.45	52.90	58.44 *	58.30 *	54.28	56.47 *	54.85	61.04 *	57.09	60.39 *	47.70 *	55.80
Electrocardiogram	95.19	95.35	95.52	93.97 *	95.08	95.31	95.37	93.93 *	94.48	95.49	83.54 *	93.29 *
24 Hour ECG Monitoring	9.93	9.67	10.49 *	9.73	9.90	10.02	9.67	12.92 *	9.39	12.21 *	5.90 *	8.63
Diagnostic Imaging	31.09	35.13	30.95 *	16.73 *	32.40	30.33 *	31.07	32.23 *	28.49	31.90	28.24	28.16 *
Stress Test	33.25	39.57	31.53 *	13.87 *	35.92	31.44 *	33.59	30.04 *	36.00	31.97	26.92 *	31.22 *
Intervention Procedures												
Coronary Artery Bypass Graft	17.86	22.32	16.54 *	3.70 *	22.02	14.82 *	18.58	10.47 *	17.28	15.93 *	11.56 *	17.25
Angioplasty, including stents	24.99	30.66	22.85 *	9.19 *	26.50	24.00 *	25.84	16.83 *	24.71	21.41 *	17.62 *	23.11 *
Permanent or Temporary Pacemaker or Electrophysiological Testing or Cardioversion	5.60	5.54	6.13 *	4.65 *	6.66	4.89 *	5.72	4.62 *	5.62	5.18	3.01 *	4.77
Severity Indicators												
Non-imaging CV Hemodynamic Monitoring	21.96	26.28	20.98 *	7.73 *	25.77	19.22 *	22.51	16.26 *	22.12	20.41 *	15.85 *	21.67
Ventilator Support	6.31	7.08	6.29 *	3.49 *	6.98	5.87 *	6.37	5.45 *	5.68	8.50 *	5.21	5.61
ICU Admissions	17.65	17.06	18.39 *	18.39 *	17.65	17.74	17.41	18.17	21.47 *	24.33 *	14.49	21.30 *

Table 6-4 (continued)

Rates of Cardiac Procedures and Diagnostic Tests During Hospitalization and the 6 Month Period Prior to Admission Per 100 Medicare FFS Beneficiaries Admitted with a Principal Diagnosis of Ischemic Heart Disease by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Procedure	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native Americans	Other/ Unknown
Consults and Physician Services												
Renal, Neurology, Respiratory or Infectious Diseases Consult	19.04	18.53	20.53 *	17.83	19.73	18.72 *	18.47	24.15 *	20.98	23.41 *	14.78	20.36 *
Cardiology Consult	74.55	77.52	74.95 *	62.95 *	75.98	73.72 *	75.03	70.06 *	76.59	73.01 *	57.95 *	72.28 *
Cardiothoracic Surgical Consult	8.01	9.36	7.92 *	3.07 *	9.20	7.17 *	8.16	5.40 *	10.14 *	11.40 *	5.57	9.18
Cardiac Rehab Physician Services	1.29	1.69	1.08 *	0.36 *	1.41	1.21 *	1.38	0.59 *	1.13	0.53 *	0.44 NR	0.75 *

NOTES:

* = Significant at the .01 level.

NR = Not statistically reliable.

n = 350,704

[1]Age, Sex, and Race Adjusted; [2]Sex and Race Adjusted; [3]Age and Race Adjusted;[4] Age and Sex Adjusted

Significance tests were conducted:

a. by age using the 65-74 age group as the reference group; b. by gender using males as the reference group; c. by race using whites as the reference group.

SOURCE: HER analysis of 100% 1997 Denominator, MedPAR, Physician/Supplier, and OPD files.

Table 6-5

Rates of Cardiac Procedures and Diagnostic Tests Provided During the 6 Month Period Prior to Hospitalization Per 100 Medicare FFS Beneficiaries Admitted with a Principal Diagnosis of Unstable Angina by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Procedure	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native Americans	Other/ Unknown
Diagnostic Procedures												
Right or Left Heart Catheterization and/or Angiography	5.61	6.71	5.36 *	1.96 *	6.58	4.91 *	5.73	4.07 *	5.72	6.8	5.78 NR	5.67
Echocardiogram/Doppler Flow Mapping	18.1	16.94	19.62 *	18.92	18.02	18.21	17.58	21.82 *	19.59	25.42 *	10.31 NR	22.52
Electrocardiogram	55.74	53.4	57.77 *	59.79 *	55.1	56.27	55.43	58.15	52.21	60.11	40.46 *	60.26
24 Hour ECG Monitoring	6.87	6.67	7.14	7.09	6.59	7.11	6.69	8.19	5.72	11.63 *	2.3 NR	7.6
Diagnostic Imaging	11.32	12.84	11.15 *	6.11 *	12.4	10.58 *	11.4	10.6	9.08	12.2	10.56 NR	10.71
Stress Test	11.96	14.34	11.18 *	4.83 *	13.32	10.97 *	12.2	9.47 *	12.72	10.92	13.75	11.04
Cardiac Laboratory Tests	29.33	28.33	30.21 *	30.69	28.7	29.7	29.12	31.35	24.21	32.16	28.34	30.08
Pulse oximetry	11.16	10.76	11.64	11.52	10.99	11.28	10.98	11.8	9.94	15.22 *	8 NR	14.78
Intervention Procedures												
Coronary Artery Bypass Graft	0.38	0.42	0.44	0.08 NR	0.43	0.34	0.38	0.27 NR	0.40 NR	0.89 NR	1.24 NR	0.46 NR
Angioplasty, including stents	1.89	2.33	1.68 *	0.67 *	2.12	1.72	1.97	0.90 *	2.62 NR	1.90	3.54 NR	1.21 NR
Permanent or Temporary Pacemaker or Electrophysiological Testing or Cardioversion	1.33	1.18	1.52	1.5	1.65	1.13 *	1.36	1.08	1.4 NR	0.83 NR	0 NR	1.41 NR
Severity Indicators												
Non-imaging CV Hemodynamic Monitoring	2.02	2.16	2.21	1.08 *	2.26	1.86	1.97	2.34	2.00 NR	2.37	1.18 NR	3.25
Ventilator Support	2.53	2.74	2.46	2.01	2.78	2.37	2.51	2.52	1.15 NR	4.4	3.14 NR	2.77
ICU Admissions	3.29	3.32	3.39	2.93	3.21	3.33	3.16	4.54 *	1.44 NR	6.08	0 NR	3.92
Preadmission physician direction of EMS or use of ER	37.39	34.57	38.67 *	44.8 *	34.93	39.08 *	36.59	46.41 *	24.96 *	41.36 *	38.04	40.29
Observation Bed Admission	4.52	4.27	4.58	5.16	4.4	4.58	4.61	4.03	1.2 NR	3.09	3.48 NR	4.68
Office Services after Hours	1.19	1.11	1.19	1.54	1.07	1.28	1.02	2.42 *	2.24 NR	1.7	4.32 NR	2.8

Table 6-5

Rates of Cardiac Procedures and Diagnostic Tests Provided During the 6 Month Period Prior to Hospitalization Per 100 Medicare FFS Beneficiaries Admitted with a Principal Diagnosis of Unstable Angina by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Procedure	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native Americans	Other/ Unknown
Consults and Physician Services												
Renal, Neurology, Respiratory or Infectious Diseases Consult	6.27	5.84	7.09 *	5.98	6.39	6.22	5.89	9.33 *	6.39	9.32 *	5.73 NR	9.68
Cardiology Consult	13.17	12.46	13.85 *	14.04	13.27	13.09	12.97	14.61	12.94	15.79	10.44 NR	14.37
Cardiothoracic Surgical Consult	0.73	0.75	0.79	0.56	0.9	0.63	0.72	0.79	0 NR	1.67	1.24 NR	1.02 NR
Cardiac Rehab Physician Services	0.84	1.07	0.76	0.11 *	1.01	0.70	0.91	0.35 *	0.40 NR	0.53 NR	0.00 NR	0.00 NR
Physical Therapy	1.38	1.55	1.34	0.94 *	1.23	1.5	1.38	0.95	3.39 NR	2.53	3.2 NR	1.74 NR

NOTES:
* = Significant at the .01 level.
NR = Not statistically reliable.
n = 350,704
[1]Age, Sex, and Race Adjusted; [2]Sex and Race Adjusted; [3]Age and Race Adjusted;[4] Age and Sex Adjusted

Significance tests were conducted:
a. by age using the 65-74 age group as the reference group; b. by gender using males as the reference group; c. by race using whites as the reference group.

SOURCE: HER analysis of 100% 1997 Denominator, MedPAR, Physician/Supplier, and OPD files.

Table 6-6

Rates of Cardiac Procedures and Diagnostic Tests Provided During the 6 Month Period Prior to Hospitalization Per 100 Medicare FFS Beneficiaries Admitted for Coronary Artery Bypass Graft by Age, Gender, and Race/Ethnicity

		Age Group[2]			**Gender[3]**		**Race/Ethnicity[4]**					
Procedure	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native Americans	Other/ Unknown
Diagnostic Procedures												
Right or Left Heart Catheterization and/or Angiography	27.82	30.92	25.91 *	20.93 *	30.18	26.16 *	28.14	24.78	28.42	26.71	24.4	26.45
Angiography Greater than 60 days before CABG	1.93	2.01	1.75	2.01	1.88	1.94	1.85	2.09	1.67 NR	5.15	0 NR	3.43
Echocardiogram/Doppler Flow Mapping	30.25	28.84	30.65 *	34.43 *	29.03	31.07 *	29.8	34.65 *	32.92	30.77	15.36 *	31.49
Electrocardiogram	67.83	66.77	67.81	71.81 *	67.18	68.21	67.83	67.01	71.8	72.89 *	46.33 *	68.09
24 Hour ECG Monitoring	7.36	6.58	7.8 *	9.09 *	7.37	7.32	7.21	9.17	4.51	10.92	3.28 NR	5.59
Diagnostic Imaging	27.07	29.47	26.33 *	19.95 *	28.39	26.19 *	27.25	27.08	21.56	26.74	21.75	22.35
Stress Test	34.72	39.07	33.13 *	22.47 *	38.26	32.3 *	35.14	31.39	34.13	32.41	26.77	32.43
Cardiac Laboratory Tests	38.11	40.11	37.49 *	32.58 *	37.37	38.73	38.15	36.45	40.21	41.86	40.39	37.94
Pulse oximetry	11.51	11.48	11.52	11.59	11.37	11.59	11.45	11.94	10.84	14.1	7.35 NR	11.43
Intervention Procedures												
Coronary Artery Bypass Graft	0.22	0.24	0.24	0.16 NR	0.26	0.2	0.22	0.12 NR	0.18 NR	0.93 NR	2.34 NR	0.17 NR
Angioplasty, including stents	3.03	3.42	2.65 *	2.53	2.7	3.26	3.04	2.77	2.73 NR	2.44	3.6 NR	4.22
Permanent or Temporary Pacemaker or Electrophysiological Testing or Cardioversion	1.38	1.2	1.47	1.87	1.61	1.23	1.39	1.47	1.35 NR	0.63 NR	0 NR	0.95 NR

Table 6-6 (continued)

Rates of Cardiac Procedures and Diagnostic Tests Provided During the 6 Month Period Prior to Hospitalization Per 100 Medicare FFS Beneficiaries Admitted for Coronary Artery Bypass Graft by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Procedure	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native Americans	Other/ Unknown
Severity Indicators												
Non-imaging CV Hemodynamic Monitoring	2.27	2.33	2.29	1.95	2.14	2.35	2.2	2.96	2.42 NR	2.35	0 NR	2.74
Ventilator Support	2.16	2.26	1.99	2.46	2.1	2.24	2.04	3.02	2.92 NR	3.49	2.34 NR	3.21 NR
ICU Admissions	3.99	3.63	3.69	5.83 *	3.23	4.45 *	3.74	6.18 *	6.63	5.59	1.26 NR	4.68
Preadmission physician direction of EMS or use of ER	27.8	25.95	27.79 *	34.95 *	23.95	30.48 *	27.03	36.17 *	22.13	35.91 *	23.64	25.74
Observation Bed Admission	5.81	6.08	5.52	5.61	5.83	5.8	6.02	4.49	2.6 *	3.71	5.94 NR	4.34
Office Services after Hours	0.88	0.73	0.81	1.51	0.73	0.96	0.8	1.52	1.02 NR	1.51	0 NR	1.52 NR
Consults and Physician Services												
Renal, Neurology, Respiratory or Infectious Diseases Consult	5.14	4.93	5.2	5.92	4.66	5.5	4.74	9.33 *	6.07 NR	5.97	5.02 NR	5.52
Cardiology Consult	18.21	16.91	17.65	24.36 *	16.64	19.3 *	17.98	20.43	16.13	18.76	10.81 NR	19.56
Cardiothoracic Surgical Consult	2.96	3.42	2.66 *	1.87 *	3.11	2.84	2.94	2.87	2.91 NR	4.33	1.26 NR	2.93
Cardiac Rehab Physician Services	1.18	1.41	1.12	0.65 *	1.22	1.19	1.25	0.54 *	1.15 NR	0.26 NR	0 NR	1.86 NR
Physical Therapy	1.11	1.16	1.2	0.8	1.09	1.14	1.14	0.64	2.57 NR	1.44	0 NR	0.55 NR

Table 6-6 (continued)

Rates of Cardiac Procedures and Diagnostic Tests Provided During the 6 Month Period Prior to Hospitalization Per 100 Medicare FFS Beneficiaries Admitted for Coronary Artery Bypass Graft by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Procedure	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native Americans	Other/ Unknown
Patient and Sociological Factors												
Unavailability of Other Medical Facilities for Care	0.03	0.03	0.04	0 NR	0.04	0.02	0.03	0.03 NR	0 NR	0 NR	0 NR	0 NR
Preadmission History of Surgical or Other Procedure not carried out because of Contraindication	0.32	0.3	0.34	0.27 NR	0.27	0.34	0.28	0.84 NR	0 NR	0.2 NR	0 NR	0.31 NR
Preadmission History of Surgical or Other Procedure Not Carried Out Because of Patient's Decision	0.07	0.08	0.06	0.09 NR	0.09	0.06	0.05	0.14 NR	0.5 NR	0.14 NR	0 NR	0.31 NR
Family history of housing, household, economic or psychosocial circumstances	0.07	0.08	0.05	0.07 NR	0.04	0.09	0.07	0.14 NR	0 NR	0 NR	0 NR	0 NR

NOTES:
* = Significant at the .01 level.
NR = Not statistically reliable.
n =63,210
[1]Age, Sex, and Race Adjusted; [2]Sex and Race Adjusted; [3]Age and Race Adjusted;[4] Age and Sex Adjusted

Significance tests were conducted:
a. by age using the 65-74 age group as the reference group; b. by gender using males as the reference group; c. by race using whites as the reference group.

SOURCE: HER analysis of 100% 1997 Denominator, MedPAR, Physician/Supplier, and OPD files.

Table 6-7

Rates of Cardiac Procedures and Diagnostic Tests Provided During the 6 Month Period Prior to Hospitalization Per 100 Medicare FFS Beneficiaries Admitted for Angioplasty by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Procedure	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native Americans	Other/ n
Diagnostic Procedures												
Right or Left Heart Catheterization and/or Angiography	22.35	24.01	22.29 *	16.88 *	24.3	21.13 *	22.37	21.31	33.37 *	23.11	22.91	22.5
Angiography Greater than 60 days before Angioplasty	1.38	1.47	1.33	1.2	1.4	1.37	1.37	1.47	0.69 NR	2.13	0 NR	1.39 NR
Echocardiogram/Doppler Flow Mapping	25.98	24.79	27.43 *	27.12	25.2	26.61 *	25.34	31 *	37.5 *	32.71 *	19.75	26.06
Electrocardiogram	63.91	62.56	65.17 *	66.56 *	63.72	64.19	63.53	66.13	69.15	71.24 *	54.99	66.66
24 Hour ECG Monitoring	7.99	7.36	8.49 *	9.48 *	7.79	8.22	7.84	9.49	10.16	10.08	2.62 NR	7.41
Diagnostic Imaging	26	28.21	25.85 *	18.42 *	27.3	25.17 *	26.18	24.47	21.8	29.23	29.83	24.39
Stress Test	32.74	36.62	31.73 *	21.12 *	35.99	30.6 *	32.99	28.79 *	45.32 *	33.11	33.88	32.91
Cardiac Laboratory Tests	34.77	35.71	35.43	30.18 *	33.94	35.49 *	34.39	37.47 *	34.62	38.56	33.52	38.46
Pulse oximetry	11.38	10.98	12.07 *	11.48	11.16	11.59	11.23	12.08	13.71	14.79	10.33 NR	12.86
Intervention Procedures												
Coronary Artery Bypass Graft	0.54	0.64	0.51 NR	0.24	0.53	0.55	0.57	0.34	0.57 NR	0.4 NR	1.29 NR	0.28 NR
Angioplasty, including stents	6.84	6.87	6.91	6.71	7.19	6.63	6.85	6.93	6.42	5.52	15.33 *	6.63
Permanent or Temporary Pacemaker or Electrophysiological Testing or Cardioversion	1.8	1.5	2.03 *	2.54 *	2.2	1.56 *	1.79	1.81	2.43	3.08	0 NR	1.32 NR

Table 6-7 (continued)

Rates of Cardiac Procedures and Diagnostic Tests Provided During the 6 Month Period Prior to Hospitalization Per 100 Medicare FFS Beneficiaries Admitted for Angioplasty by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Procedure	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native Americans	Other/n
Severity Indicators												
Non-imaging CV Hemodynamic Monitoring	2.48	2.74	2.44	1.66 *	2.53	2.47	2.45	2.78	3.09	3.19	11.09 *	1.72
ICU Admissions	3.65	3.3	3.78	4.54 *	3.19	3.93 *	3.51	4.7	3.44	7.3 *	2.57 NR	3.96
Ventilator Support	2.14	2.19	2.27	1.66	2.09	2.19	2.09	2.93	0.95 NR	3.07	3.2 NR	1.3 NR
Preadmission physician direction of EMS or use of ER	29.87	27.7	30.52 *	36.41 *	26.81	32.01 *	29.11	38.25 *	20.52 *	33.97	38.05	29.27
Observation Bed Admission	4.95	5.01	5.13	4.47	4.94	5.01	5.11	3.72 *	1.77 *	3.87	6.32 NR	4.25
Office Services after Hours	1.03	0.93	1.05	1.29	0.88	1.13	0.96	1.36	0.81 NR	1.86	1.29 NR	1.72
Consults and Physician Services												
Renal, Neurology, Respiratory or Infectious Diseases Consult	5.11	4.75	5.47 *	5.58	4.59	5.47 *	4.83	7.62 *	5.91 NR	8.6 *	4.27 NR	5.05
Cardiology Consult	18.76	17.57	19.42 *	21.91 *	18.29	19.18	18.57	21.03 *	18.86	19.78	18.32	18.21
Cardiothoracic Surgical Consult	0.89	0.93	0.9	0.78	0.95	0.87	0.86	0.96	2.66	1.35	1.92 NR	1.13 NR
Cardiac Rehab Physician Services	1.87	2.31	1.63 *	0.85 *	1.95	1.82	2	0.98 *	1.27 NR	0.39 NR	0 NR	0.78 NR
Physical Therapy	1.43	1.44	1.54	1.21	1.27	1.56	1.51	0.53 *	2.42 NR	1.42	0 NR	1.28 NR

Table 6-7 (continued)

Rates of Cardiac Procedures and Diagnostic Tests Provided During the 6 Month Period Prior to Hospitalization Per 100 Medicare FFS Beneficiaries Admitted for Angioplasty by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Procedure	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native Americans	Other/ n
Patient and Sociological Factors												
Unavailability of Other Medical Facilities for Care	0.03	0.02	0.04	0.05 NR	0.02	0.03	0.03	0 NF	0 NR	0 NR	0 NR	0 NR
Preadmission History of Surgical or Other Procedure not carried out because of Contraindication	0.23	0.24	0.26	0.1 NR	0.24	0.22	0.23	0.24 NF	0.27 NR	0.22 NR	0 NR	0.2 NR
Preadmission History of Surgical or Other Procedure Not Carried Out Because of Patient's Decision	0.05	0.05	0.05	0 NR	0.05	0.04	0.05	0.02 NF	0 NR	0.15 NR	0 NR	0 NR
Family history of housing, household, economic or psychosocial circumstances	0.06	0.04	0.06	0.1 NR	0.03	0.07	0.05	0.11 NF	0 NR	0 NR	0 NR	0.47 NR

* = Significant at the .01 level.

NR = Not statistically reliable.

n = 81,693

[1]Age, Sex, and Race Adjusted; [2]Sex and Race Adjusted; [3]Age and Race Adjusted;[4] Age and Sex Adjusted

Significance tests were conducted:

a. by age using the 65-74 age group as the reference group; b. by gender using males as the reference group; c. by race using whites as the reference group.

SOURCE: HER analysis of 100% 1997 Denominator, MedPAR, Physician/Supplier, and OPD files.

Table 6-8

Multinomial Logistic Regression Odds Ratios of Likelihood of Angioplasty or CABG Relative to Medical Treatment During Admission for Ischemic Heart Disease for Medicare Fee-for-Service Beneficiaries

Sociodemographic/SES Characteristics	Angioplasty	CABG
Black	0.686 ***	0.565 ***
Asian	1.031	1.018
Hispanic	1.022	1.054
Native American	0.720 *	0.760
Age 75 -84	0.655 ***	0.643 ***
Age 85 +	0.213 ***	0.113 ***
Male	1.208 ***	1.756 ***
Rural	0.844 ***	0.895 ***
Dual Medicare/Medicaid	0.617 ***	0.508 ***
Patient Lives in Low Income Area	0.905 ***	0.951 ***
Family history of housing, economic, or psychosocial problems	0.699	0.997
Preadmission history of surgical or other procedure not carried out because of patient's decision	0.911	0.999
Unavailability of other medical facilities for care	0.550 *	0.824
Pre-admission Co-morbidity		
Severity Adjustors		
Charlson Co-morbidity Index	0.870 ***	0.937 ***
Admission from ER	0.443 ***	0.377 ***
History of fluid, electrolyte, and acid-base imbalance	0.690 ***	0.619 ***
History of anemias and other blood diseases	0.801 ***	0.705 ***
Risk Factors for AMI		
History of lipid metabolism disorder	1.285 ***	1.368 ***
History of obesity	1.248 ***	1.449 ***
Family history of cardiovascular or heart disease	2.005 ***	2.049 ***
History of surgical or other procedures not carried out because of contraindication	1.295 **	1.413 ***
Diagnosis of Unstable Angina		
History of unstable angina	1.177 ***	1.380 ***
Principal Diagnosis of Unstable Angina	0.244 ***	0.212 ***

Table 6-8 (continued)

Multinomial Logistic Regression Odds Ratios of Likelihood of Angioplasty or CABG Relative to Medical Treatment During Admission for Ischemic Heart Disease for Medicare Fee-for-Service Beneficiaries

	Angioplasty	CABG
Diagnostic Testing		
Non-invasive Testing		
Preadmission non-invasive diagnostic testing (echocardiogram, doppler, EKG, 24 hour monitoring, imaging)	1.013 **	0.991
Index Admission non-invasive diagnostic testing (echocardiogram, doppler, EKG, 24 hour monitoring, imaging)	1.805 ***	2.980 ***
Stress Testing		
Preadmission stress testing	2.102 ***	2.089 ***
Index Admission stress testing	0.383 ***	0.336 ***
Other		
Preadmission Unstable Angina Guideline Testing	1.026 ***	1.053 ***
Prior Revascularization		
History of CABG	0.718 ***	0.250 ***
History of prior Angioplasty	1.874 ***	0.783 ***
Admission Severity/Complications		
Principal Diagnosis of AMI	0.843 ***	0.581 ***
Cardiac Arrest	0.613 ***	0.916 *
Cardiogenic Shock	1.333 ***	1.401 ***
Congestive Heart Failure	0.568 ***	0.958
Pseudo R-square	0.172	

* = significant at 5% level; ** = significant at 1% level; *** = significant at .1% level.

NOTES: Number of observations = 336, 301

SOURCE: RTI International analysis of 1997 MedPAR, Physician and Outpatient Hospital claims data.

Table 6-9

Probability of Medicare Fee-For-Service Beneficiaries Admitted with Ischemic Heart Disease Undergoing Revascularization versus Medical ManagementControlling for all Factors Other than Race

	Adjusted Probability		
Race	Medical Management	Angioplasty	CABG
White	0.59	0.23	0.18
Black	0.67 ***	0.20 ***	0.13 ***
Asian	0.58 ***	0.24 ***	0.19 **
Hispanic	0.58 ***	0.23	0.19 ***
Native American	0.64 ***	0.19 ***	0.17 ***

NOTES: Number of observations = 336, 301
Stars denote statistical significance: *<0.05, **<0.01, ***<0.001

SOURCE: RTI International analysis of 1997 MedPAR, Physician, and Outpatient Department clain

Longitudinal Study of Ischemic Heart Disease Among Aged Medicare Beneficiaries

Final Report

Volume II
Chapters 7, 8, Appendices

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7

Mortality Among Aged Medicare Beneficiaries Admitted with Ischemic Heart Disease

This chapter presents rates of mortality within 30 days, 90 days, and one year of a beneficiary's index IHD admission. Mortality rates are calculated from the date of the index IHD admission forward, with our sample being the number of beneficiaries with an index IHD admission. All rates are provided by age, gender, and race/ethnicity, with a few tables providing further stratification by income. All rates are age, gender, race, and/or income adjusted as indicated on the tables (this methodology is discussed in Chapter 4).

The mortality rates are followed by multivariate analyses explaining the likelihood of dying within 30 days or one year of an IHD-primary admission as a function of clinical, demographic, SES, and hospital characteristic variables. Additionally, this chapter presents results of the multivariate analysis of long-term survival. This regression model will predict three-year survival as a function of age, race, gender, socioeconomic status, hospital characteristics, area characteristics, and clinical comorbidity, as measured by principal diagnosis and with our cardiovascular comorbidity variables, and stratified by intervention, i.e., CABG, PTCA.

All tables are at the end of the chapter.

7.1 Descriptive Mortality Rates

This section presents rates of mortality by age, gender, and race/ethnicity 30 days, 90 days and one year after the IHD index admission. Results are provided for all IHD patients in Table 7-1, those with an index admission of AMI (Table 7-2) and IHD patients with ESRD (Table 7-3). We also examine differences in mortality by median zip code income in Table 7-4.

All Patients. Mortality rates for all IHD patients are provided in Table 7-1. Over 8 percent of our IHD sample patients die within 30 days of their 1997 index IHD admission. Approximately 6 percent die in the hospital. The overall mortality rates increase to nearly 11 percent within 90 days of admission and 17.7 percent die within one year of their 1997 index IHD admission. Mortality rates increase dramatically with age, with less than 5 percent of IHD patients ages 65-74 dying within 30 days of their index admission compared to nearly 18 percent of those aged 85 and older. Nearly 40 percent of IHD patients aged 85 and older die within one-year of their 1997 index IHD admission.

Women tend to have lower mortality rates than men, but the relation is inconsistent with age. Younger women (except blacks) have higher mortality rates than men. This relation is more than offset among patients aged 85 and older where the one-year mortality rate for men is over 40 percent compared to about 35 percent for women.

Within 30-days of the index admission, whites have a higher mortality rate (8.0) compared to blacks (7.9) and Hispanics (7.0). However, the mortality rate among blacks is higher than whites within 90 days and one-year. Although the mortality rates for

Asians and Native Americans appear substantially higher than whites in most categories, the small number of observations does not allow for statistically significant findings and, in some cases, the estimates for Native Americans are unreliable.

AMI Patients. Mortality rates among patients with an index IHD admission of AMI are provided in Table 7-2. These mortality rates are more than twice those of all IHD patients, which include less severe diagnoses such as chronic stable angina. Over 17 percent of patients whose index IHD admission was due to AMI die within 30 days of the index admission, increasing to nearly 22 percent within 90 days and over 30 percent within one year.

Blacks have higher 90-day (22.9) and one-year (34.2) mortality rates compared to whites (21.4 and 29.7, respectively). Unlike the overall IHD mortality rate results, women have higher rates of mortality in all three periods compared to men. These differences, however, are primarily driven by patients aged 65 to 74. One-year mortality rates among men and women aged 75 to 84 are identical (34.3%), while rates in all three post-admission periods are lower for women compared to men among IHD patients aged 85 and older.

ESRD Patients. Mortality rates among IHD patients with comorbid ESRD are considerably higher than those of the overall IHD population although considerably below rates for AMI patients (Table 7-3). Nearly one-half of IHD patients with ESRD die within one-year compared to less than 18 percent among all IHD patients. One-year death rates rise to over 60 percent for the over-85 group. Due to the small sample sizes of the IHD population with ESRD, a number of estimates in the smaller subcells of age, gender, and race/ethnicity are unreliable. The only statistically significant finding on this table is that black women ages 65 to 74 have lower rates of mortality (39.8%) compared to men in the same age group (46.1%).

Income Quartiles. Mortality rates by gender, race/ethnicity, and median income are provided in Table 7-4. Male IHD patients in the lowest income quartile have the highest 30-day mortality rates overall (8.3%), while male patients in the highest income quartile have the lowest mortality rate (6.8%). Thus, males living in wealthy zip codes are 18 percent less likely to die after their index admission than males living in poor zip codes. This disparity remains for 90 day and one-year mortality rates. Differences in mortality rates for women, although statistically significant, are not as great. Mortality rates in all three post-admission periods for black and white men in the lowest income quartile are significantly higher than mortality rates among patients in the top two income quartiles – especially for blacks.

7.2 Multivariate Analysis of 30-Day and One-Year Mortality

7.2.1 Rationale

Bivariate analysis of mortality rates by risk factor, while useful, can often result in misleading conclusions, especially when many of the risk factors are highly correlated. Similarly, differences in death rates across races might be due more to differing <u>combinations</u> of risk factors, in which case bivariate comparisons using a single risk factor will be misleading. Multivariate statistical analysis is needed in order to properly assess the mortality effects of each patient characteristic, controlling for all others.

7.2.2 Methods

Model. The standard method for modeling a binary outcome such as mortality is logistic regression. Linear least squares, in which a dichotomous outcome (here, survival or death coded as 0 or 1) is regressed directly on a set of explanatory variables, produces biased and inefficient coefficient estimates. Probit estimation, a common alternative to logistic regression, produces efficient and unbiased estimates, but its parameter coefficients lack a convenient, straightforward marginal interpretation. Logistic regression, efficient and unbiased, produces an odds ratio for every regression, thus providing simple estimates of each regression's effect on the dependent variable.

Unlike least squares regression, the coefficients from logistic regression are not directly interpretable. Fortunately, a convenient interpretation of the coefficients is found in the odds ratio (Hosmer and Lemeshow, 1989). Assume we are interested in assessing the effects of the presence or absence of CABG surgery (CABG) on 30-day mortality. The odds ratio, denoted by Ψ, is defined as the ratio of the odds of death for x=1 (CABG surgery) to the odds for x=0 (no revascularization) , and is represented by the equation

(7.1)
$$\psi = \frac{\pi(1)/[1-\pi(1)]}{\pi(0)-[1-\pi(0)]} = e^{\beta CABG}$$

where $\pi(1)/[1-\pi(1)]$, where $\pi(1)$ is the probability of death given the presence of CABG. β_{CABG} is the CABG coefficient in the logistic regression. An odds ratio of 1.35, for example, would indicate that a CABG patient is thirty-five percent more likely to die than a patient without CABG, while an odds ratio of .50 indicates the patient is only half as likely to die. Relative risk is defined as the ratio $\pi(1)/\pi(0)$. Ψ is a good estimate of relative risk when $\pi(x)$ is small for both x=0 and x=1, as in the case of our mortality model. Note that an odds ratio must be greater than zero; variables having a negative effect on the outcome variable will have an odds ratio between 0 and 1.

Equation Specification. Logistic regression was performed using two different dependent variables: mortality within 30 days and one year following admission for IHD. The general specification of the logistic model was as follows:

$$(7.2) \qquad P[O_i = 1|X_i] = f\,[RACE_i; DEMOSES_i; SEVERITY_i; HOSP_{ih}, PROC_i]$$

where the dependent variable is the probability, P, of an outcome $O_i = 1$ if death occurs for the *i*-th patient, given the set, X_i, of patient characteristics. For purposes of this study, the relevant set of independent variables include a vector of dummy variables for the race/ethnicity of the patient ($RACE_i$); a vector of sociodemographic and socioeconomic characteristics of the *i*-th patient ($DEMOSES_i$); a vector of severity indicators ($SEVERITY_i$); a vector of characteristics of the hospital within which the *i*-th patient is admitted (H_{ih}); and a vector of procedures during the index IHD admission, including revascularization with either CABG and angioplasty ($PROC_i$).

Specification of Mortality Models. Because the longitudinal database contains a very large number of clinical variables, we employed a variation of a model-building strategy recommended by Hosmer and Lemeshow (1989). Because of the sheer number of clinical variables in our database, we estimated separate models for each vector of variables of interest and assessed the level of association between each independent variable and 30-day mortality within each vector of similar variables. A 10 percent confidence level is then used as the standard for assessing association and including risk factors in our model building strategy.[1]

A preliminary set of 11 logistic models is estimated with 30-day mortality as the dependent variable to allow us to assess the overall strength of each vector of variables. For example, we estimate three alternative specifications of the severity vector and four alternative specifications of the procedure vector. Appendix 7.A provides definitions of all explanatory variables. Appendix 7.B contains all eleven logistic regression models. Several comments are noteworthy. Using the Hosmer and Lemeshow chi-square as a measure of goodness of fit of each model, we observe that the model containing the parsimonious Charlson index has a substantially higher chi-square than the vector containing the individual variables representing comorbidity present at the time of admission. The vector of acute medical conditions also has a substantially higher Chi-

[1] As researchers, we must balance the need to be confident that an association with mortality truly exists with the desire to avoid overlooking an association, particularly an adverse one. A Type II error occurs when a null hypothesis of no significant effect is accepted, when, in fact, one exists. Insistence on a high confidence threshold might cause us to reject a pertinent risk factor simply because the variable was not always accurately reported. For these reasons, a 10 percent confidence level was selected. With almost 350,000 observations, the models have considerable power in avoiding a Type II error.

square than the vector containing individual variables representing comorbidity at time of admission.

Second, of the four vectors of procedures, the vector containing procedures provided only during the index admission has the highest Chi-square relative to three other vectors.

Third, because inclusion of insignificant variables increases the variance in estimation of individual probabilities, we are interested in developing a parsimonious model. Therefore, we undertook a second round of regression modeling to further isolate clinical variables most highly correlated with 30-day mortality, controlling for underlying comorbidity and sociodemographic characteristics of interest in this study. Based on the regression results, a final subset of clinical variables were selected and are used in the 30- and 1-year regression models. We also created a few composite variables to further reduce the number of variables included in the model by combining variables that had coefficients of the same magnitude and direction.

Variable Means. Table 7-5 provides definitions of all dependent and independent variables used in the final set of multivariate mortality analyses. The mean value for each variable is displayed. Mean values for the dichotomous variables represent the proportion of cases for which the condition is present.

Estimation Methods. A final set of six mortality models are estimated, first, for the 30-day period following admission, and second, for the 365-day period following admission. We use the same set of variables in both models to allow for the assessment of changes in the influence of the independent variables over time. The first model simply contains dummy variables representing four minority races. Odds ratios greater than (less than) 1.0 for these variables would suggest that minorities have a higher (lower) likelihood of death than whites[2] before controlling for any other factors associated with mortality.

The second model steps in sociodemographic (e.g., age categories) and socioeconomic variables (e.g., Medicare/Medicaid dual eligibility) Stepping these variables into the model is analogous to adjusting for such variables in descriptive comparison of mortality rates. If none of the racial/ethnicity odds ratios change as the other variables are stepped into the regression, we could conclude that these factors are uncorrelated with race/ethnicity. If any race/ethnicity odds ratio changes with the inclusion of additional variables, then the racial group is correlated with one or more of the new variables.[3] By controlling for these factors that positively affect death rates, we "remove" their effects from the race/ethnic odds ratios and they can be compared on an "adjusted" basis.[4] Again, this model does not control for differences across the races in comorbidity.

[2] Beneficiaries with a race code of unknown or other are excluded from all multivariate analyses since we do have income information. Inclusion of these beneficiaries would have resulted in shifting populations across the regression models, thereby making interpretation of changes in odds ratios across the models difficult.

[3] When more than one variable is added at a step, the change in the race/ethnic odds ratio can represent offsetting influences. For example, controlling for low income will lower blacks likelihood of dying while controlling for age should raise their likelihood assuming blacks have shorter lifetimes after age 65 (and age is positively related to 30-day death rates in the model).

[4] The original odds ratio without controls is said to be biased upwards if it falls as more variables are added. The bias = (d (r,z) x b_z, where d (r,z) – the coefficient of a bivariate regression of r on z (e.g., race on dual eligible status) times the coefficient of z in the expanded regression (Greene, 2000, p.335).

The third and fourth models step in two vectors of severity. In Model 3, comorbidity, as reflected by the Charlson index and severity at the time of admission as reflected by source of admission ER, are added. In Model 4, variables representing proxies for clinical severity during the admission are added. Principal diagnosis of AMI and unstable angina are added to allow for the direct examination of the effect on mortality of either diagnosis relative to those admitted with chronic stable angina. A set of variables are included that capture the presence of severe clinical conditions during the hospitalization, either through diagnosis or provision of cardiovascular hemodynamic support, treatment in an ICU, or renal, neurology, respiratory, or infection disease consultations. A reduction in the odds ratio for blacks would imply that they experience a higher comorbidity level than do whites. Any decline in race/ethnic odds ratios between Model 4 and Model 2 provides a direct estimate of the contribution of casemix severity to observed mortality differences between blacks and whites.

The last two models step in hospital characteristics (Model 5) and procedures (Model 6) that are provided during the hospitalization. We documented in Chapter 6 significant disparities in the rate at which blacks and Hispanics received diagnostic and revascularization procedures. If Model 6 that includes such procedures shows them to reduce the likelihood of dying (which they do), then the odds ratios for blacks and Hispanics should be less than in either Model 4 or Model 5. Including revascularization procedures might be criticized as "endogenous." By this one means that they depend, in some way, on variables already in the model.[5] This is not a problem so long as the race/ethnic odds ratios are interpreted carefully. Controlling for the presence of revascularization, blacks and Hispanics should be less likely to die, but, of course, a smaller proportion undergo revascularization; hence, their overall odds ratio is higher than it would be if they were equally likely as whites to undergo CABG or PTCA. No bias in either the race or revascularization coefficients results from stepping the latter in to the model. We simply gain a better understanding of how much unequal revascularization rates contribute to the differences in race/ethnic mortality.

Generalizability. There is a potentially serious problem with generalizability of the results, however, since we are only evaluating Medicare FFS beneficiaries age 65 years and older who have been admitted to an acute care hospital with a principal diagnosis of ischemic heart disease. We cannot assume that the relative risk estimates for race, sociodemographic and socioeconomic factors, patient comorbidity factors, and revascularization obtained from this analysis are representative of all IHD patients at any age or who are not hospitalized for at least one year. If hospitalized IHD patients are systematically sicker than those that are not hospitalized during a given year, then this study may overstate the predicted reduction in relative risk between blacks and whites when controlling for (presumably narrower differences in) casemix across all IHD patients.

[5] Following this logic, one could argue that many variables already included in the model, such as dual eligibility, low income, and comorbidity are also endogenous. The key assumption is that the revascularization likelihood does not depend on the dependent (mortality) variable which would set up a “reverse causality” and procedure coefficient bias.

7.2.3 Results of Multivariate Analysis of 30-Day Mortality following Admission for Ischemic Heart Disease

Table 7-6 reports the odds ratios and Chi-square p-values for six 30-day mortality models. Coefficient estimates themselves are not reported because they are not directly interpretable; attention is instead focused on odds ratios that indicate the degree to which the presence of a risk factor affects mortality. The overall model Chi-square (and p-value) and the number of observations are included at the bottom of each regression.

Model 1 contains only race dummy variables indicating the race of the beneficiary as contained in the Medicare Enrollment Database with whites embedded in the intercept. Thus, the odds ratios reflect likelihood of dying relative to whites. Beneficiaries with an unknown race or those classified as other are excluded from all multivariate modeling of analyses. All four minority race odds ratios are less than one, signifying less likelihood of dying than whites; however, only the odds ratio for Hispanics is statistically significant. An odds ratio of 0.79 suggests that risk of death within 30 days of admission for IHD is roughly 21 percent lower for Hispanics than for whites. The insignificance of the remaining odds ratios suggests limited cross-sectional racial differences among whites, blacks, Asians, and Native Americans in mortality, unadjusted for SES, patient severity, or diagnostic or therapeutic interventions during the hospitalization.

Model 2 includes the same four race dummy variables as well as a set of other dummy variables reflecting sociodemographic and socioeconomic factors that appear to be correlated with mortality to varying degrees in the univariate analyses. This model also contains a dummy variable reflecting whether the Medicare beneficiary has a known family history of housing, household, economic or psychosocial circumstances as coded by physicians on a Medicare claim. All socioeconomic and sociodemographic factors are highly significant in Model 2. Age increases the likelihood of death. Beneficiaries age 75 to 84 are twice as likely to die within 30 days of an IHD admission as are beneficiaries 65 to 74, and beneficiaries age 85 and over are more than four times as likely to die versus the youngest age group. Males are 7 percent more likely to die than females. Beneficiaries residing in rural areas are 4 percent more likely to die than are those residing in urban areas. Dual enrollees are 26 percent more likely to die than are beneficiaries who are not dually enrolled in both Medicare and Medicaid. And, beneficiaries living in the lowest income quartile areas are roughly 4 percent more likely to die than are beneficiaries residing in higher income zip code areas. Beneficiaries with a previous family history of housing, household, economic or psychosocial circumstances are 75 percent more likely to die than those without this family history noted as a secondary diagnosis on a Medicare Part B claim.

The odds ratio for the race dummy variable for blacks declines to 0.95 and becomes statistically significant at the 10 percent level of significance with the introduction of these other sociodemographic and socioeconomic factors. Hispanics continue to have significantly lower odds of dying than whites. From previous chapters, we know that blacks live disproportionately in low income areas and are dual enrollees. By controlling for these factors that positively affect death rates, we "remove" their effects from the race/ethnic odds ratio. In this way, we better understand why race/ethnic groups are, or are not, more likely to die than whites 30 days after an IHD admission.

Mortality rates appear to be strongly correlated with pre-admission co-morbidity or severity as measured by the Charlson Index and admission from the emergency department (Model 3). Each of these factors increases the likelihood of death and is highly statistically significant. Each one point increase in the Charlson Index increases the likelihood of dying by 5 percent. Admission through the ER significantly increases the likelihood of death within 30 days by 68 percent. The magnitude and direction of the socioeconomic and sociodemographic odds ratios are little affected by the inclusion of these two comorbidity variables, indicating no significant correlation between these two sets of variables.

Co-morbidity measured at the time of admission is correlated with race. When controlling for co-morbidity differences between blacks and whites, the odds ratio for blacks, becomes statistically highly significant. Blacks are now 9 percent less likely to die than whites within 30 days of admission. Although elderly Medicare blacks are no less likely to die 30 days after an IHD admission than whites (Model 1), they appear to be so once we recognize their poorer health status upon admission. Hispanics continue to be about 20 percent less likely to die than whites.

Model 4 contains a vector of severity proxies as measured by principal diagnosis, AMI or unstable angina, and medical events or complications that occur during the admission, e.g., cardiac arrest, cardiogenic shock, acute renal failure, etc. All of these variables are highly significant in Model 4. The risk of 30-day post-admission mortality is nearly 15 times higher if a beneficiary experiences cardiac arrest or cardiogenic shock during the admission. Compared to beneficiaries admitted with a principal diagnosis of chronic stable angina, admission with a principal diagnosis of an acute myocardial infarction increases the risk of death five-fold. Interestingly, beneficiaries admitted with a principal diagnosis of unstable angina are almost 20 percent less likely to die than patients admitted with chronic stable angina. This may reflect favorably upon the AHRQ guidelines for unstable angina. Once patients are identified as having unstable angina, evidence-based care pathways are implemented resulting in a very favorable outcome.

Not surprisingly, beneficiaries who experience an acute medical condition or complication of an arrhythmia, respiratory distress, acute acid-base imbalance, viral or bacterial pneumonia, or stroke are almost 2.5 times more likely to die within 30 days of admission than are beneficiaries who do not experience these medical conditions. The presence of other clinical conditions of rupture of vasculature, congestive heart failure, or renal failure during the IHD hospitalization increases the risk of death by 29 percent over cases without these conditions. Beneficiaries who receive cardiovascular hemodynamic monitoring and support, are admitted to an ICU, or have a neurology, respiratory, infectious diseases, or renal consultation during the hospitalization are almost twice as likely to die as compared to those without these services.

After controlling for severity, as measured by principal diagnosis and complicating conditions during the hospitalization, admission through the ER no longer exerts a statistically significant effect on mortality. Thus, ER status serves as a proxy for admission severity. Also, after controlling for differences in sociodemographic, socioeconomic, and casemix, men are no longer more likely to die than women within 30-days of admission for IHD. Generally speaking, the magnitudes of the relative risk estimates of the remaining socioeconomic and sociodemographic factors in Model 4 do not differ greatly from their counterparts in Model 3.

Including additional casemix or severity variables further reduces the likelihood of blacks dying within 30 days of admission relative to whites.

Model 5 steps in the vector of hospital characteristics that previous research has shown to be correlated with risk of death for cardiovascular patients. After controlling for race, sociodemographic and socioeconomic factors, pre-admission comorbidity, and observed complications during hospitalization, admission to a major teaching (COTH) hospital reduces the risk of 30-day mortality by 9 percent as compared to a non-teaching hospital and admission to a hospital with a coronary care unit reduces the 30-day mortality risk also by about 9 percent. There does not appear to be any significant correlation between the vector of hospital characteristics and the vectors of variables in Model 4. The magnitudes of the relative risk estimates of the variables in Model 5 do not differ greatly from their counterparts in Model 4.

Model 6 is our full model that allows for the direct examination of relative risk of 30-day post admission mortality across racial/ethnic classes after fully controlling for variation in all previous variables plus any diagnostic and interventional procedures during the IHD admission. Chapter 6 reported the presence of significant disparities in the rate at which most racial minorities receive revascularization procedures and some, but not all, diagnostic procedures. The provision of a cardiac catheterization and/or angiography during the hospital admission reduces the 30-day mortality risk by almost 60 percent, holding constant all other factors. Diagnostic tests, such as echocardiogram, 24 hour ECG monitoring, cardiac imaging, or a cardiology consultation reduces the 30-day mortality relative risk by almost 50 percent. Revascularization appears to significantly improve 30-day survival, *ceteris paribus*. Beneficiaries who receive a CABG are almost 40 percent less likely to die in 30 days than those that do not receive a CABG, and beneficiaries who receive angioplasty are 50 percent less likely to die than those that do not receive angioplasty. This is true controlling for many severity factors that might increase or decrease a patient's likelihood or undergoing revascularization.

Adding the vector of diagnostic and interventional services further reduces the odds of blacks dying relative to whites, *ceteris paribus*. Blacks are 23 percent less likely to die than whites within 30 days of an IHD admission controlling for demographic, severity, and treatment modality. Hispanics also continue to demonstrate far more favorable "short run" outcomes than whites, although their odds of dying does not seem to be influenced by the rate at which they receive diagnostic or interventional procedures. The relative risk of dying within 30 days of admission continues to be 16 percent less for Hispanics than for whites. Black, 30-day, mortality is explained, in part, by their greater severity upon and during admission. Failure to control for their lower catheterization and revascularization rates raises the black death rate relative to whites by 8 percentage points (.87-.77).

These estimated minority mortality rates in model 6 are far lower than what was observed in our descriptive analyses of 30-day mortality and other research (Peterson, *et al.*, 1997) that has examined racial/ethnic differences in mortality for patients with cardiovascular disease. Previous research may not have fully accounted for underlying differences between blacks and whites in socioeconomic and demographic characteristics, comorbidity, complications during the hospitalization, admitting hospital characteristics, and rates of diagnostic and invasive interventions. They also do not focus on a natural sample of over-65 elderly.

The odds ratio for the open-heart unit hospital characteristic, statistically insignificant in Model 5, becomes statistically significant with the inclusion of the diagnostic and interventional procedures. The risk of dying increases 24 percent if admitted to a hospital with an open heart unit. This variable most likely represents increased severity controlling for revascularization.

The magnitudes of the relative risk estimates of many of the other variables in Model 6 do not differ greatly from their counterparts in Model 5 for most variables. However, the change in the odds ratio for the variable representing family history of housing, household, economic or psychosocial circumstances for several other variables is noteworthy. The lower odds ratio for family problems becomes statistically significant at only the 10 percent significance level. The family problem variable must be correlated with one or more of the intervention variables.

7.2.4 Results of Multivariate Analysis of One Year Mortality following Admission for Ischemic Heart Disease

The overall mortality within one year from admission for IHD is roughly 18 percent. Table 7-7 reports the odds ratios and chi-square p-values for six one-year logistic regression mortality models. These models mirror those that were developed for the 30-day period to allow us to assess the longer-term effects of these highly significant variables in the previous modeling exercise. Generally speaking, the direction and magnitude of the relative risk estimates of most variables in the one-year mortality model remained fairly consistent with their counterparts in the 30-day mortality model. Therefore, we limit our discussion in this section to notable differences between the 30-day and one-year models for key race variables.

Most notably, black Medicare beneficiaries are 14 percent more likely to die than are white Medicare beneficiaries within one-year of admission for ischemic heart disease, not controlling for any severity or in-hospital treatment factors (Model 1). At 30 days, the odds ratio for blacks was not statistically different from unity. This is fairly consistent with findings in the published literature.

However, the addition of sociodemographic and socioeconomic factors as well as comorbidity and severity variables substantially changes the odds of blacks dying. As is observed in Model 4, controlling for the just noted factors, blacks are 7 percent less likely to die than whites. This very dramatic change suggests that blacks have a significantly higher level of severity of illness and this higher level of severity leads to a higher one-year death rate for blacks relative to whites. This point is further supported in Model 6, where, *ceteris paribus,* blacks are 14 percent less likely to die than are whites within a one-year window from admission but are 23 percent less likely to die than are whites within a 30-day window.

Hispanics continue to exhibit lower odds of dying than whites. Not controlling for any factors, Hispanics have a 17 percent lower likelihood of death relative to whites at one year. At 30 days, Hispanics were 21 percent less likely to die than whites. At one year, Hispanics have a 22 percent lower likelihood of dying than whites, *ceteris paribus,* which is in contrast to a 16 percent lower likelihood of dying as compared to whites within 30 days. Thus, for blacks the favorable lower odds of dying relative to whites diminishes over time, while for Hispanics the favorable lower odds increases. Further, Asians now exhibit a statistically significant 13 percent lower relative rate of death than whites within one-year of admission at a 10 percent significance level. There were no statistically significant differences within a 30-day period.

The finding that blacks have a lower relative risk of dying than whites at 1-year when controlling for sociodemographic and socioeconomic factors, comorbidity, severity of illness during the hospitalization, treatment hospital characteristics, and revascularization is somewhat surprising given previous research has generally found higher rates of death among blacks as compared to whites. Even more peculiar is the finding that Hispanics, who have a lower likelihood of death than whites at 30 days, further improve their relative risk of dying as the odds ratio for Hispanics falls between 30 days and one-year. One explanation could be that these findings are a function of our population, elderly hospitalized Medicare FFS beneficiaries. A similar set of analyses on a more general population may not produce the same results.

7.3 Survival Analysis

In addition to explaining 30-day and 1-year mortality among the different races, we also investigated survival over a period of 2-2.5 years using survival analysis. As with the logistic regression discussed in Section 7.2, the index event for the survival analysis is the first admission after July 1, 1997. For each beneficiary, the survival time equals the interval, in days, between the index admission, and the date of death. Beneficiaries who were alive for the entire period were censored as of January 31, 2000. While the analysis period spans 31 months, beneficiaries were observed for varying periods, ranging from 25 to 31 months, depending upon the index admission date, July-December 1997.

7.3.1 Cox Proportional Hazards Regression Models

The Cox proportional hazards regression is a method for analyzing the effects of several explanatory variables on survival (mortality) (Cleves, *et al.*, 2002; Kleinbaum, 1996). It is a semi-parametric approach to survival analysis; that is, the model assumes that the effect of any one explanatory (parametric) variable on survival is constant over time yet builds on the actual (non-parametric) survival experience of the population. For example, the effect of race on survival is assumed to be (proportionally) the same during the months immediately following an index admission as during the last months in the analyses period. The Cox model estimates the risk, or hazard, of death controlling for the other variables included in the model. Results are usually expressed as hazard ratios that represent the risk of dying associated with a particular factor compared to the risk of dying in the absence of the factor for any given period. A hazard ratio of more than 1 for an explanatory variable indicates that the hazard, in this case death, is higher relative to the reference group (e.g., whites); a hazard ratio of less than 1 indicates that death is relatively less likely.

We conducted a series of Cox proportional hazards regression models to analyze the changes in the hazard ratios for race after controlling for sociodemographic factors, comorbidities, severity upon admission, diagnostic procedures, and cardiac revascularization procedures. The first model generated the hazard ratios for each race without controlling for any other variable. When plotted, they produce standard Kaplan-Meier unadjusted survival curves for each race. A second Cox regression includes a set of sociodemographic factors, comorbidity measures, measures of severity upon admission, and diagnostic testing. We estimated a third Cox regression model that included the same explanatory variables and, in addition, cardiac revascularization procedures – CABG and PTCA. We estimated a fourth stratified Cox regression model that is similar to the third except that it uses the three treatment groups (CABG, PTCA, and Medical Management) as strata.[6] Finally, we estimated separate survival models for each race/ethnic group allowing the effects of each risk factor to vary. The predicted survival rates were then compared to the unadjusted rates for each group.

7.3.2 Unadjusted Survival Rates

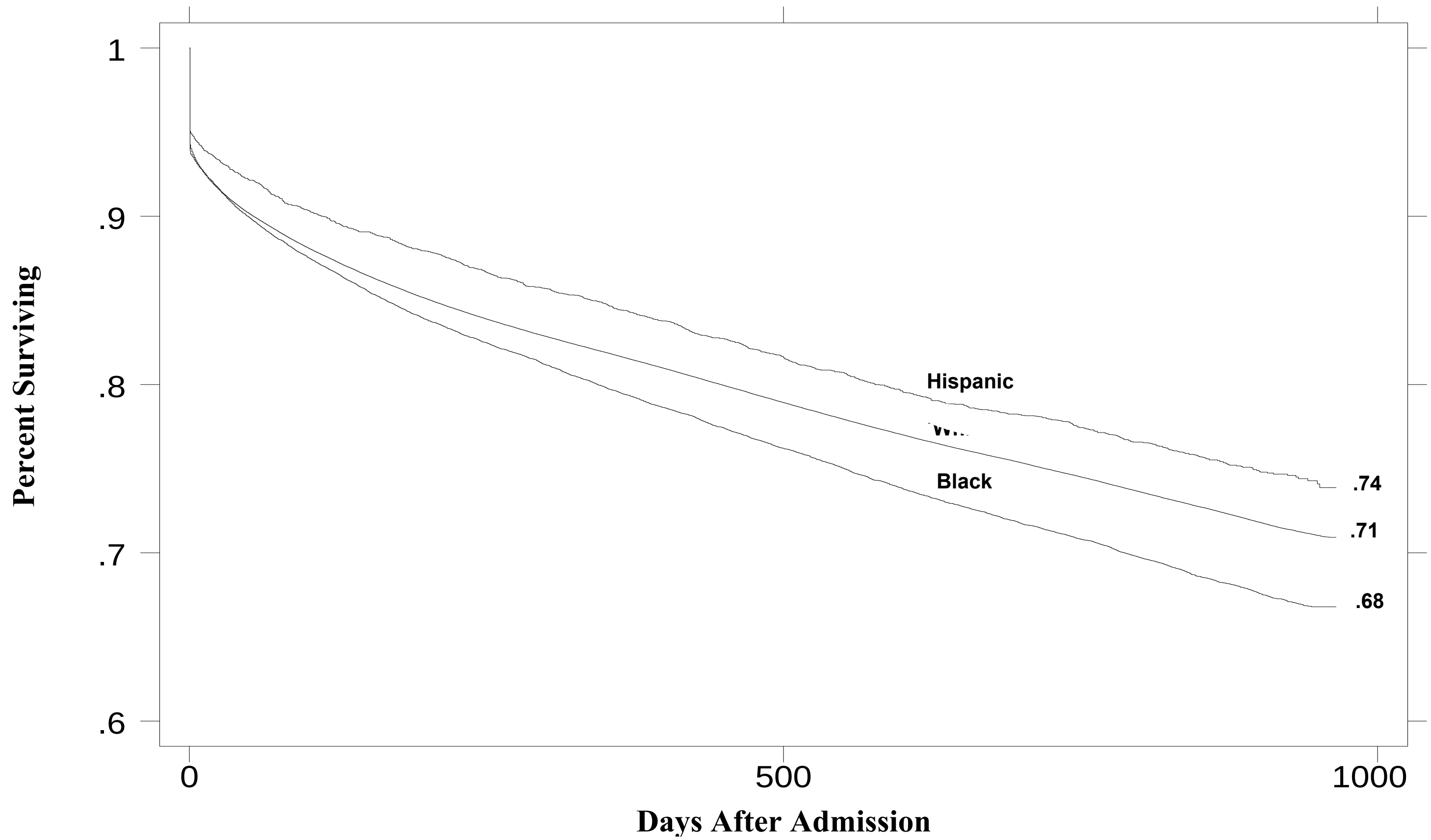
We first present the unadjusted survival curves and rates for the period of analysis, which is between July 1, 1997 and January 31, 2000. About 28 percent of the

[6] A stratified Cox proportional hazards model estimates separate hazard (and survival) functions for each stratum and constrains the regression coefficients on the explanatory variables to be the same.

aged Medicare IHD sample died during the 2.5 year analysis period. Figure 7-1 shows the unadjusted Kaplan-Meier curves for the three largest groups: black, Hispanic, and white beneficiaries (Asians and Native Americans were too few to plot meaningful curves). The Kaplan-Meier curves are graphs of the observed survivor functions for each race. The survival curves begin with all individuals alive at the time (=0) of index admission and trace the implications of deaths on survival rates through January 31, 2000. It is not uncommon for individuals with ischemic heart disease to die on the day of admission. These deaths are represented by the initial vertical drop in the survival curve for the three races during the admission.[7] The curves terminate with the percent of beneficiaries who were still alive as of January 31, 2000 (roughly 1000 days). These percentages also appear in Row 2, Table 7-8.

[7] We set the time to death equal to .5 days for individuals who died on the day of admission, since time to death must be greater than 0. The time to death for all other individuals who died equals the number of whole days between the index admission date and the date of death.

Figure 7-1
Unadjusted Kaplan-Meier Survival Curves for Blacks, Hispanics & White Beneficiaries Following IHD Admission, 1997



NOTES:
1. Survival rates are unadjusted for age, comorbidity or other factors.

SOURCE: RTI/HER analysis of SOURCE 1997-1999 100% Denominator and MedPAR files.

As indicated in Figure 7-1, Hispanics were the least likely to die among the three races during this period, with a survival rate of 74 percent; blacks were the most likely to die, with a survival rate of 68 percent. The survival curves are shifted downwards by about 5 percent on the first day of admission due to immediate IHD catastrophes (e.g., cardiac arrest, cardiogenic shock). Hispanics are slightly more likely to survive on the first day of admission compared to the other groups. This gap widens to 3 points over whites and 6 points over blacks at 2.5 years. Blacks and whites had similar survival rates on the first day of admission, but whites were more likely (71 percent) to survive than blacks over 2.5 years. Differences in survival may be explained by the sociodemographic factors, comorbidities, severity of disease, or procedures used to treat ischemic heart failure.

7.3.3 Determinants of Survival

Table 7-9 presents the results from three Cox proportional hazards regressions. The first column shows the hazard ratios from a model that includes race without other explanatory factors. Compared to whites, blacks and Native Americans are 17 percent and 6 percent more likely to die over any period while Asians and Hispanics, with hazard ratios of .90 and .87 respectively, are less likely to die. Hazard ratios for all race-ethnic groups except Native Americans were statistically different versus whites. [8] The second

[8] The hazard ratios in Table 7-9, col. 1, are the ratios of the integrated hazard functions for each minority group relative to whites (Greene, 1997, p. 989). For example, the black hazard ratio equals the ratio of the logged survival rates in Table 7-8; 1.17 = ln(.681)/ln(.722).

column of Table 7-9 presents the results from the second Cox proportional hazards regression that includes factors in addition to race. The variables included are identical to the factors used in the logistic regression Model 6 presented earlier in Section 7.2, with two exceptions. First, we did not include hospital characteristics in the survival model. Second, we included only two diagnostic procedures. The third column displays results that also include the revascularization procedures for treating ischemic heart failure (PTCA and CABG). The second and third models produce similar results.

Race or Ethnic Differences

Once the sociodemographic factors, comorbidities, severity during admission, and diagnostic testing and revascularization procedures are included, blacks are less likely to die than whites. The hazard ratio falls from 1.17 (the first model) to .92 (Model 3) after including these variables. This result is striking because it implies that, at any point up to 2.5 years post discharge, blacks are less likely to die compared to whites, after controlling for severity and comorbidities. This implies that blacks with IHD are sicker than whites upon admission and explains the disparity observed in unadjusted survival. Of note is that blacks are even more likely than whites to survive once the revascularization procedures for ischemic heart failure are included in the analysis. (Note the decline in the black hazard ratio from .96 to .92.) Nevertheless, whether blacks actually undergo revascularization only makes their survival rate marginally better; controlling for health status already shows them less likely to die than whites.

Figure 7-2 plots survival curves for the three largest race/ethnic groups after adjusting for all patient and treatment characteristics.[9] The gap between each group versus whites has narrowed considerably such that black-white survival curves are almost overlapping—especially after 360 days.

Sociodemographic Factors

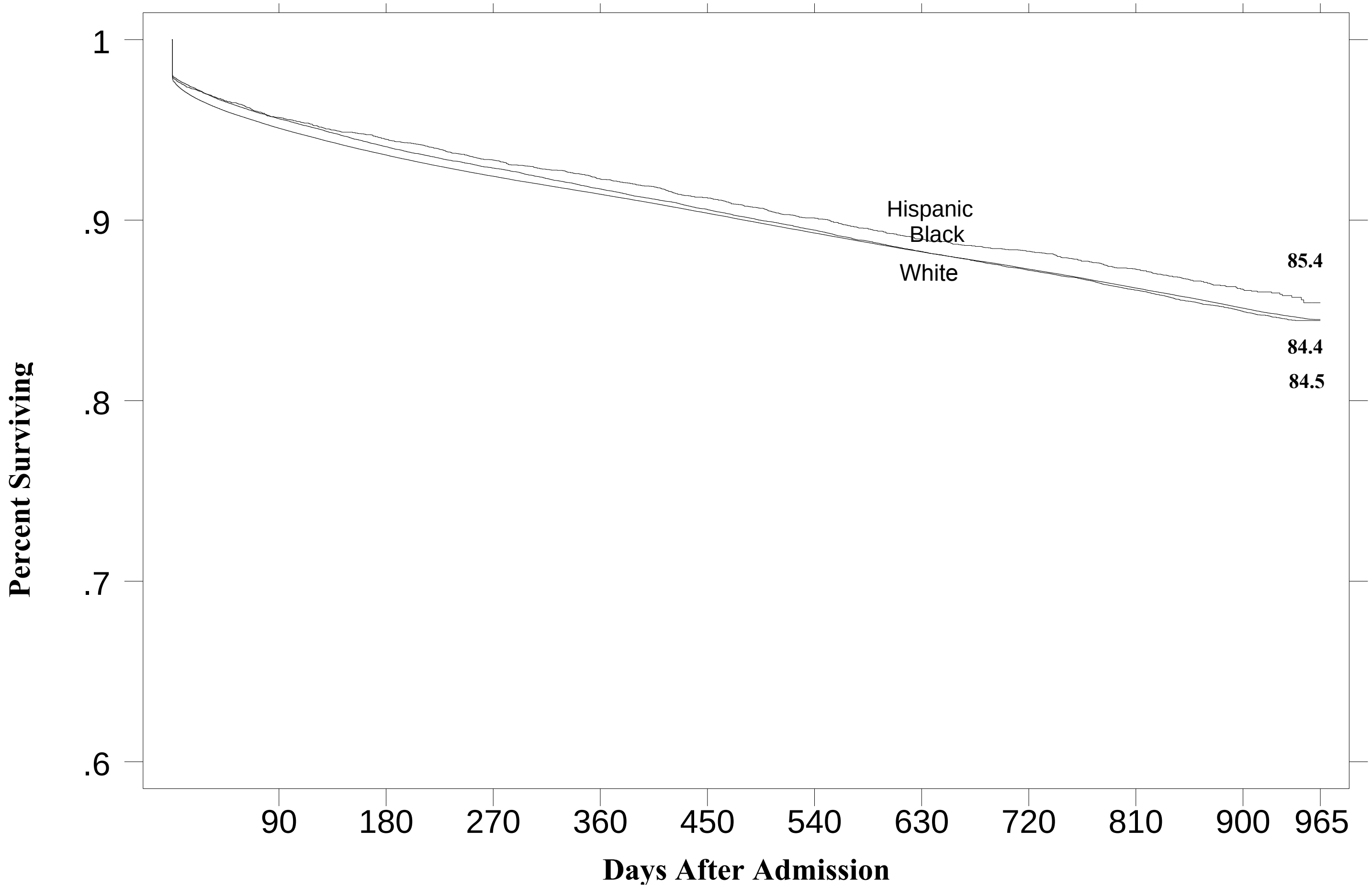
Among all of the sociodemographic factors, age affects survival the most, as expected. The age categories have very large hazard ratios of 1.56 (75-84) and 2.33 (85+), respectively, and are statistically significant at the 1 percent level. All sociodemographic factors are statistically significant except for presence of a family problem.

Comorbid Conditions

As with the logistic models presented earlier, we include the Charlson Index and admission from the emergency department as measures for comorbid conditions upon admission. The presence of comorbid conditions decreases survival for all races. Each

[9] As with the unadjusted survival curves (Figure 7-1) these curves are plotted from regressions on each race/ethnicity separately.

Figure 7-2
Kaplan-Meier Survival Curves for the Three Largest Race/Ethnic Groups, Adjusted for Sociodemographic Factors, Severity Upon Admission, Comorbidities, Diagnostic Procedures, and Revascularization Procedures



NOTES:
1. Survival curves are based on rate-specific Cox proportional hazards models for each racial/ethnic group.

SOURCE: RTI/HER analysis of 1997-1999 100% Denominator and MedPAR files.

one point increase in the Charlson Index increases the hazard of dying in any period by 16 percent. Having one or more admissions to an emergency room increases the likelihood of dying by 14 percent. This is true even holding cardiac arrest and other variables constant. These results are similar to the results found in the logistic models.

Severity

Severity upon admission comprises six measures in the survival model. All of these measures are highly significant and all but the unstable angina measure decrease survival over 2-2.5 years. Having a heart attack is particularly hazardous.

Cardiac Diagnostic Procedures

Two diagnostic treatment variables are included in this survival model: (1) cardiac catheterization or angiography during hospital admission, and (2) testing or monitoring including echocardiogram, 24-hour EKG monitoring, cardiac imaging, or a cardiology consultation. These diagnostic factors increase survival and are statistically significant. Undergoing cardiac catheterization or angiography substantially reduces the risk of death, as indicated by the hazard ratio of .59.[10] Receiving testing or monitoring as described above, also improves the chance of survival by a lesser amount.

[10] McClellan, *et al.* (1994) reminds us that the effects of angiography are overstated to a minor degree due to positive selective referrals to the procedure for patients most likely to benefit from it. See, also, Section 6.3 above.

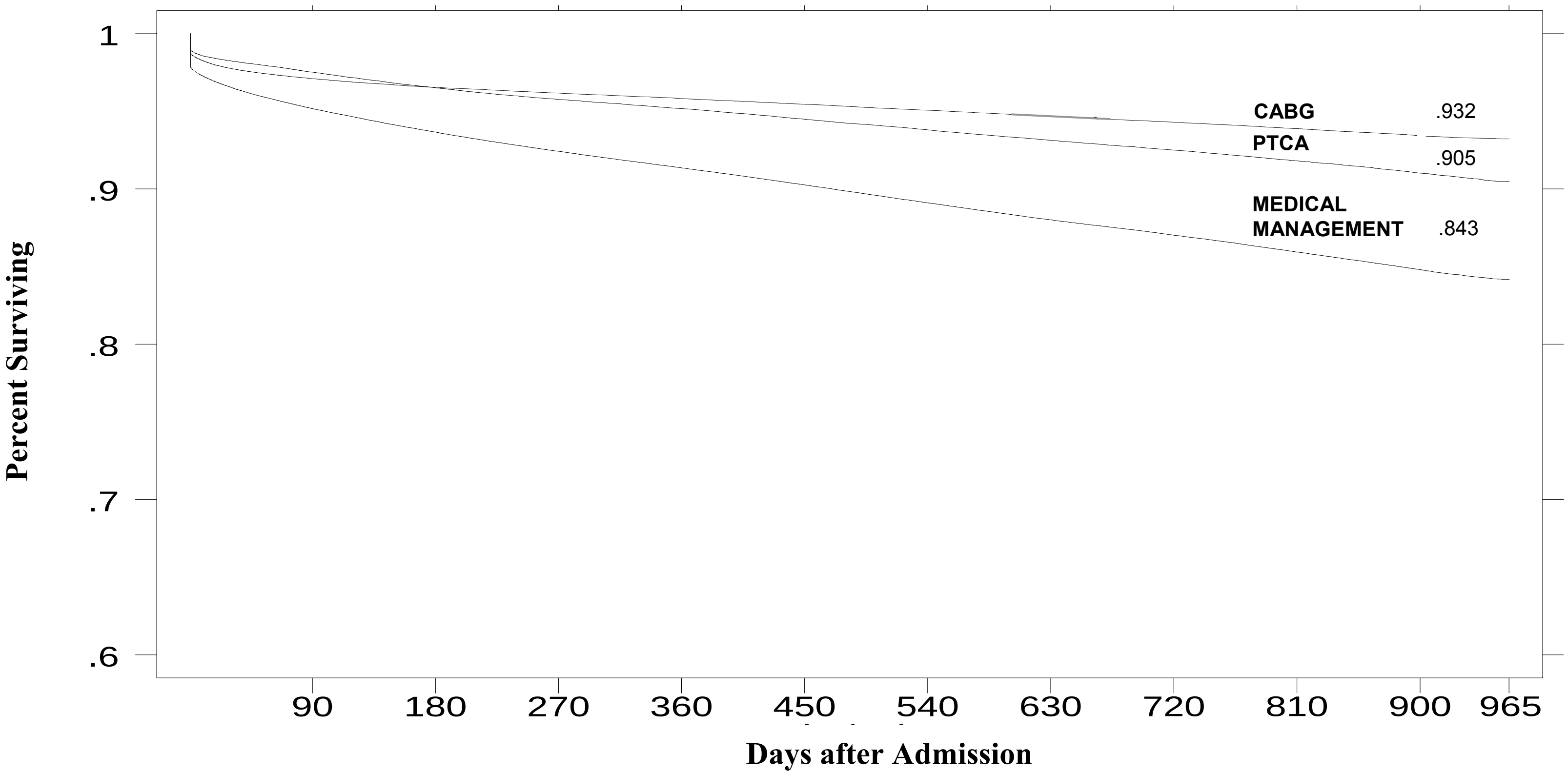
Cardiac Revascularization Procedures

All beneficiaries received one of three treatments for ischemic heart disease: coronary angioplasty (PTCA), bypass surgery (CABG), or other medical management.[11] Undergoing one of the two revascularization procedures had a large and statistically significant effect on survival. Among all the variables included in the model, CABG had the largest affect on survival, with a hazard ratio of .45; the hazard ratio for PTCA was .59.

7.3.4 Survival by Cardiac Revascularization Procedure

We also re-estimated Model 3 stratified by the three treatment groups (CABG, PTCA, and Medical Management). The estimated hazard ratios are identical to those in Model 3 that included CABG and PTCA as dummy variables, but the underlying survival curves are allowed to vary. Figure 7-3 displays the Kaplan-Meier survival curves for the three revascularization treatment groups after adjusting for all of the variables described above. The adjusted 2.5 year survival rates are above 93 percent for individuals receiving CABG, and slightly above 90 percent for individuals undergoing PTCA. Medical management survival rates are only 84 percent. Since most of the variables have a negative affect on survival with hazard ratios above 1.0 (e.g., age >85), adjusting for these factors shifts all three curves upward compared to the unadjusted survival curves

[11] CABG and PTCA are included as dummy variables. Beneficiaries who received both PTCA and CABG are in both groups. The stratified analysis allows for the underlying survivor functions to vary according to the treatment group but forces the hazard ratios to be the same for each of the explanatory variables across the strata.



NOTES:
1. PTCA, CABG, Other Medical Management groups are based on assigning patients to one type of intervention; patients receiving both CABG and PCTA are in both groups.
2. Survival rates are adjusted for race/ethnicity, age, comorbidity, severity of admission and diagnostic procedures.
3. Curves are estimated from a Cox proportional hazards regression stratified by treatment group.

SOURCE: RTI/HER analysis of SOURCE 1997-1999 100% Denominator and MedPAR files.

shown in Figure 7-1. In effect, the curves represent the expected survival of a white individual with none of the sociodemographic factors present, having no severity indicators or comorbidities, and not having had the diagnostic procedures.

Note that the PTCA and CABG survival curves cross at roughly 180 days. This implies, first, that the assumption of a single, uniform proportional survival curve must be rejected for these two revascularization interventions.[12] Second, it appears that patients undergoing PTCA are slightly less likely to die than CABG patients in the first six months post-procedure; however, after six months, CABG survivors are more likely to survive in the next two years versus PTCA patients thereby producing a 3 percentage point survival difference. Third, patients "discharged", including inpatient deaths, without revascularization are less likely to survive during the first hospital day even controlling for other factors, and increasingly less likely to survive compared to revascularized patients through 2.5 years. Clearly, having one of the two cardiac revascularization procedures substantially improves the survival for beneficiaries with ischemic heart failure regardless of race. As noted in the multinomial analysis of revascularization in Chapter 6, patients are "selected" to some degree for CABG or PTCA based on expected benefits; hence, the survival gap between CABG, PTCA, and Medical Management in Figure 7-3 is somewhat overstated.

[12] Although both Model 3 and the stratified model control for the effects of CABG and PTCA, the stratified model is preferable because differences in survival by treatment group can be explored.

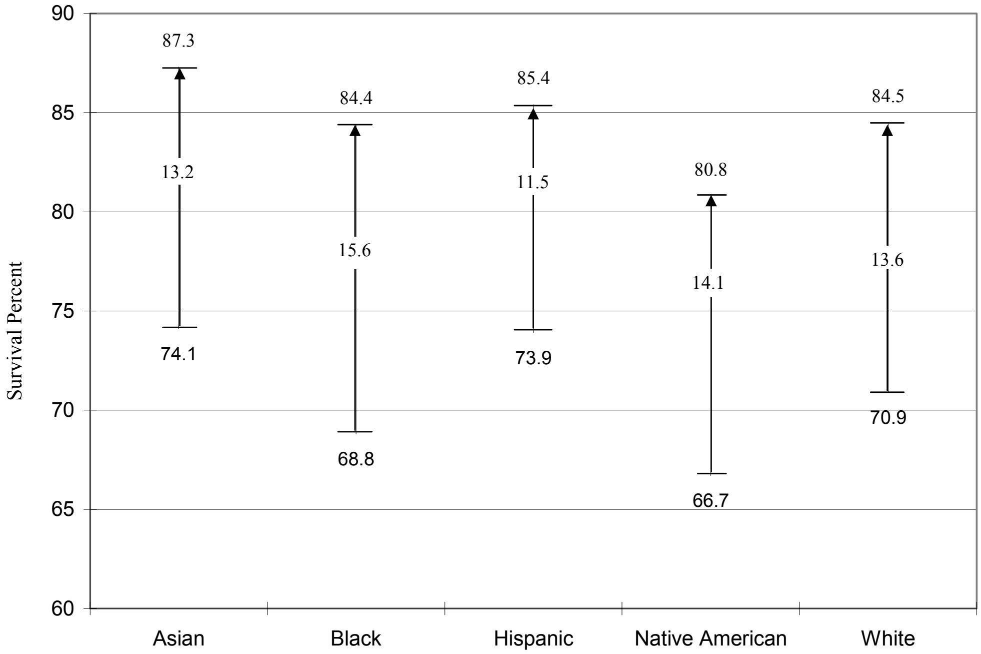
7.3.5 Racial/Ethnic Differences in Survival

The set of Cox proportional hazards regression models reveal that observed differences in survival between whites and each of the four ethnic/racial groups are almost exclusively due to factors other than race. Yet, so far we have not allowed the hazard ratios of individual explanatory variables to vary by race. In addition to the regressions presented, we also ran separate regression models for each race, thereby allowing the coefficients for each explanatory variable to differ by race. These models included the same explanatory variables as models 2, 3, and 4 described above and, like model 4, were stratified by treatment group. The hazard ratios for all of the explanatory variables within each race are similar in size to the hazard ratios shown in the three pooled models in Table 7-9 (see Appendix 7.C for the results). The fully adjusted survival rates for each race-specific model on day 1 of admission and at 2.5 years appear in Table 7-10. For all beneficiaries, the survival rate is 98 percent during the first day of admission versus 87.5 percent after 2.5 years, controlling for the sociodemographic factors, comorbidities, severity upon admission, diagnostic procedures, and revascularization procedures. The 2.5-year adjusted survival rates range from 80.8 percent for Native Americans to 87.3 percent for Asians. Among the other groups, the adjusted survival rates were within three percentage points. The survival rates between blacks and whites differed by just .1 percent, indicating that the observed disparity in survival between blacks and whites disappears once other health-related factors are considered.

For only those beneficiaries undergoing by-pass surgery, whites were slightly more likely to survive (93.4 percent) than the other groups, even after adjusting for the included factors (see Table 7-10 CABG – After 2.5 years). Among all beneficiaries receiving PTCA, whites were slightly more likely to survive (90.6 percent) than blacks (89.6 percent), and slightly less likely than Asians (92 percent) or Hispanics (89.0 percent) controlling for the factors discussed previously. (The small sample size for Native Americans did not allow us to estimate adjusted survival percents within the revascularization procedure groups.) In the medical management treatment group, on the other hand, whites were slightly less likely to survive compared to all race/ethnic groups accept for Native Americans.

Figure 7-4 compares the observed (unadjusted) survival percents from Table 7-8 to the adjusted percents for each race/ethnic group from Table 7-10. The difference in the observed and adjusted survival percents were largest among blacks, at 15.6 (84.4 – 68.8) percentage points, and smallest among Hispanics, at 11.5 (85.4 – 73.9) percentage points. Among minorities, blacks experience the largest health differences compared to whites. Adjusting for poorer health upon admission explains essentially all of the initial gap in survival rates for blacks.

Figure 7-4
Differences in Unadjusted and Adjusted Survival Rates 2-2.5 Years Following IHD Index Admission by Race for Medicare Beneficiaries, 1997



NOTES: All rates are based on Cox proportional hazards regression models for each race/ethnicity. Adjusted survival rates are adjusted for sociodemographic factors, comorbidities, severity upon admission, diagnostic testing, and revascularization procedure.

SOURCE: RTI/HER analysis of 1997-1999 100% Denominator and MedPAR files.

7.4 Summary of Findings

Summarizing, first, the descriptive results that adjust for age, gender, race, and income:

- 6 percent of IHD patients died in the hospital on their first admission in 1997.
- 8 percent of IHD patients died within 30 days of their first admission, a rate that increased to 11 percent within 3 months and to nearly 18 percent within one year.
- IHD death rates rise sharply with age and nearly 40 percent of the over-85 patients die within one year of their first admission in the year.
- Blacks and whites have essentially identical 30-day death rates for their first IHD admissions but after one year 20 percent of blacks die versus only 17.4 percent of whites.
- Hispanic mortality differs markedly from other minorities in that their 30-day death rate is one full percentage point below whites, a difference that persists after one year.
- Female death rates are one percentage point lower than males after one year but are essentially equal after the first 30 days post-discharge.
- Nearly one-half of IHD patients with comorbid ESRD die within one year of their first IHD admission compared to only 18 percent of IHD discharges without ESRD.
- Beneficiaries living in the top median income quartile of zip codes exhibit significantly lower death rates than those living in the poorest quartile.
- Higher survival rates in the top income quartile are consistent across all race/ethnic groups but are far less significant for females than males.

Summarizing, next, the multivariate logistic results for race/ethnic differences based on the likelihood of dying within 30 days or one year:

- No difference is found in the 30-day death rate for aged Medicare blacks compared to whites before controlling for age or other factors. Blacks are 14 percent more likely to die within one year, however.

- Hispanics are over 20 percent less likely to die than whites at 30 days post-discharge, a difference that remains relatively constant through one year.
- Asians and Native Americans exhibit slightly lower, but statistically insignificant, death rates than whites before any adjustments.
- Revascularization reduces the aged Medicare beneficiary's likelihood of dying within one year by roughly 50 percent controlling for prior and admission severity, age, and other variables.
- Aged Medicare blacks increase their likelihood of dying within 30 days or one year by roughly 8 percentage points by their lower rates of diagnostic angiography and revascularization.
- Mortality rates are 8 percent lower 30 days post-discharge from a major teaching hospital. Any protective effects, however, disappear after one year.
- Living in a low income zip code area increases 1-year mortality by 5 percent even after controlling for health status and age.
- Dual Medicare/Medicaid eligibles are more likely to die because they undergo revascularization less often even after controlling for health status. The same is true of the over-75 IHD patients as well as blacks.

Summarizing, last, the results from the 2.5-year survival curve analyses:

- Unadjusted survival rates varied from a low of 68 percent for blacks to a high of 74 percent for Hispanics with white rates equal to 71 percent.
- Adjusting for demographic characteristics, prior admission severity, and angiography, results in equivalent survival rates for blacks and whites.
- Patients undergoing either PTCA or CABG were more likely to survive than those with just medical management after controlling for health status and age.
- Survival rates are lower for CABG patients up to six months post-discharge compared to PTCA, but after six months, CABG survivors fair slightly better than PTCA patients.

After controlling for numerous demographic and health status indicators, we find that blacks have an equivalent likelihood of surviving to whites at any time during the analysis period. This somewhat surprising finding is consistent with the findings of Chen, *et al.* (2001), who also found adjusted mortality rates among blacks to be lower than whites in a Medicare FFS population (Chen, 2001), and with Peterson, *et al.* (1994), who investigated mortality between blacks and whites in a veterans population. Findings differ from a study of patients with ischemic heart disease treated at a large teaching hospital (Peterson, 1997), who found black mortality to be higher than for whites even after adjusting for prognostic (including anatomy) and demographic characteristics. The patient population in that study comprised both elderly and non-elderly individuals. Peterson (1994) also hypothesized that blacks reaching the teaching hospital may represent "healthy survivors" or that the progression of heart disease may be different between blacks and whites. Our study also differs from Peterson in using national Medicare admissions to thousands of hospitals with different diagnostic and treatment capabilities.

Table 7-1

Mortality Rates (in percent) of IHD Patients from their Index Admission through One Year[1] by Age, Gender, and Race/Ethnicity: 1997

	All Ages		
	Total (age/sex adjusted)		
Race/Ethnicity	30-day	90-day	One-Year
Total (race adjusted)	8.0	10.9	17.7
White	8.0	10.9	17.4
Black	7.9 *	11.4 *	20.1 *
Asian	8.5	11.6	17.6
Hispanic	7.0 *	9.8 *	16.4 *
Native American	8.6	12.4	20.5
Other	8.7 *	11.9 *	19.08 *

NOTES:
[a]Based on age as of December 31, 1997.
[1] Intervals based on number of days following the index admission.
NR = Not statistically reliable.
* Statistically significant difference at the .01 level compared to whites.
† Statistically significant difference at the .01 level compared to men.

SOURCE: RTI/HER analysis of 1997-1999 100% Denominator and MedPAR files.

Table 7-2

Mortality Rates (in percent) of AMI Patients from their Index Admission through One Year[1] by Age, Gender, and Race/Ethnicity: 1997

All Ages

Race/Ethnicity	Total (age/sex adjusted) 30-day	Total (age/sex adjusted) 90-day	Total (age/sex adjusted) One-Year	Men (age adjusted) 30-day	Men (age adjusted) 90-day	Men (age adjusted) One-Year	Women (age adjusted) 30-day	Women (age adjusted) 90-day	Women (age adjusted) One-Year
Total (race adjusted)	17.1	21.6	30.1	16.6	21.1	29.7	17.6 †	22.1 †	30.7 †
White	17.1	21.4	29.7	16.6	20.9	29.2	17.5 †	21.9 †	30.2 †
Black	17.2	22.9 *	34.2 *	16.3	22.2 *	34.1 *	17.8 †	23.4 * †	34.4 *
Asian	18.6	24.0	32.3	16.8	22.2	30.7	20.0	25.3	34.0
Hispanic	17.1	21.8	31.2	15.3	20.2	29.5	18.3	22.9	32.5
Native American	17.1	23.8	32.9	20.1	25.4	35.8	15.1	22.7	31.1
Other	18.8 *	24.1 *	33.14 *	17.2	22.3	31.4	19.9	25.5 *	34.5 *

Ages 65-74[a]

Race/Ethnicity	Total (sex adjusted) 30-day	Total (sex adjusted) 90-day	Total (sex adjusted) One-Year	Men 30-day	Men 90-day	Men One-Year	Women 30-day	Women 90-day	Women One-Year
Total (race adjusted)	12.3	15.5	21.7	11.2	14.1	20.0	13.1 †	16.4 †	22.8 †
White	12.2	15.1	21.0	11.1	13.8	19.4	12.9 †	16.1 †	22.2 †
Black	13.5 *	18.0 *	27.1 *	12.7 *	17.1 *	26.3 *	14.1	18.6 *	27.6 *
Asian	15.0	19.2	26.4	11.7	16.3	21.7	17.3	21.3	29.7 *
Hispanic	13.8	17.2	25.6 *	12.4	15.7	22.7	14.7	18.2	27.7 *
Native American	17.2	22.7	30.9	17.9	21.4	29.5	16.7	23.6	31.9
Other	13.1	17.0	23.6	11.0	13.9	20.5	14.6	19.0	25.7

Table 7-2 (Continued)

Mortality Rates (in percent) of AMI Patients from their Index Admission through One Year[1] by Age, Gender, and Race/Ethnicity: 1997

	Ages 75-84[a]								
	Total (sex adjusted)			Men			Women		
Race/Ethnicity	30-day	90-day	One-Year	30-day	90-day	One-Year	30-day	90-day	One-Year
Total (race adjusted)	19.5	24.6	34.3	19.0	24.3	34.3	19.8 †	24.8 †	34.3
White	19.5	24.5	34.0	19.1	24.3	34.0	19.8 †	24.7	33.9
Black	18.4 *	24.4	37.3 *	17.1	23.6	36.8 *	19.3	25.1	37.6 *
Asian	20.1	25.1	34.0	19.7	25.0	34.1	20.4	25.2	34.0
Hispanic	18.0	22.2	32.0	16.1	20.4	31.9	19.3	23.5	32.1
Native American	17.0	23.0	34.0	24.1	31.5	44.4	12.2 NR	17.1 NR	26.8
Other	23.6	29.7	40.0	22.6	29.4	39.9	24.2	29.9 *	40.2 *

	Ages 85+[a]								
	Total (sex adjusted)			Men			Women		
Race/Ethnicity	30-day	90-day	One-Year	30-day	90-day	One-Year	30-day	90-day	One-Year
Total (race adjusted)	29.8	38.0	52.4	30.5	39.2	54.3	29.2 †	37.1 †	51.1 †
White	30.0	38.0	52.3	31.0	39.4	54.3	29.4 †	37.0 †	51.0 †
Black	27.9 *	37.5	54.0	28.0	38.1	56.7	27.8	37.1	52.2
Asian	28.9	39.6	52.6	28.6	37.8	56.3	29.1	40.9	50.0
Hispanic	27.2	38.2	50.7	24.1	37.0	49.1	29.4	39.0	51.9
Native American	17.5 NR	29.9	38.3	18.8 NR	25.0 NR	37.5 NR	16.7 NR	33.3 NR	38.9 NR
Other	28.2	37.4	52.4	26.9	35.7	51.4	29.1	38.6	53.2

NOTES:
[a]Based on age as of December 31, 1997.
[1] Intervals based on number of days following the index admission.
NR = Not statistically reliable.
* Statistically significant difference at the .01 level compared to whites.
† Statistically significant difference at the .01 level compared to men.

SOURCE: RTI/HER analysis of 1997-1999 100% Denominator and MedPAR files.

Table 7-3

Mortality Rates (in percent) of IHD Patients with ESRD from their Index Admission through One Year[1] by Age, Gender, and Race/Ethnicity: 1997

	All Ages								
	Total (age/sex adjusted)			Men (age adjusted)			Women (age adjusted)		
Race/Ethnicity	30-day	90-day	One-Year	30-day	90-day	One-Year	30-day	90-day	One-Year
Total (race adjusted)	12.5	20.7	45.7	12.4	20.2	44.7	12.6	21.2	46.3
White	12.5	20.9	46.3	12.4	20.5	45.1	12.6	21.2	47.0
Black	12.1	19.6	42.2	12.2	18.4	43.5	12.2	20.3	41.4
Asian	16.9	24.2	44.3	15.7	22.4	46.1	18.6	26.4	45.7
Hispanic	11.2	18.3	36.5	8.7	13.1	33.7	11.8	20.2	37.7
Native American	21.5 NR	35.1	38.8	37.2 NR	50.8	54.8	10.3 NR	24.0	27.4
Other	11.4	18.1	39.51	8.9 NR	15.2	35.1	13.4	20.3	42.7

	Ages 65-74[a]								
	Total (sex adjusted)			Men			Women		
Race/Ethnicity	30-day	90-day	One-Year	30-day	90-day	One-Year	30-day	90-day	One-Year
Total (race adjusted)	11.0	18.5	40.6	10.5	17.3	39.4	11.2	19.2	41.4
White	10.9	18.5	41.1	10.6	17.5	40.0	11.1	19.2	41.9
Black	10.8	17.8	37.1	9.6	16.2	36.9	11.6	18.8	37.3
Asian	18.3	29.4	44.9	12.1 NR	21.2 NR	30.3	22.5 NR	35.0	55.0
Hispanic	8.4	12.4	31.3	8.4	11.5	31.3	8.4	13.0	31.3
Native American	27.5 NR	27.5 NR	34.6	38.5 NR	38.5 NR	46.2 NR	20.0 NR	20.0 NR	26.7 NR
Other	10.8	16.3	33.5	9.3 NR	13.3 NR	30.7	11.8 NR	18.4	35.5

Table 7-3 (Continued)

Mortality Rates (in percent) of IHD Patients with ESRD from their Index Admission through One Year[1] by Age, Gender, and Race/Ethnicity: 1997

	Ages 75-84[a]								
	Total (sex adjusted)			**Men**			**Women**		
Race/Ethnicity	30-day	90-day	One-Year	30-day	90-day	One-Year	30-day	90-day	One-Year
Total (race adjusted)	13.1	21.5	47.3	13.4	22.0	46.9	12.9	21.2	47.6
White	13.0	21.6	48.0	13.3	22.1	47.3	12.9	21.3	48.5
Black	14.1	20.9	42.4	15.1	21.9	46.1	13.4	20.1	39.8 *
Asian	21.2	25.9	47.0	22.9 NR	28.6	57.1	20.0 NR	24.0 NR	40.0
Hispanic	8.5 NR	17.6	38.1	12.5 NR	20.8	37.5	5.8 NR	15.4 NR	38.5
Native American	20.4 NR	20.4 NR	20.4 NR	50.0 NR	50.0 NR	50.0 NR	0.0 NR	0.0 NR	0.0 NR
Other	11.5 NR	19.7	45.9	4.0 NR	16.0 NR	36.0	16.7 NR	22.2 NR	52.8

	Ages 85+[a]								
	Total (sex adjusted)			**Men**			**Women**		
Race/Ethnicity	30-day	90-day	One-Year	30-day	90-day	One-Year	30-day	90-day	One-Year
Total (race adjusted)	17.0	27.6	60.7	16.6	26.3	59.0	17.3	28.5	61.8
White	17.5	28.2	61.2	17.0	27.7	59.1	17.8	28.5	62.6
Black	12.8	22.7	61.1	14.7 NR	17.6 NR	61.8	11.5 NR	26.2	60.7
Asian	4.5 NR	4.5 NR	46.6 NR	11.1 NR	11.1 NR	77.8	0.0 NR	0.0 NR	25.0 NR
Hispanic	23.7 NR	35.5 NR	49.1 NR	0.0 NR	0.0 NR	33.3 NR	40.0 NR	60.0 NR	60.0 NR
Native American	0.0 NR	100.0 NR	100.0 NR	0.0 NR	100.0 NR	100.0 NR	n/a	n/a	n/a
Other	14.7 NR	21.3 NR	46.7 NR	20.0 NR	20.0 NR	50.0 NR	11.1 NR	22.2 NR	44.4 NR

NOTES:
[a]Based on age as of December 31, 1997.
[1] Intervals based on number of days following the index admission.
NR = Not statistically reliable.
* Statistically significant difference at the .01 level compared to whites.
† Statistically significant difference at the .01 level compared to men.

SOURCE: RTI/HER analysis of 1997-1999 100% Denominator and MedPAR files.

Table 7-4

Mortality Rates (in percent) of IHD Patients from their Index Admission through One Year[1] by Gender, Race/Ethnicity, and Median Income

	Total[2]	White	Black	Asian	Hispanic	Native American
30-Day Mortality Rates						
Men						
Total (income adjusted)	**7.6**	**7.7**	**6.9**	**8.0**	**5.9**	**12.0**
Income Groups[3]						
Lowest Quartile	8.3	8.2	8.6	9.0	7.4	9.5
2nd Quartile	8.0 *	8.1	7.8	6.8	5.6	13.2 NR
3rd Quartile	7.4 *	7.6 *	6.0 *	9.6	5.7	6.5 NR
Top Quartile	6.8 *	7.0 *	5.6 *	6.7	5.3	18.2 NR
Women						
Total (income adjusted)	**8.9**	**9.0**	**7.4**	**8.9**	**6.3**	**7.3**
Income Groups[3]						
Lowest Quartile	9.0	9.1	8.4	9.4	6.5	6.8
2nd Quartile	9.1 *	9.3	7.5	7.7	6.8	9.8 NR
3rd Quartile	8.8 *	9.0	6.4 *	10.6	7.3	13.3 NR
Top Quartile	8.6 *	8.8	7.2	8.0	4.7	0.0 NR
90-Day Mortality Rates						
Men						
Total (income adjusted)	**10.6**	**10.5**	**10.5**	**11.3**	**8.6**	**14.1**
Income Groups[3]						
Lowest Quartile	11.4	11.3	12.5	14.3	9.9	12.2
2nd Quartile	11.1 *	11.0	12.0	9.5	8.6	15.8
3rd Quartile	10.3 *	10.4 *	9.3 *	12.3	8.1	9.7
Top Quartile	9.5 *	9.6 *	8.8 *	9.7	8.0	18.2
Women						
Total (income adjusted)	**12.0**	**12.1**	**10.7**	**12.0**	**8.7**	**11.6**
Income Groups[3]						
Lowest Quartile	12.0	12.0	11.7	12.5	8.8	10.7
2nd Quartile	12.1 *	12.3	10.4	11.0	10.1	17.1
3rd Quartile	12.0 *	12.2	9.9 *	14.0	9.1	20.0
Top Quartile	11.8 *	12.0	10.9	10.6	6.8	0.0

Table 7-4 (Continued)

Mortality Rates (in percent) of IHD Patients from their Index Admission through One Year[1] by Gender, Race/Ethnicity, and Median Income

	One Year Mortality Rates					
	Men					
	Total[2]	White	Black	Asian	Hispanic	Native American
Total (income adjusted)	**17.4**	**17.1**	**19.9**	**18.1**	**14.8**	**24.7**
Income Groups[3]						
Lowest Quartile	18.6	18.3	22.2	22.4	16.8	18.6
2nd Quartile	18.0 *	17.7 *	21.2	15.8	16.1	26.3
3rd Quartile	17.0 *	16.9 *	18.8 *	18.6	14.1	25.8 NR
Top Quartile	16.0 *	15.8 *	17.8 *	16.3	12.7	27.3 NR
	Women					
	Total[2]	White	Black	Asian	Hispanic	Native American
Total (income adjusted)	**19.1**	**19.2**	**18.7**	**17.3**	**14.6**	**16.7**
Income Groups[3]						
Lowest Quartile	18.9	18.9	19.9	18.1	15.9	18.1
2nd Quartile	19.1 *	19.3	18.2 *	13.7	15.2	24.4
3rd Quartile	18.9 *	19.1	17.7 *	20.7	14.0	26.7 NR
Top Quartile	19.3 *	19.5 *	19.1	16.5	13.5	0.0 NR

NOTES:

[1]Intervals based on number of days following the index admission.

[2]Race adjusted.

[3]Income distribution:

Bottom quartile - income <= $21,073.62; 2nd quartile - $21,073.62 < income <= $26,757.5;
3rd quartile - $26,757.5 < income <= $35,686.7; Top quartile - income > $35,686.7.

* Statistically significant difference at the .01 level compared to the lowest quartile.

SOURCE: RTI/HER analysis of 1997-1999 100% Denominator and MedPAR files.

Table 7-5

Description of Variables Used in the Mortality Multivariate Analyses and Mean Values

Independent Variable	Description	Mean
All variables are equal to 1 if the condition is met, otherwise it equals 0 unless otherwise indicated.		
Demographic and SES variables		
Black	Patient was black	0.063
Asian	Patient was Asian	0.006
Hispanic	Patient was Hispanic	0.014
Native American	Patient was Native American	0.001
Age 75 to 84	Patient was 75-84 years of age	0.402
Age 85 and older	Patient was 85 years of age or older	0.136
Male	Patient was male	0.51
Rural	Patient lives in a rural area	0.289
Dual Medicaid/Medicare	Patient was dually enrolled in Medicaid the month of their IHD admission	0.129
Low Income Zip Codes	Patient lived in a low income zip code as measured by median income in the lowest quartile	0.252
Family Problem	Family history of housing, household, economic or psychosocial circumstances	0.0007
Comorbidity At Time of Admission		
Charlson Index	A weighted sum of previous diagnoses (occuring within 6 months of index admission) including prior myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, senile and presnile organic psychotic conditions, chronic pulmonary diseases, rheumatologic disease, peptic ulcer disease, mild liver disease, diabetes without organ manifestations, diabetes with chronic complications, hemiplegia or paraplegia, chronic renal failure, any malignancy, including leukemia and lymphoma, but excluding skin cancer, moderate of severe liver disease, secondary malignant neoplasm of lymph nodes and other organs, and AIDS	1.81
ER	Admission from the Emergency Department	0.56
Severity During Admission		
AMI	Patient was admitted with principal diagnosis of AMI	0.356
Unstable Angina	Patient was admitted with principal diagnosis of unstable angina	0.112
Arrhythmias, Imbalnce, Pneumonia, Stroke	Significant (potentially life-threatening arrhythmias during hospitalization), acute bout of fluid, electrolyte or acid-base imbalance, viral or bacterial pneumonia, stroke (occlusive or hemorrhagic)	0.219
Cardiac Arrest/Cardiogenic Shock	Cardiac Arrest or Cardiogenic Shock	0.036
Vas. Rupture, CHF, Renal Failure	Rupture of vascularture, Congestive Heart Failure, Acute renal failure, including nephritis, with no previous history of renal disease	0.148
CV Hemo support, ICU, Consults	Non-imaging CV Hemodynamics: Arterial or Venous Central Line for Pressure Monitoring, including Swan-Ganz and EJ with probe technique, Admission to an ICU, or Neurology, Renal, Respiratory, Infectious Disease Consult	0.377
Hospital Characteristics		
COTH	Member of the Council of Teaching Hospitals	0.183
OTEACH	Other teaching hospital	0.2
CCU	Cardiac Care Unit	0.865
OPENHRT	Provides Open Heart Surgery Services	0.55

Table 7-5 (continued)

Description of Variables Used in the Mortality Multivariate Analyses and Mean Values

Independent Variable	Description	Mean
All variables are equal to 1 if the condition is met, otherwise it equals 0 unless otherwise indicated.		
Procedures During Index Admission		
Catheterization/Angiography, Stress Test	Right or Left Heart Catheterization and/or Selective venous and/or arterial angiography with or without catheterization Treadmill or Bicycle Stress Test or pharmacological stress, Ergonovine Provocation Test	0.558
Echocardiogram, Holter, Imaging, Cardiology Consult	2D or M-mode echocardiogram, Doppler echo or color velocity flow mapping Telephonic transmission of post-symptom ECG strips, Patient demand single or multiple event recording, Single averaged ECG, or ECG Monitoring for 24 Cardiac MRI, CT of Thorax, Myocardial Perfusion and Imaging, Cardiac blood pool imaging, nuclear medicine blood flow c-vhemodynamics and cardiac shunt detection, and assessment of cardiac output by electrical bioimpedence Consult with Cardiologist	0.814
CABG	Coronary Artery Bypass Graft	0.181
PTCA	Percutaneous single or multiple vessel balloon angioplasty, percutaneous single or multiple vessel stent, or percutaneous single or multiple vessel atherectomy	0.233

SOURCE: RTI/HER analysis of 1997-1999 100% Denominator and MedPAR files.

Table 7-6

Multivariate Logistic Regression Analysis of Mortality Within 30 Days of Admission for Ischemic Heart Disease for Medicare Aged Beneficiaries

Parameter	Model 1		Model 2		Model 5		Model 6	
	Odds Ratio	p≤	Odds Ratio	p≤	Odds Ratio	p≤	Odds Ratio	p≤
Sociodemographic								
Black	0.98		0.95	*	0.85	***	0.77	***
Asian	0.96		0.93		0.86		0.87	
Hispanic	0.79	***	0.81	***	0.81	***	0.84	**
Native American	0.90		0.96		0.77		0.71	
Age 75 to 84			1.96	***	1.83	***	1.56	***
Age 85 and older			4.14	***	3.75	***	2.28	***
Male			1.07	***	0.99		1.02	
Rural			1.04	**	1.09	***	1.06	***
Dual Medicaid/Medicare			1.26	***	1.21	***	1.05	**
Low Income Zip Code			1.04	**	1.07	***	1.05	**
Family Problem			1.75	***	1.69	**	1.50	*
Comorbidity								
Severity During Admission								
Hospital Characteristics								
Procedures								
Catheterization/Angiography, Stress Test							0.42	***
Echocardiogram, Holter, Imaging, Cardiology Consult							0.53	***
CABG							0.62	***
PTCA							0.50	***
Number of Cases	336,301		336,301		335,259		335,259	
Chi-Square (p<)	0		53	***	292	***	208	***

NOTES: * p<0.10; ** p<0.05; *** p<0.01

SOURCE: RTI/HER analysis of 1997-1999 100% Denominator and MedPAR files.

Table 7-7

Multivariate Logistic Regression Analysis of Morality within One Year after Admission for Ischemic Heart Disease for Medicare Aged Beneficiaries

	Model 1		Model 2		Model 5		Model 6	
Parameter	Odds Ratio	p≤	Odds Ratio	p≤	Odds Ratio	p≤	Odds Ratio	p≤
Sociodemographic								
Black	1.14	**	1.07	***	0.94	***	0.86	***
Asian	0.96		0.87	**	0.88	*	0.87	*
Hispanic	0.83	***	0.79	***	0.77	***	0.78	***
Native American	1.00		1.04		0.90		0.85	
Age 75 to 84			2.05	***	1.91	***	1.69	***
Age 85 and older			4.79	***	4.41	***	2.94	***
Male			1.14	***	1.08	***	1.14	***
Rural			0.98	**	1.01		1.00	
Dual Medicaid/Medicare			1.45	***	1.30	***	1.15	***
Low Income Zip Code			1.05	**	1.07	***	1.06	***
Family Problem			1.67	***	1.46	**	1.32	
Comorbidity								
Severity During Admission								
Hospital Characteristics								
Procedures								
Catheterization/Angiography, Stress Test							0.51	***
Echocardiogram, Holter, Imaging, Cardiology Consult							0.79	***
CABG							0.42	***
PTCA							0.53	***
Number of Cases	336,301		336,301		335,259		335,259	
Chi-Square (p<)	0		124	***	291	***	103	***

NOTES: * p<0.10; ** p<0.05; *** p<0.01

SOURCE: RTI/HER analysis of 1997-1999 100% Denominator and MedPAR files.

Table 7-8

Unadjusted Estimated Survival Rates Upon Admission, 2 - 2.5 years following IHD Index Admission for Medicare Beneficiaries, by Race and Revascularization Treatment, 1997

	White	Asian	Black	Hispanic	Native American
All Treatments					
Upon Admission	94.3%	93.6%	93.9%	95.1%	94.4%
After 2-2.5 Years	70.9	74.1	68.8	73.9	66.7
After 2-2.5 Years by Treatment Group					
CABG					
PTCA	85.9	83.1	79.7	83.2	80.4
Medical Management	62.6	67.3	63.7	70.8	65.9

NOTES:
1. PTCA, CABG, other Medical Management groups are based on assigning patients to one type of intervention; patients receiving CABG and PTCA are in both groups.
2. Survival rates are estimated from Cox proportional hazards regression models for each race/ethnic group. Survival rates are unadjusted for age, comorbidity, or other factors.

SOURCE: RTI/HER analysis of 1997-1999 100% Denominator and MedPAR files.

Table 7-9

Multivariate Cox Proportional Hazards Regression Analysis of Survival within 2.5 years Following Admission for Ischemic Heart Disease for Medicare Beneficiaries, 1997

	Model 1		Model 2		Model 3	
Parameter	Hazard Ratio	p<	Hazard Ratio	p<	Hazard Ratio	p<
Sociodemographic						
Black	1.17	***	0.96	***	0.92	***
Asian	0.90	**	0.85	***	0.84	***
Hispanic	0.87	***	0.84	***	0.83	***
Native American	1.06		0.94		0.90	
Age 75 to 84			1.63	***	1.56	***
Age 85 and older			2.54	***	2.33	***
Male			1.10	***	1.13	**
Rural			0.99		0.98	**
Dual Medicaid/Medicare			1.19	***	1.15	***
Low Income Zip Code			1.04	***	1.04	***
Family Problem			1.13		1.10	
Comorbidity						
Severity During Admission						
Diagnostic Procedures						
Catheterization/Angiography, Stress Test			0.50	***	0.59	***
Echocardiogram, Holter, Imaging, Cardiology Consult			0.84	***	0.84	***
Revascularization Procedures						
CABG					0.45	***
PTCA					0.59	***
Number of Cases	336,301		336,301		336,301	

NOTES: * p<0.10; ** p<0.05; *** p<0.01

SOURCE: RTI/HER analysis of 1997-1999 100% Denominator and MedPAR files.

Table 7-10

Adjusted Survival Rates Upon Admission and 2-2.5 Years Following IHD Index Admission for Medicare Beneficiaries, by Race/Ethnicity and Revascularization Treatment, 1997

	Race/Ethnicity-Specific Models					
	Asian	Black	Hispanic	Native American	White	**All Beneficiaries**
Unstratified Models						
All Treatments						
Upon Admission	97.8%	98.0%	97.9%	97.8%	97.8%	98.2%
After 2.5 years	87.3	84.4	85.4	80.8	84.5	87.5
Stratified Models						
CABG						
Upon Admission	97.5	98.4	97.6	99.1	98.7	98.7
After 2.5 years	93.0	91.4	92.7	-	93.4	93.2
PTCA						
Upon Admission	99.3	99.1	98.7	98.9	99.0	98.9
After 2.5 years	92.0	89.6	89.0	-	90.6	90.5
Medical Management						
Upon Admission	98.0	98.0	98.2	97.7	97.8	97.8
After 2.5 years	86.9	84.4	85.3	80.6	84.3	84.2

SOURCE: RTI/HER analysis of 1997-1999 100% Denominator and MedPAR files.

8 Race/Ethnic Differences in Index/Transfer Revascularization and Choice of Hospital

8.1 Introduction

Previous chapters have focused on risk factors prior to the patient's first 1997 admission and subsequent procedure rates and mortality. In this chapter we explore differences in revascularization rates among whites and minorities with special emphasis is given to the *pattern* of inpatient care upon first IHD admission versus any transfers. Are their systematic differences in diagnostic catheterization and PTCA/CABG rates across race/ethnic groups that widen (or narrow) once transfers to "tertiary" hospitals are taken into consideration? The chapter's last sections investigate differences, if any, in the teaching orientation and availability of open heart surgery in areas where whites, blacks, and other minorities reside.

All tables appear at the end of the chapater.

8.2 Revascularization Rates in Index and Transfer Admissions

The longitudinal Part A file of Medicare IHD admissions is well-suited to support studies of revascularization rates among racial/ethnic groups. Over 794,000 IHD index and transfer admissions from acute care hospitals are available for the year 1997.[1] These observations are linked by a unique patient identification number (HICNO). Angioplasty (PTCA) and heart bypass (CABG) rates are calculated for 6 racial/ethnic groups using the ICD9 codes on the MedPAR claims. Rates are then used to construct procedure decision diagrams, or flow charts (see Appendix 8.A), employing the following logic. When first admitted in 1997 with a primary diagnosis of IHD, we ask whether the patient underwent diagnostic catheterization? If yes, did the patient undergo PTCA, CABG, or neither (i.e., no revascularization, NOREVAS)? If no, did the patient still undergo PTCA or CABG? These 6 decision nodes, PTCA, CABG, or NOREVAS, with or without diagnostic catheterization, result in six possible transfer rates to another acute care facility within 24 hours of discharge. Once in a second facility, the same set of 6 decision nodes occur resulting in 36 possible revascularization rates (see Appendix 8.A). Because less than one-half of one percent of patients undergoing revascularization in their index admission were transferred, we consider only transfers for patients not revascularized during their first 1997 admission. Hence, 18 PTCA, CABG, NOREVAS endpoints are tracked in the model, six endpoints in the index admission plus another 12 among transferred patients who were initially “cathed” or not but not revascularized in their first (index) admission.

[1] In this report we analyze only immediate transfers along with index 1997 admissions. The longitudinal file will support extended analyses of multiple IHD admissions as a patient’s illness progresses.

8.2.1 Decomposition Model

These 18 decision nodes can be reduced to a set of 8 likelihood probability ratios that decompose a race/ethnic group's overall revascularization rate:

(8.1) REV/IA = [IC/IA] x [IREV/IC] + [INOC/IA] x [IREV/INOC] + [TRC/IA] x [TRREV/TRC] + [TRNOC/IA] x [TRREV/TRNOC] ,

where

REV/IA = the overall index + transfer revascularization rate based on IA index admissions,

[IC/IA], [INOC/IA] = the catheterization and non-cath rates for IA index admissions,

[IREV/IC], [IREV/INOC] = the PTCA+CABG revascularization rates for IC "cathed" and INOC "non-cathed" patients during their index admission,

[TRC/IA], [TRNOC/IA] = transfer rates for patients "cathed" and "non-cathed" patients during their index admission,[2] and

[TRREV/TRC], [TRREV/NTROC] = the PTCA+CABG revascularization rates during the transfer admission for "cathed" and "non-cathed" patients during their index admission.

The product of the first two right-hand-side ratios gives the revascularization rate for cathed patients during their index admission while the product of the second two ratios is the revascularization rate for non-cathed index admission patients. Added to

[2] These rates are the product of the index cath (or non-cath) rate times the probability of being transferred if not revascularized on the first admission.

these two “index” revascularization rates are corresponding “transfer” revascularization rates linked to whether the patient was cathed or not in their index admission.

8.2.2 Results

Table 8-1 presents the 8 rates from equation (8.1) along with the overall revascularization rate, including any transfers, in column (1), for the 6 racial/ethnic groups. None of the rates, which are based on counts from the claims file, are age-gender adjusted. Figures in parentheses below each group’s probability rates standardize them to the rates for whites. The table is interpreted as follows using whites and blacks as examples. The overall revascularization rate for whites was 42.5 percent during 1997. The overall revascularization rate for blacks was 25.7 percent, or only 60.5 percent that of whites. Once admitted in 1997, whites were cathed 42.6 percent of the time (and not catheterized 57.4%). When diagnostically cathed, whites underwent revascularization 57.6 percent of the time during the index admission versus 41.5 percent for blacks. Even when not cathed, whites were revascularized 14.9 percent of the time upon first admission. Columns 5-8 capture transfer frequencies and revascularization rates. Thus, 4.0 percent of whites were cathed then transferred without revascularization to another hospital where they underwent revascularization 92.5 percent of the time. Another 9.6 percent of whites who were transferred without being cathed underwent revascularization 59.3 percent of the time during their transfer admission. Based on Table 8-1 we can answer the following questions.

Are there systematic differences in overall revascularization rates across racial/ethnic groups?

Yes, a hierarchy exists with Asians and whites most likely to undergo revascularization, followed by Hispanics, then Native Americans, and lastly, blacks. The overall revascularization rate of blacks is only 60% of whites (= .257/.425). Blacks are even 17% less likely to undergo revascularization than Native Americans (=1- .257/.311), the group with the next lowest revascularization rate.

Are blacks less likely than whites to undergo revascularization because they are less likely to be diagnostically cathed or transferred to a facility where they are revascularized?

No. Referring to the standardized catheterization and revascularization rates for blacks in parentheses below their actual rates, we find that even when cathed during their index admission, blacks are only 72 percent (= .415/.576) as likely as whites to undergo revascularization. They are only half as likely as whites to be revascularized even without being cathed on their first admission. Moreover, even though blacks are less likely to be cathed and, hence, undergo revascularization on their index admission, they still are only 64 percent (= .061/.096) as likely to be transferred to a second facility even when not cathed at their first hospital (col. 7). One might have expected blacks to have higher transfer rates because they are less likely to be cathed on their first admission. And for those non-cathed blacks who are transferred, they are only 73 percent (= .433/.593) as likely as whites to undergo revascularization (col. 8).

Blacks are 17 percentage points (42.5%–25.7%) less likely to undergo revascularization than whites. Nine points of this difference is explained by lower revascularization rates after being cathed on their index admission;[3] another 4 points is explained by lower index revascularization rates when not cathed upon first admission; 3 points is explained by a lower likelihood of being transferred without an index admission cath and still not undergoing revascularization after transfer; and 1 point is due to a lower transfer rate when cathed at the first facility but simply discharged with no revascularization or transfer to another facility.

If blacks exhibited the same rate of diagnostic catheterization in their index admission as whites, would they undergo revascularization at the same overall rate as whites?

No. Substituting the index cath rates for whites into the black decomposition formula raises their overall revascularization rate to 29.8 percent, a 16 percent increase. This rate is still far below the 42.5 percent rate for whites.

Is the low revascularization pattern of Native Americans similar to that of blacks?

The pattern differs in two respects. Although both groups have similar cath rates upon first admission, Native Americans are then revascularized 51 percent of the time during the same admission compared to only 42 percent for blacks.[4] Second, Native Americans who are not cathed in their first admission are almost twice as likely to be

3 Determined as (.426) * (.576) – (.368) * (.415).

4 The Native American revascularization rate is higher than blacks even though they are less likely to be admitted to a teaching or open heart hospital compared to blacks (see Section 8.2 below).

transferred to another hospital as non-cathed blacks (11.8 versus 6.1 percent). Transfer revascularization rates of blacks and Native Americans are nearly identical.

How likely is it that whites compared to other racial/ethnic groups receive neither diagnostic catheterization nor revascularization on their index and transfer admissions?

Roughly 4-in-10 whites received neither diagnostic catheterization nor revascularization in their index and transfer admissions. As a generalization, whites, Asians, and Hispanics are similarly unlikely to undergo diagnostic cath revascularization. Blacks and Native Americans form a second group with "non-intervention" rates about 25 percent higher (i.e., roughly 5-in-10).

When revascularized, are minorities more inclined to undergo angioplasty instead of heart bypass compared to whites?

Yes, especially blacks and Native Americans. All race/ethnic groups are more inclined to undergo PTCA than open heart surgery (see Table 8-2). The greater likelihood of undergoing PTCA during the index admission ranges from a low of 1.21 (= 18.4/15.1) for whites to a high of 1.47 (=12.1/8.2) for blacks. Whites had PTCA 23.4 percent of the time (col. 3) on either their index or transfer admission versus CABG 19.6 percent of the time.

The dominance of PTCA over CABG declines when transfers are taken into consideration. This is particularly true of blacks and Native Americans. Their PTCA/CABG rate falls 6 to 9 percentage points when including transfers, suggesting that when they are transferred it is more often for open heart surgery. Even so, the overall

CABG rate for blacks (10.8%) and Native Americans (13.2%) is far lower than for whites and Asians (19.6%).

8.3 Disparities in Hospital Choice

8.3.1 Admission and Transfer Rates by Hospital Teaching Status

Table 8-3 presents admission and transfer rates to teaching hospitals with AMA residents by race/ethnic group. Column (1) gives total index admissions, defined as the first reported hospital a beneficiary was admitted to in 1997 with IHD as the primary reason for admission. Whites had 633,298 such admissions versus 846 for Native Americans. The total number of index admissions in 1997 reporting resident status was 700,343 with roughly 1 percent of unknown race/ethnic origin.[5]

Are blacks and other minorities less likely to be admitted to a teaching hospital?

No. Blacks are more likely to be directly admitted to a teaching hospital than whites or any other race/ethnic group. For example, blacks are directly admitted to teaching hospitals 44 out of every 100 admissions versus only 33 per 100 admissions for whites. Hispanics and Native Americans exhibit slightly lower index admission rates to teaching hospitals than whites.

[5] The total number of index admissions is slightly less than the 700,682 total index admissions because of non-reporting of AMA residents in a few hospitals.

After including transfers, do the disparities in admissions to teaching hospitals disappear among race/ethnic groups?

No. While it is true that whites (7.1%, col. 4) are more likely to be transferred in to a teaching facility versus blacks (5.6%), even including transfers the admission rate to teaching hospitals remains far higher for blacks, 50-in-100, see col. 6, than any other race/ethnic group. Hispanics not only show a relatively low likelihood of being directly admitted to a teaching hospital, 31-in-100 admissions, but they are least likely to then be transferred into a teaching facility. Native Americans exhibit the highest transfer rate from non-teaching to teaching facilities. After transfers, Native Americans and whites are almost equally likely to have been treated in a teaching hospital.

Table 8-4 presents admission and transfer rates to COTH (Council of Teaching Hospitals) by race/ethnic group. These are a smaller, more prestigious set of teaching hospitals in America.[6] Blacks remain far more likely to be directly admitted (col. 3) to a COTH hospital than whites or any other race/ethnic group. Whites, Asians, Hispanics, and Native Americans have similar admission rates to COTH facilities taking transfers into account.

8.3.2 Admission and Transfer Rates by Hospital Open Heart Surgery Status

Given that blacks are more likely than whites to be admitted for IHD care to teaching hospitals, are they also more likely to be admitted to hospitals offering open heart surgery?

[6] According to the AHA (AHA, 1994, Table 10a), there were 394 COTH members out of 1,197 hospitals with residency programs. Over half of COTH hospitals had at least 500 beds.

Surprisingly, No. Table 8-5 presents admission and transfer rates to hospitals offering or not offering open heart surgery. The results suggest a different admission/transfer pattern than one might expect from an analysis of teaching hospitals. Whites and blacks are directly admitted at equal rates (55%) to hospitals offering open heart surgery. This is in contrast to the 11 percentage point greater likelihood of blacks being directly admitted to teaching hospitals. This large discrepancy is explained by a much higher proportion of whites admitted to non-teaching hospitals that do offer open heart surgery.

When blacks are first admitted to a hospital without open heart surgery, they are less likely than whites to be transferred to an open heart facility (see col. 4). Over 13 percent of all white admissions to non-open heart hospitals are then transferred into an open heart facility versus only 8.9 percent of blacks.

Consequently, as a result of the high transfer rate of whites, nearly 7-in-10 (69%) eventually are admitted (col. 6) to a hospital with open heart services compared to only 64 percent of blacks. This is true in spite of blacks exhibiting a higher overall admission rate to teaching and COTH hospitals. These results are likely explained by two factors. First, many hospitals with residents do not offer open heart surgery. Blacks are more likely to be admitted to such facilities. Second, whites are more likely than blacks to be admitted to open heart surgery hospitals without any residents.

Which minority group is least likely to be admitted directly or through transfer, to an open heart hospital?

Only Native Americans have a lower likelihood than blacks of being directly admitted or transferred to a hospital offering open heart surgery (60 versus 64%; see col. 6). Upon first admission, Native Americans are 9 percentage points less likely than blacks to be treated in an open heart hospital, but the former have a much higher transfer rate to such facilities (col. 4) thereby more than halving the initial difference.

8.3.3 Disparities in Hospital Choice Controlling for Beneficiary Zip Code Residence

One explanation for why blacks may be more likely than whites to be first admitted to a teaching hospital is that they reside in zip codes in closer proximity to such facilities. In this analysis we seek to answer the question:

> *What if index admissions of blacks (and other minorities) were distributed across zip codes in the same proportion as whites? Would they still be more likely to be admitted to teaching and COTH facilities?*

To answer this question, we first calculated the proportion of index admissions to "specialty" hospitals (e.g., teaching, offering open heart surgery) by race/ethnic group for over 50,000 different zip codes. We next applied two sets of weights to the racial/ethnic admission rates in each zip code. The first set was simply each race/ethnic group's own number of admissions to specialty hospitals within each zip code. Except for minor differences due to missing zip codes, the resulting overall average (zip code) admission rates to specialty hospitals should be identical to an unweighted average when treating all admissions as unique observations. The second set of weights was the number of white admissions to specialty hospitals by zip code. Using white admission rates in each zip code controls for the possibility than minorities, and particularly blacks, may live disproportionately in zip codes with uniformly higher admission rates to specialty facilities.

A comparison of the admission rates is shown in Table 8-6. White rates of admission to COTH, teaching, CCU, and open heart hospitals are unaffected by which set of weights are used because the same set of weights are applied in both instances. For blacks, however, the weighting scheme has substantial effects. The 11 percentage point greater likelihood of blacks versus whites being first admitted to a teaching hospital is reduced to slightly over 2 percentage points when the white zip code distribution of admissions is used (col. 1 and 2). Moreover, the 10 point gap in COTH admission rates between whites and blacks is narrowed to 1.5 percentage points. And the nearly identical likelihood of blacks and whites being first admitted to an open heart hospital is replaced by roughly a 6 percentage point lower rate for blacks (col. 8).

Asians, Hispanics, and Native Americans show inconsistent effects of applying the set of white zip code admission rates. Were these groups distributed in zip codes where whites tend to live, they would be more likely to go to COTH and teaching hospitals, a result counter to the finding for blacks. Like blacks, however, the other minorities would all be less likely to go to an open heart hospital in their first 1997 admission.

Thus, beneficiary location does make a difference in the likelihood of minorities, and especially blacks, being admitted to a specialty hospital. If blacks were distributed nationally like whites, they would not be as likely to be admitted to teaching or open heart hospitals. This strongly suggests that blacks tend to live in areas served by teaching facilities or those providing open heart surgery.

8.4 Disparities in Travel Distances to COTH, CCU, and Open Heart Hospitals

Another approach to determining the effect of location on minority access to specialty hospitals is to measure average travel distances.

Do whites travel farther to their index admission hospital than minorities? More specifically, do whites travel farther when first admitted to teaching hospitals or facilities offering either CCU care or open heart surgery.

If transferred to a second facility, what is the increase in the patient's median travel distance? Do any racial/ethnic differences in travel distances observed for first admissions disappear when patients must travel to a second facility for specialized heart care?

To answer these questions, we determined the travel distance in linear miles from the patient's zip code of residence to that of their index and transfer hospitals. Distances were based on zip code latitude and longitude (see Appendix 8.B for how latitude and longitude were converted into miles). Hospital latitude and longitude were available from the CMS data files. Patient zip code location was made available by Lee Mobley at RTI from her work on another CMS project. Because of a few anomalous patient travel distances exceeding 5,000 miles, the final data set was limited to 250 miles for the index admission and 500 miles for any transfer admissions, thereby eliminating about 3-4 percent of the observations (and 20 or so zip codes). These travel maximums also delete cases where patients travel extraordinary distances for "centers of excellence" care (e.g., Mayo or Cleveland Clinic). The focus of this analysis is on distances patients "most likely have to travel" to find a hospital that can care for them. Median values were then used to avoid the distortions from highly skewed data.

Table 8-7 presents median linear travel distances by race/ethnic group for index and transfer admissions. Not surprisingly, blacks travel the fewest miles on average to their index hospital (4.5 miles).[7] Whites travel 60 percent farther than blacks on average (7.3 miles). Only Native Americans travel farther (14.3 miles) than whites to their first hospital.

All race/ethnic groups travel at least 2 to 3 times farther when first going to a COTH facility, and Native Americans actually travel 4 times farther, 57 miles, to a COTH hospital versus their more typical index hospital. Blacks still have the shortest travel distance to a prestigious COTH facility (less than 10 miles), which is less than half the distance for whites (22.4 miles).

The gap in travel distance between whites and blacks narrows considerably when first going to an open heart hospital. Whites on average need to travel only 1.5 miles more than blacks to reach an open heart hospital, implying that these hospitals are quite

[7] McClellan, et al., (1995) also found that black Medicare AMI patients were more likely than whites to live within 2.5 miles of a hospital offering diagnostic catheterization or revascularization.

accessible to whites and minorities alike--with the possible exception of Native Americans, 50 percent of whom must travel nearly 10 miles. It is also noteworthy that open heart facilities are generally more accessible, distance-wise, than are COTH teaching hospitals or even those with specialized CCUs. That COTH facilities involve longer travel distances than to open heart facilities is because COTH hospitals are only one-third as common. Longer travel to a CCU versus open heart may be explained by some open heart facilities not having a designated cardiac ICU, distinct from a general surgical ICU.

The median distance patients must travel when transferred ranges from a low of 9.6 miles for Asians to nearly 65 miles for Native Americans--a six-fold difference. Whites being transferred again travel farther than do blacks, Hispanics, or Asians. Transfers to an open heart hospital, while requiring about 2-3 times the travel compared to the first hospital, still require less travel than when transferred to COTH or CCU facilities.

Table 8-1

Likelihood of Revascularization during Index or Transfer Admission, by Racial/Ethnic Group, 1997

		Index Admission								Transfer Admission						
Racial/Ethnic Group	**Overall Revas Rates**	**Diagnostic Cath Rate**		**Revas Rate with Cath**		**Non-Cath Rate**		**Revas Rate Without Cath**		**Rate of Index Cath ADM Transferred**		**Revas Rate for Index Cath ADM**		**Rate of Non-Cath Index ADM Transferred**		**Revas Rate for Index Non-Cath ADM**
	IREV /IA	IC /IA	x	IREV /IC	+	INOC /IA	x	IREV /INOC	+	TRCA /IA	x	TREV /TRC	+	TRNOC /IA	x	TREV /TRNOC
		(1)	x	(2)	+	(3)	x	(4)	+	(5)	x	(6)	+	(7)	x	(8)
Whites	0.425	0.426 (1.00)		0.576 (1.00)		0.574 (1.00)		0.149 (1.00)		0.040 (1.00)		0.925 (1.00)		0.096 (1.00)		0.593 (1.00)
Blacks	0.257 (0.605)	0.368 (0.86)		0.415 (0.72)		0.632 (1.10)		0.076 (0.51)		0.032 (0.80)		0.898 (0.97)		0.061 (0.64)		0.433 (0.73)
Asians	0.431 (1.014)	0.446 (1.05)		0.597 (1.04)		0.554 (0.97)		0.167 (1.12)		0.030 (0.75)		0.951 (1.03)		0.071 (0.74)		0.603 (1.02)
Hispanics	0.373 (0.878)	0.441 (1.04)		0.553 (0.96)		0.559 (0.97)		0.113 (0.76)		0.025 (0.63)		0.913 (0.99)		0.077 (0.80)		0.561 (0.95)
Native Americans	0.311 (0.732)	0.351 (0.82)		0.509 (0.88)		0.649 (1.13)		0.085 (0.57)		0.030 (0.75)		0.880 (0.95)		0.118 (1.23)		0.431 (0.73)

NOTES:
1. Figures in parentheses are ratios of racial/ethnic-to-white rates.
2. Column headings correspond to eight variables defined in text.
3. Rates unadjusted for age, gender, or other risk factors.

SOURCE: Based on MedPAR claims for IHD admissions in 1997. PROGRAM: IG08V2

Table 8-2

PTCA versus CABG Revascularization Rates by Racial/Ethnic Group, 1997

Racial/Ethnic Group	**Index Use Rate**		**Transfer + Index Use Rate**		**Odds of PTCA v. CABG**	
	PTCA	CABG	PTCA	CABG	Index	Index + Transfer
Whites	18.4	15.1	23.4	19.6	1.21	1.19
Blacks	12.1	8.2	15.1	10.8	1.47	1.41
Asians	20.4	16.1	24.2	19.6	1.27	1.23
Hispanics	17.4	13.8	21.0	16.9	1.26	1.24
Native Americans	14.1	9.6	18.2	13.2	1.47	1.38
Unknown	16.6	12.7	20.6	16.9	1.30	1.22

NOTES: Index/Transfer rate including both index and transfer readmissions.
Rates include minor overlap from patients undergiong both PTCA and CABG.

SOURCE: Developed by 1997 MedPAR claims for IHD as primary reason for admission. PROGRAM: IGO8V2

Table 8-3

Percent of Admissions and Transfers to Teaching and Non-Teaching Hospitals, by Race/Ethnicity, 1997

			Teaching				Non-Teaching		
Race	Total Index Admissions	Index Transfer Rate	Index Admission Rate	Transfer Rate In	Transfer Rate Out	Index + Transfer Admission Rate	Index Admission Rate	Transfer Rate In	Transfer Rate Out
Whites	633,298	13.7%	33.0%	7.6%	5.8%	40.6%	67.0%	6.1%	17.6%
Blacks	44,216	9.4	44.4	5.6	5.0	50.1	55.6	3.8	13.0
Asians	4,014	10.2	36.9	5.8	5.9	42.7	63.1	4.4	12.7
Hispanics	9,865	10.3	31.1	4.7	4.7	35.8	68.9	5.5	12.0
Native Americans	846	15.0	31.1	9.9	6.8	41.0	68.9	5.1	18.5
Unknown	8,104	12.0	35.4	6.6	6.5	42.0	64.6	5.4	15.0

NOTES:
1. Transfer Rate In/Out: Percent of all IHD patients transferred in to, or out of, a resident teaching or non-resident facility.
2. Index + Transfer Admission Rate: Percent of all IHD patients either directly admitted or transferred to a resident facility. Includes a small percent of "double counted" patients transferred from one resident facility to another.
3. Index Transfer Rate: Percent of all index admissions that are transferred.
4. Total Index Admissions: Sum of first reported IHD admissions in 1997. Count varies slightly by hospital characterisitic due to non-reporting.

SOURCE: Developed from 1997 MedPAR claims for Ischemic Heart Disease diagnoses. PROGRAM: IG06.

Table 8-4

Percent of Admissions and Transfers to COTH and NON-COTH Hospitals, by Race/Ethnicity, 1997

			COTH				NON-COTH		
Race	Total Index Admissions	Index Transfer Rate	Index Admission Rate	Transfer Rate		Index + Transfer Admission Rate	Index Admission Rate	Transfer Rate	
				In	Out			In	Out
Whites	609,306	13.6%	17.1%	5.3%	2.6%	22.4%	82.9%	8.3%	16.1%
Blacks	42,405	9.5	28.2	4.5	2.5	32.7	71.8	5.0	12.2
Asians	3,843	10.1	20.0	3.9	3.0	23.9	80.0	6.2	12.2
Hispanics	9,364	10.0	15.7	3.2	5.5	19.0	84.3	6.8	11.5
Native Americans	828	15.1	14.5	5.9	0.8	20.4	85.5	9.2	17.5
Unknown	7,793	11.9	17.6	4.5	3.5	22.1	82.4	7.4	14.0

NOTES:
1. Transfers In/Out: Percent of all IHD patients transferred in to, or out of, a COTH or NON-COTH facility.
2. Index + Transfer Admissions: Percent of all IHD patients either directly admitted or transferred to a COTH facility. Includes a small percent of "double counted" patients transferred from one COTH facility to another.
3. Index Transfer Rate: Percent of all index admissions that are transferred.
4. Total Index Admissions: Sum of first reported IHD admissions in 1997. Count varies by hospital characterisitic due to non-reporting of COTH.

SOURCE: Developed from 1997 MedPAR claims for Ischemic Heart Disease diagnoses. PROGRAM: IG06.

Table 8-5

Percent of Admissions and Transfers to Hospitals Performing Open Heart Surgery, by Race/Ethnicity, 1997

			Open Heart				No Open Heart		
Race	Total Index Admissions	Index Transfer Rate	Index Admission Rate	Transfer Rate		Index + Transfer Admission Rate	Index Admission Rate	Transfer Rate	
				In	Out			In	Out
Whites	620,920	13.8%	55.9%	13.1%	1.7%	69.0%	44.1%	0.7%	28.9%
Blacks	43,071	9.4	55.3	8.9	1.4	64.2	44.7	0.6	19.4
Asians	3,849	10.2	64.1	9.5	2.1	73.6	35.9	0.7	24.4
Hispanics	9,610	10.3	62.1	9.8	1.3	71.9	37.9	0.5	24.4
Native Americans	810	15.3	45.9	14.3	0.3	60.2	54.1	1.0	26.9
Unknown	7,813	12.2	56.6	11.4	1.8	68.1	43.4	0.7	24.9

NOTES:
1. Transfers In/Out: Percent of all IHD patients transferred in to, or out of, a facility with open heart services.
2. Index + Transfer Admissions: Percent of all IHD patients either directly admitted or transferred to a facility with open heart services. Includes a small percent of "double counted" patients transferred from one open heart facility to another.
3. Index Transfer Rate: Percent of all index admissions that are transferred.
4. Total Index Admissions: Sum of first reported IHD admissions in 1997. Count varies by hospital characterisitic due to non-reporting of Open Heart.

SOURCE: Developed from 1997 MedPAR claims for Ischemic Heart Disease diagnoses. PROGRAM: IG06.

Table 8-6

Comparison of Rates of First (Index) Admission to COTH, Teaching, CCU, and Open Heart Hospitals Using Race/Ethnic Groups' Own Versus White Zipcode Weights

	Teaching		**COTH**		**Open Heart**		**CCU**	
Racial/ Ethnic Group	Race's Own Zipcode Weights	White Zipcode Weights	Race's Own Zipcode Weights	White Zipcode Weights	Race's Own Zipcode Weights	White Zipcode Weights	Race's Own Zipcode Weights	White Zipcode Weights
Whites	33.0%	33.0%	20.3%	20.3%	54.8%	54.8%	86.4%	86.4%
Blacks	44.4	35.3	30.9	21.8	53.8	49.2	84.9	84.6
Asians	36.9	38.8	22.3	25.9	61.4	59.2	90.6	91.5
Hispanics	31.1	33.8	19.2	20.4	60.5	55.1	84.8	88.5
Native Americans	31.1	29.4	15.1	15.7	43.9	46.1	72.8	80.8
Unknown	35.4	33.6	19.3	18.9	54.6	52.6	86.2	86.9

NOTES:
1. "Own Zipcode Weights": Zipcode level admission rates for each race/ethnic group weighted by frequency of race/ethnic group in particular zipcode.
2. "White Zipcode Weights": Zipcode level admissions rates for each race/ethnic group weighted by frequency of white admissions in a particular zipcode.
3. Rates based on "own zipcode" weights differ slightly from previous tables because of a small percent of missing zipcodes.

SOURCE: Based on MedPAR claims for IHD index admissions in 1997; hospital characteristics taken from CMS Provider of Service file. PROGRAM: IG12STAT.

Table 8-7

Median Travel Distances from Patient to Hospital
Zipcode Location, Overall and by Hospital Type, by Racial/Ethnic Group, 1997

Admission Type/ Hospital Characteristic	**Whites**	**Blacks**	**Asians**	**Hispanics**	**Native Americans**	**Unknown**
Index Admission	7.3 mi.	4.5 mi.	4.6 mi.	4.7 mi.	14.3 mi.	5.9 mi.
COTH	22.4	9.7	13.7	10.7	57.0	17.4
CCU	6.6	4.7	4.8	5.5	11.7	6.9
Open Heart	5.5	4.1	3.8	4.0	9.6	4.9
Transfer Admission	29.2	20.7	9.6	11.4	64.8	24.0
COTH	39.0	27.3	30.8	23.3	87.5	37.6
CCU	21.6	15.5	8.2	10.8	54.3	26.6
Open Heart	16.7	10.2	5.4	10.5	33.7	13.8

NOTES:
1. Distances determined as "straight-line" distance, in miles, between patient and hospital zipcodes using latitude and longitude.
2. Sample constrained to index admission distances <250 miles and transfers <500 miles - resulting in 3-4 percent fewer observations.

SOURCE: Based on MedPAR claims for IHD admissions in 1997; hospital characteristics taken from CMS Provider Service file. PROGRAM: IG13

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Appendix 4.A

Imputing and Merging Socioeconomic Status (SES) Characteristics Onto The Longitudinal File

APPENDIX 4.A

IMPUTING AND MERGING SOCIOECONOMIC STATUS (SES) CHARACTERISTICS ONTO THE LONGITUDINAL FILE

Spatial Insights data did not have a 1999 breakdown of income by race and age group. In addition, median income was not reported for Native Americans in this data set. Median income for the "Other Race" category includes Native Americans and other unknown racial groups.

In explaining the likelihood of use, or access, it is desirable to have an income measure as proximate to the beneficiary as possible. Although some CMS (and other government) surveys do collect income information, CMS does not routinely collect individual incomes on beneficiaries that could be linked to claims data.

In this study, an individual's SES status will be proxied by the median SES of his/her's small area (i.e., county or zip code). Bias in SES effects can arise from measurement error using this approach. In previous research, comparisons of income effects were found to be less in tabulating claims statistics (e.g., discharge rates) against beneficiary income proxied at the zip code level than in regressions based on individuals from the Medicare Current Beneficiary Survey (Gornick, *et al.*, 1996)[1]. This is certainly due to the measurement error in assigning all beneficiaries by race/ethnicity in a zip code the same median income.

In a bivariate model, the asymptotic formula for the extent of bias is:

[1] In profiling primary care physicians in upstate New York, Fiscella and Franks (2001) found that zip code SES descriptors correlated as high or higher with patient satisfaction and health status with providers than did individual education measures. They concluded that "profiles not accounting for differences in patient SES by physician practice may underestimate the performance of physicians caring for poorer populations while overestimating the performance of those with more affluent practices." (P. 13) The success of zip code data surprised the researchers given the expected SES measurement error of using aggregate measures to explain individual patient ratings of health and providers. Hofer (2001) explains the result by suggesting that "some geographic based measure...captures some aspect of the context in which the individuals live." (P. 4) Estimated effects of individual patient education, in other words, may be biased upwards because contextual effects load on a patient's education. For example, lower education patients may be more likely to be treated by less qualified physicians attracted to a poorer community.

$$\text{plim}[b] = \beta / (1 + \sigma^2_u / K),$$

where plim[b] = the probability limit in large samples of the estimated income effect, b, versus β = the true income effect (Greene, 1997, p. 437). The extent of the bias, or deviation between b and β, is a positive function of σ^2_u = the variance in the error, u, in measuring income. This error variance is further standardized by $K = \Sigma x_i^2/n$, or the average sum of squared income values. The greater the variability in measurement error due to assigning all beneficiaries the same median income, the greater the bias. The so-called attenuation effect biases the estimated income coefficient towards zero and can render it statistically insignificant in smaller samples or where the error is particularly large. Even worse, measurement error of this sort acts as a virus biasing other coefficients in the model. (Greene, 1997, p. 440)

Considering the measurement error further, area-level income and other SES variables based on the 1990 Census are forecasted by Spatial Insights at the small-area level for 8-9 years to the 1998/99 period. This introduces two error components: (1) error in assigning all beneficiaries in the area the same income; and (2) error in forecasting income from 1990 through 1998/99. The extent of error depends upon how variable beneficiary incomes are within small areas and how accurate the intercensal estimates are. If income disparities have widened among the elderly over the decade, which they have in the general population, then greater error is introduced the further away we get from 1990. It is also reasonable to assume that the median income derived from the 1990 Census is more accurate than one forecasted to near the end of the 1990s, thereby adding to any measurement error. There is nothing we can do to avoid these forms of measurement error. Consequently, income effects on use will be biased downwards to some unknown extent.

Imputing median incomes by race and age group involved two major tasks. First, 1999 median incomes by zip code were imputed for Native Americans using the following formula:

$$(1) \qquad I_{i,99,z} = I_{t,99,z} \ x \ [I_{i,90,z} / I_{t,90,z}] ,$$

where $I_{i,99,z}$ = 1999 median income of Native Americans (i) households in the z-th zip code; $I_{t,99,z}$ = 1999 median income of all households (t) in each zip code (z); and $[I_{i,90,z} / I_{t,90,z}]$ = ratio of median incomes of Native Americans households to median incomes of all households in the 1990 Census (Claritas Data). This imputation algorithm assumes that Native Americans incomes in 1999 had the same relation to median household incomes in the zip code over the 1990-1999 period. The algorithm requires first calculating the Native Americans-All household median income ratio for every zip code in 1990.

Claritas' 1990 Census data did not report median income for Native Americans households, only a frequency distribution of income ranges. Hence, a median income had to be derived from reports of households within income range (e.g., \$10-\$14,999). The Native Americans median household income in 1990 ($NAINC_{90}$) was constructed using the following formula (the zip subscript is suppressed):

$$(2) \qquad NAINC = INC_L + (\Delta INC_{L,H} \ x \ [H_{MID} - H_L]/[H_{L,H}])$$

where INC_L = the lower income threshold of the range containing the median household;

$\Delta INC_{L,H}$ = the size of the income range containing the median household;

$[H_{MID} - H_L]$ =the median number of households minus the cumulative number of households at the lower threshold of the "median income" range; and

$[H_{L,H}]$ = the total number of households in the "median income" range.

Intuitively, we first identified the income range containing the median household then added to the lower threshold of the range an amount equal to the dollar size of the range weighted by the proportion of households.

The second problem in extrapolating 1990 Native Americans incomes to 1999 is that the 1990 Claritas zip codes are often different than those used in 1999. We did not want to assume a constant 1990 Native Americans income ratio to all households for every 1999 zip code. We hypothesized that zip codes with highly concentrated Native Americans populations would exhibit higher income ratios because Native Americans median household incomes would approximate incomes of all households in the denominator. Similarly in zip codes with low percentages of Native Americans, income ratios of Native Americans to all households would also be relatively higher because lower income Native Americans are not significant enough to reduce overall household income in the denominator. It is in areas with significant, but not dominant, Native Americans populations that the income ratio would be lowest. Therefore, instead of applying a constant 1990 Claritas-based income ratio, we imputed the ratio of Native Americans to overall median household income in 1990 based on the following non-linear regression:

$$(3) \qquad Y = \alpha + \beta X + \delta X^2 + \varepsilon$$

where Y is the ratio of median Native Americans household income to overall median household income, $Y = I_{i,90,z} \ / \ I_{t,90,z}$, X is the ratio of Native Americans to the total population in the zip code, and ε = a regression error term. The regression results are shown in eq. (4):

$$(4) \qquad \underset{}{Y} = \underset{(196.5)}{0.706} - \underset{(5.4)}{0.583} * X + \underset{(4.8)}{0.627} * X^2$$

with t-statistics in parentheses underneath the coefficients. The regression results confirm the hypothesis that the Native Americans income ratio is U-shaped, falling at first as Native Americans populations rise in the zip code then rising once again as the incomes of this population come to dominate the overall household income. In zip codes where the ratio of Native Americans to total population is 5 percent, the ratio of Native Americans median household income to median household income is 0.69; in zip codes where the population ratio is 50 percent, the ratio of household income is 0.57; and in the zip codes where the population ratio is 90 percent, the ratio of Native Americans household incomes rises again to 0.69. The variation in income ratios is approximately 10 percent.

Instead of using the continuous regression to predict Native Americans incomes,[2] we first grouped the 1990 zip codes within six ranges based on the Native Americans population proportion. The ranges and associated Native Americans income ratios (in parentheses) were:

(1) X >= 0.9 (.689);
(2) 0.9 >X >= 0.5 (.571);
(3) 0.5 >X>=0.366 (.581);
(4) 0.366 >X>=0.05 (.678);
(5) 0.05 > X >= 0.016 (.697);
(6) 0.016 > X > 0 (.705).

Because the proportion of Native Americans in a zip code's total population is highly right skewed, the number of zip codes in each range varies greatly. For example, only 1 percent of zip codes exhibited Native Americans population shares greater than 36.6 percent. Conversely, fully 90 percent of all zip codes fall into the sixth range of 1.6

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[2] Groups were used to avoid illogical predictions of Native Americans incomes at the tails of the distribution. For example, the predicted ratio of Native Americans to all household incomes in zip codes comprised only of Native Americans would be .75 instead of 1.0. This arises from using just a second degree polynomial estimation model.

percent Native Americans or less. The Native Americans income ratio is highest (.705) for zip codes with the fewest Native Americans and lowest (.571) where they comprise 50-90 percent of all households.

In a final step, these income ratio values were used in eq. (1) to impute the 1999 Native Americans median household income in the most current zip codes. The ratios corresponding to the six Native Americans frequency ranges were multiplied by the reported median incomes in the Spatial Insights data in each zip code.

The decennial census has very detailed income breakdowns by racial groups by age groups. Unfortunately, such two-way breakdowns of income within zip codes are unavailable other than once a decade. Income breakdowns within zip codes do exist in 1999 for five major race/ethnic groups and by age group, but not nested by race by age of household head.

Several options exist to impute the median income of the over-65 population in a zip code by race/ethnic background. A system of simultaneous equations decomposing median income by race or by the over- versus under-65 group was considered then rejected. Although such a system could be uniquely estimated for up to three race groups, this would likely result in a single median income for Asian, Native Americans, Hispanics, and other minor races combined. As 1999 incomes are reported for Asians and Hispanics, separately, it seemed inefficient to estimate a joint income and then try to decompose it into several subgroups. One could also "update" 1990 incomes by race to 1999 by taking the ratio of 1999 overall zip code income to 1990 overall income. This assumes that the income of all races in the zip code grow at the same rate.

In the end, it was decided to decompose race/ethnic median incomes actually reported by Spatial Insights in 1999 into an over- versus under-65 age group. For whites, blacks, Asians, Native Americans, and Hispanics, this was done by multiplying reported/imputed 1999 median income for each race/ethnic group (r) ($I_{t,r,99,z}$) by the ratio of over-65 to overall median household income for each zip code, i.e.,

$$(5) \qquad I_{>65,r,,99,z} = I_{t,r,99,z} \text{ x } [I_{>65,t,99,z} / I_{t,t,99,z}] \, ,$$

where $I_{>65,t,99,z}$ stands for the median household income for all heads of households aged 65 and above in 1999, and $I_{t,t,99,z}$ stands for the median all-household income across all age groups in 1999. This assumes that the ratio of the over-65 income to overall household income was the same as the ratio of elderly-nonelderly incomes within each race/ethnic group. Using Spatial Insights data, we first calculated the ratio of over-65 median household income to the overall median household income. Since Spatial Insights only reports median household income aged 65 to 74 and aged 75 and above, we constructed median household income for aged 65 and above as a population-weighted average of median household incomes aged 65 to 74 and aged 75 and above.

We merged on income and other SES data (e.g., occupation and education levels, wealth) by zip code to all inpatient claims for all IHD patients. Since Native American income was derived from the "other" category on the Spatial Insights database and we did not recalculate income for "other", we did not have income information for this group. Thus, any SES level analyses will drop beneficiaries categorized as other/unknown. Exhibit 4-A-1 provides the percent of IHD beneficiaries by race/ethnicity that did not match by zip code. Overall, four percent did not match to the file, with nearly 1/3 of that accounted for by the other/unknown category. Native Americans had the highest percent that did not match – 11.5 percent. We also merged the SES data to our 1997 Medicare eligibles file.

Exhibit 4.A-1

SES Non-Matches by Race/Ethnicity for Medicare Patients with at Least One Admission with IHD as a Principal Diagnosis in 1997

Race/Ethnicity	Non-matches	Total Population of Medicare Patients Admitted in 1997 with IHD as a Principal Diagnosis	Percent Non-Match
Total	27,824	700,682	4.0%
White	17,449	633,609	2.8%
Black	1,602	44,235	3.6%
Asian	115	4,015	2.9%
Hispanic	453	9,868	4.6%
Native American	97	847	11.5%
Other/Unknown	8,108	8,108	100.0%

Appendix 4.B

Data Editing

APPENDIX 4.B

DATA EDITING

The MedPAR file is created by "rolling up" interim bills for each beneficiary by hospital in the inpatient SAF so that on the MedPAR file each record represents one beneficiary stay in one inpatient hospital. Thus, the file normally requires little editing. However, for our study, we wanted to be able to identify transfers separately from the initial admissions and not count transfers to other acute hospitals as readmissions.

For our study, we identified transfers as cases in which the HICNO was the same and the discharge date on the first claim from the sending hospital was equal to or one day before the admission date on the second claim from the receiving hospital. When the dates were one day apart, the first claim also had to have a discharge destination code indicating a transfer to another hospital.

For transfers, we created a flag for the second claim (and if needed, further claims) that equaled 1 if the claim was a transfer from another hospital, otherwise it was considered a new admission. For our readmission analyses, we do not include transfers as a separate readmission, thus, if a beneficiary was transferred to another acute care stay hospital during their index IHD admission, this did not count as a readmission within 30-days of discharge.

There were some cases where the dates of admission and discharge overlapped for a beneficiary (e.g., duplicate information or a beneficiary had two claims with the same admission date, but the discharge dates were different). We combined these claims into one stay for these beneficiaries.

In addition, there were some discharges with a discharge destination code indicating the patient was being sent to another hospital and yet the Provider IDs were identical. We considered these continuing care claims and combined them into one stay.

Appendix 4.C

Creating HMO Flags

APPENDIX 4.C

CREATING HMO FLAGS

Because some of our IHD patients enroll in an HMO at some point after their index admission, we lose the ability to track their health care utilization during the period they are enrolled in an HMO. This would bias our readmission rates downward as well as utilization rates of Part B procedures and any post-acute care after the index admission. Note that missing claims have no impact on our mortality rate analyses because the beneficiary's date of death is recorded on the Denominator File which is kept current regardless of enrollment in an HMO.

HMO enrollees are problematic for any analysis since there may systematic differences by race, age, etc., between those beneficiaries that enroll in an HMO and those that remain in fee-for-service. Currently, our finder file is made up of FFS beneficiaries that had a principal diagnosis of IHD on an acute-care short-stay hospital claim. We chose to address this issue by creating four fee-for-service post-index discharge flags for 30-day, 90-day, one-year, and two-year intervals. These (0,1) flags indicate that the beneficiary was enrolled in fee-for-service continuously for that period of time. For example, a beneficiary that is enrolled in fee-for-service for the 30-days post-index discharge would have a FFS flag equal to 1 for the 30-day period. If this same beneficiary enrolled in an HMO, say, 60 days after the post-index discharge, their FFS flag for the 90 day period would be 0 and they would be excluded from any analyses that extended beyond the 30-day period.

Over 95 percent of our IHD patients (667,892) did not enroll in an HMO at any time within two years of their being discharged from their index IHD admission. A small percentage (0.3%) enrolled in an HMO within 30 days of their discharge from their index IHD admission, this increased to .5 percent (5,881) within 90 days, 2.1 percent (14,660) by one year, and 4.7 percent (32,790) by two years. Thus, we have fewer observations for our readmission analyses in this report than the total number of IHD patients varying by the readmission period based on their FFS enrollment. Table 4.A-1 gives the percent distribution of 1997 IHD admissions, first, for all admissions then by period of continuous FFS enrollment. Samples are stratified by age, gender, and race/ethnicity. The distribution of cases by patient characteristic does not change significantly as we delete beneficiaries that enroll in HMOs over the study period. There is a slight decrease in the proportion of beneficiaries ages 65-74 (from 45.9% to 45.4%) and increase in beneficiaries ages 85 and older (13.9% to 14.1%). This is expected as younger beneficiaries are more apt to join HMOs. Trivial losses in minority patients to HMOs also occurs.

Table 4.C-1

Distribution of All IHD Index Admissions in 1997 and Losses Due to Discontinuous FFS Enrollment

	All IHD Admissions	Continuous FFS Enrollment Period			
		30 days	90 days	One-Year	Two-Year
Age Group[a]					
65-74	321,899	320,640	318,494	310,244	303,266
75-84	281,625	280,890	279,681	274,459	270,145
85+	97,158	96,946	96,626	95,438	94,481
Gender					
Men	362,056	360,877	358,822	350,954	344,284
Women	338,626	337,599	335,979	329,187	323,608
Race/Ethnicity					
White	633,609	631,734	628,591	615,937	605,298
Black	44,235	44,011	43,653	42,243	41,175
Asian	4,015	3,996	3,976	3,899	3,829
Hispanic	9,868	9,825	9,740	9,424	9,130
American Indian/Alaska Native	847	844	840	825	816
Other/Unknown	8,108	8,066	8,001	7,813	7,644
Number of IHD Patients (retention rate)	700,682 (100.0%)	698,476 (99.7%)	694,801 (99.2%)	680,141 (97.1%)	667,892 (95.3%)

NOTES:
[a]Based on age as of December 31, 1997.

SOURCE: HER analysis of the 1997 100% Denominator and MedPAR files.

Appendix 4.D

Constructing Diagnostic and Intervention Procedure Rates

APPENDIX 4.D

CONSTRUCTING DIAGNOSTIC AND INTERVENTION PROCEDURE RATES

Exhibit 4.D-1 displays the set of procedures selected for study and the CPT procedure codes that were used to identify these services in Medicare Part B and OPD claims data. Binary variables (0,1) were created for each of these procedures. A beneficiary was deemed to have received the service, if any of the listed procedure codes on the Part B or OPD record with dates of service corresponding to the index admission dates contained a matching CPT procedure code. Thus, beneficiaries may have more than one procedure during an index admission. Some of the procedures have both inclusion and exclusion criteria to ensure that only a particular service was provided during the index admission, i.e., CABG, single atrial graft only.

Exhibit 4.D-1

List of Procedures and Diagnostic Tests

Description	CPT Procedure Code		
Diagnostic Procedures			
Right or Left Heart Catheterization, with angiography	93501, 93510, 93511, 93514, 93524, 93526, 93527, 93528, 93529	and	93539-93562
Right or Left Heart Catheterization, without angiography	93501, 93510, 93511, 93514, 93524, 93526, 93527, 93528, 93529	and not	93539-93562
Selective venous and/or arterial angiography without cardiac catheterization	36011-36015, 36215-36218		
Intracardiac Electrophysiological Procedures	93600-93631		
2D or M-mode echocardiogram	93307-93317, 93350		
Doppler echocardiogram	93320-93325		
Doppler color velocity flow mapping	93325		
ECG -- resting	93000-93014, 93040-93042		
Telephonic transmission of post-symptom ECG strips	93012,93014, 93268-93272, G0004 - G0007, G0015-G0016		
Signal averaged ECG	93278		
ECG Monitoring for 24 hours	93224-93237		
CT of Thorax	71250, 71260, 71270		
Cardiac blood pool imaging, rest or stress, gated equilibrium or planar, single or multiple, including MUGA	78472, 78473, 78481, 78483		
Treadmill or Bicycle Stress Test or pharmacological stress/Ergonovine Provocation Test	93015-93018, 93024, J1245		
Myocardial Perfusion	78459-78465, 78478-78480, G0030-G0047		
Myocardial Imaging	78459, 78466-78469		

Exhibit 4.D-1 (continued)

List of Procedures and Diagnostic Tests

Description	CPT Procedure Code		
Intervention Procedures			
CABG			
CABG, Single Vein Graft	33510		
CABG, Two or Three Vein Grafts	33511, 33512		
CABG, Four, Five, or Six or More Vein Grafts	33513, 33514, 33516		
CABG, Single Arterial Graft	33533	and not	33517-33523
CABG, Two or More Arterial Grafts	33534, 33535, 33536	and not	33517-33523
CABG, Single Arterial Graft and Single Vein Graft	33533	amd	33517
CABG, One or More Arterial Grafts and any number of Venous Grafts	33533, 33534, 33535, 33536	and	33517-33523
CABG or Valve Reoperation more than 1 month after original procedure	33530		
Coronary Endarterectomy, open, in conjunction with CABG, each vessel	33572		
Thrombolysis by intracoronary infusion	92975		
Thrombolysis by intravenous infusion	92977		
Percutaneous Single Vessel Stent	92980		
Percutaneous Multiple Vessel Stent	92980	and	92981
Percutaneous Single Vessel Balloon Angioplasty	92982		
Percutaneous Multiple Vessel Balloon Angioplasty	92982	and	92984
Percutaneous Single or Multiple Vessel Atherectomy, Mechanical or other method, with or without balloon angioplasty	92995, 92996		
Permanent Pacemaker or Implantable Cardioverter-defibrillator	33200,33201, 33206, 33207, 33212, 33216, 33208, 33213, 33214, 33217, 33240, 33242, 33245, 33246, 33249, 93640-93642		
Aortic, Mitral, Triscuspid, Pulmonary Valvuloplasty, Valvectomy, Valvotomy, and other valvular-related repairs/Aortic, mitral, pulmonary valve percutaneous balloon valvulplasty	33400-33417, 33420-33430, 33460-33468, 33470-33478, 92986, 92987, 92990		

Exhibit 4.D-1 (continued)

List of Procedures and Diagnostic Tests

Description	CPT Procedure Code		
Severity Indicators			
Insertion of Temporary Pacing Wires or Temp. Transcutanous Pacing	33210, 33211, 92953		
Cardiac Assist Device -- prolonged extracorporeal, intra-aortic balloon (open or percutaneous insertion), ventricular assist device	33960, 33961, 33970, 33971, 33973, 33975, 33976, 93536, 92970, 92971		
Non-imaging CV Hemodynamics: Arterial or Venous Central Line for Pressure Monitoring, including Swan-Ganz and ej with probe technique	36489, 36491, 36620, 36625, 93503		
Ventilation Support, including CPAP and CNP	94656-94668		
Cardiopulmonary Resuscitation	92950		
Cardioversion	92960		
Consults			
ICU visit during index admission	99291,99292		
Cardiology consult during index admission	99221-99239, 99251-99275	and	specialty = 06
Renal consult during index admission	99221-99239, 99251-99275	and	specialty = 39
Neurology consult during index admission	99221-99239, 99251-99275	and	specialty = 13
Pulmonary consult during index admission	99221-99239, 99251-99275	and	specialty = 29
Cardiothoracic surgeon consult during index admission	99221-99239, 99251-99275	and	specialty = 33
Infectious diseases consult during index admission	99221-99239, 99251-99275	and	specialty = 44

Appendix 4.E

Patients Eligible for Readmission Analyses

APPENDIX 4.E

PATIENTS ELIGIBLE FOR READMISSION ANALYSES

Tables 4.E-1 through 4.E-3 provide the number of beneficiaries eligible for each of the readmission periods by age, gender, and race/ethnicity – the denominators for our readmission rates. Over 40,000 IHD patients (nearly 6%) died during their index admission and were eliminated from the readmission analyses. Another 2,206 enrolled in an HMO within 30-days of the date of discharge on their index admission, decreasing the total number of IHD patients eligible for the 30-day readmission analysis to 658,005 – approximately 94 percent of the total 700,682 IHD patients. Nearly 4,000 additional patients enrolled in an HMO sometime within the 90-day window. Another 14,658 patients enrolled in an HMO sometime within one-year of being discharged from their index IHD admission, leaving us with approximately 91 percent of our original IHD patients for the one-year readmission rates analysis.

Table 4.E-1

Distribution of IHD Patients Eligible for the 30-Day Readmission Analyses by Age, Gender, and Race/Ethnicity: 1997

		Race/Ethnicity					
	Total	White	Black	Asian	Hispanic	Native American	Other
Total	658,005	595,113	41,472	3,748	9,349	796	7,527
Ages 65-74[a]	309,732	276,433	21,472	1,895	5,441	498	3,993
Men	183,290	167,634	9,220	1,108	2,805	268	2,255
Women	126,442	108,799	12,252	787	2,636	230	1,738
Ages 75-84[a]	263,273	241,177	14,940	1,505	3,281	232	2,138
Men	129,612	120,781	5,518	871	1,467	107	868
Women	133,661	120,396	9,422	634	1,814	125	1,270
Ages 85+[a]	85,000	77,503	5,060	348	627	66	1,396
Men	28,796	26,499	1,473	174	193	25	432
Women	56,204	51,004	3,587	174	434	41	964

NOTE:
[a]Based on age as of December 31, 1997.

SOURCE: HER analysis of the 100% 1997 Denominator and MedPAR files.

Table 4.E-2

Distribution of IHD Patients Eligible for the 90-Day Readmission Analyses by Age, Gender, and Race/Ethnicity: 1997

		Race/Ethnicity					
	Total	White	Black	Asian	Hispanic	Native American	Other
Total	654,330	591,970	41,114	3,728	9,264	792	7,462
Ages 65-74[a]	307,586	274,613	21,247	1,888	5,393	495	3,950
Men	181,974	166,502	9,098	1,103	2,776	266	2,229
Women	125,612	108,111	12,149	785	2,617	229	1,721
Ages 75-84[a]	262,064	240,137	14,828	1,495	3,249	231	2,124
Men	128,990	120,240	5,465	864	1,453	106	862
Women	133,074	119,897	9,363	631	1,796	125	1,262
Ages 85+[a]	84,680	77,220	5,039	345	622	66	1,388
Men	28,679	26,398	1,464	172	189	25	431
Women	56,001	50,822	3,575	173	433	41	957

NOTE:
[a]Based on age as of December 31, 1997.

Appendix 4.F

Example of Age-Adjusted Race/Ethnic Mortality Rates

APPENDIX 4.F

EXAMPLE OF AGE-ADJUSTED RACE/ETHNIC MORTALITY RATES

To calculate an age-adjusted mortality rate of IHD per 1,000 white men of all ages, the rate for each of the three men's age groups is multiplied by the proportion of the total eligible population that is in each of the age cells. The age distribution of all elderly Medicare eligibles is 51.71 percent for those aged 65-74, 34.67 percent aged 75-84, and 13.62 percent aged 85 and older. The 30-day mortality rate for white men for each of these age groups is 4.63 percent, 8.98 percent, and 19.28 percent respectively. Hence, the age-adjusted 30-day mortality rate for all elderly white men is: (4.63*.5171) + (8.98*.3467) + (19.28*.1362) = 8.13 percent. The unadjusted death rate for white men ages 65 and older is 7.66. Consequently, controlling for deviations in the white male age distribution from the all-elderly average raises the white male mortality rate because of the greater weight placed on the older age groups (white males have a shorter lifespan than other groups – especially women).

Appendix 4.G

ESRD IHD Beneficiaries

APPENDIX 4.G

ESRD IHD BENEFICIARES

Tables 4.G-1 and 4.G-2 provide counts of Medicare eligibles with ESRD (0.4% of the total number of Medicare eligibles). This population differs greatly from the overall Medicare population. Mortality for this population is greater. For example, among the 85 and older ESRD patients, when weighted for months alive and enrolled in Part A FFS, the counts drop by 20 percent (compared to the 8% in the overall population). Less than 7 percent of the Medicare eligibles with ESRD are 85 years of age or older, much lower than that of the overall Medicare eligible population. Nearly one-half of the Medicare eligibles with ESRD are men, a much higher proportion than that found in the overall Medicare population. There is also a higher proportion of minorities in the ESRD population: 28 percent are Black, 2 percent are Asian, and 3 percent are Hispanic.

Table 4.G-3 provides counts of ESRD patients from the United States Renal Data System (USRDS). These data are from the enrollment form for ESRD and are generally taken to be complete. The total numbers compared to Table 4.G-1 are very close. However, when examined by race, it provides a good estimate of the racial undercount in the EDB. The numbers for whites and other are over-represented in our IHD sample compared to the USRDS data. The numbers for blacks are very close. The main disparities exist for the Asian, Hispanic, and Native American numbers where our IHD totals are 42 percent, 57 percent, and 47 percent of the USRDS totals, respectively.

Table 4.G-1

Distribution of Medicare Beneficiaries with ESRD by Age, Gender, and Race/Ethnicity: 1997

		Race/Ethnicity					
	Total	White	Black	Asian	Hispanic	Native American/ Alaska Native	Other
Total	117,350	75,226	32,906	1,772	3,871	578	2,997
Ages 65-74[a]	66,122	39,396	20,706	986	2,690	416	1,928
Men	32,556	21,324	8,485	485	1,304	169	789
Women	33,566	18,072	12,221	501	1,386	247	1,139
Ages 75-84[a]	43,184	30,130	10,325	668	1,061	141	859
Men	21,858	16,761	3,845	348	498	48	358
Women	21,326	13,369	6,480	320	563	93	501
Ages 85+[a]	8,044	5,700	1,875	118	120	21	210
Men	3,942	3,045	671	63	50	7	106
Women	4,102	2,655	1,204	55	70	14	104

NOTES:
[a]Based on age as of December 31, 1997.
Includes all ESRD Medicare beneficiaries that were age 65 or older and enrolled in FFS Part A at some point in CY97 and lived in the 50 states or DC.
These beneficiary counts are a subset of those found in Table 2-1A.

SOURCE: HER analysis of the 100% 1997 Denominator File.

Table 4.G-2

Distribution of Medicare Beneficiaries with ESRD Weighted by Months of Eligibility by Age, Gender, and Race/Ethnicity: 1997

		Race/Ethnicity					
	Total	White	Black	Asian	Hispanic	Native American/ Alaska Native	Other
Total	101,967	64,640	29,257	1,546	3,437	506	2,580
Ages 65-74[a]	58,507	34,498	18,655	887	2,432	369	1,667
Men	28,775	18,714	7,613	441	1,177	152	678
Women	29,732	15,784	11,042	446	1,255	217	989
Ages 75-84[a]	36,998	25,601	9,054	569	909	120	746
Men	18,686	14,240	3,377	296	428	37	307
Women	18,312	11,361	5,677	272	480	83	438
Ages 85+[a]	6,462	4,541	1,548	91	97	17	168
Men	3,142	2,431	543	45	39	5	80
Women	3,320	2,110	1,005	46	58	12	88

NOTES:
[a]Based on age as of December 31, 1997.
Includes all ESRD Medicare beneficiaries that were age 65 or older and enrolled in FFS Part A at some point in CY97 and lived in the 50 states or DC.
These beneficiary counts are a subset of those found in Table 2-1B.

SOURCE: HER analysis of the 100% 1997 Denominator File.

Table 4.G-3

United States Renal Data System (USRDS) Distribution of Medicare Beneficiaries by Age, Gender, and Race/Ethnicity: 1997

		Race/Ethnicity					
	Total	White	Black	Asian	Hispanic	Native American/ Alaska Native	Other
Total	117,307	69,856	33,496	4,200	6,761	1,243	1,751
Ages 65-74[a]	70,611	39,517	21,931	2,492	4,610	887	1,174
Men	34,960	21,476	9,189	1,171	2,234	337	553
Women	35,651	18,041	12,742	1,321	2,376	550	621
Ages 75-84[a]	40,032	26,052	9,899	1,450	1,856	312	463
Men	20,143	14,411	3,832	715	864	106	215
Women	19,889	11,641	6,067	735	992	206	248
Ages 85+[a]	6,664	4,287	1,666	258	295	44	114
Men	3,175	2,251	590	131	131	16	56
Women	3,489	2,036	1,076	127	164	28	58

SOURCE: Personal communication from Paul Eggers.

Appendix 5.A

Replication of CMS' Table 1:
Any IHD Diagnosis

Table 5.A-1

Replication of CMS' Table 1
All Short-Stay Hospital IHD Admissions with Any Diagnosis of IHD for Medicare Aged Beneficiaries by Age, Sex, and Race/Ethnicity: 1997

	All Persons			Race/Ethnicity: White			Black			Asian			Hispanic			Native American/ Alaska Native		
	Count	Admission Rate[1,2]	Transfer Rate[3]	Count	Admission Rate[1,2]	Transfer Rate[3]	Count	Admission Rate[1,2]	Transfer Rate[3]	Count	Admission Rate[1,2]	Transfer Rate[3]	Count	Admission Rate[1,2]	Transfer Rate[3]	Count	Admission Rate[1,2]	Transfer Rate[3]
All persons	2,994,084	100.4	3.9	838,726	102.3	13.1	56,393	90.4	9.4	5,132	60.6	9.8	12,926	101.4	10.0	1,150	103.3	16.0
65-74	1,130,459	75.7	5.3	995,401	76.5	5.6	92,896	75.4	3.4	6,272	45.2	4.2	20,228	82.0	4.0	2,093	92.9	5.3
75-84	1,273,305	120.6	3.9	1,158,773	122.6	4.0	80,324	105.1	2.4	6,614	76.1	3.2	15,817	125.6	2.8	1,274	116.6	4.6
85+	590,320	141.0	1.4	535,917	144.5	1.5	37,500	113.7	0.7	2,193	101.7	1.3	4,765	167.5	0.9	442	129.8	3.6
Men	1,466,371	120.9	4.4	1,342,327	124.9	4.5	80,894	90.6	2.9	8,427	75.3	3.4	18,478	103.8	3.5	1,866	111.0	5.7
65-74	647,176	95.9	5.5	585,361	98.8	5.7	39,904	76.1	3.6	3,567	58.0	4.0	10,109	87.8	4.3	1,087	100.4	6.1
75-84	621,075	150.0	4.0	575,180	154.3	4.1	30,439	110.0	2.6	3,756	93.0	3.6	6,895	130.1	3.0	608	129.5	5.4
85+	198,120	168.0	1.8	181,786	174.3	1.9	10,551	117.2	1.0	1,104	119.2	1.3	1,474	159.6	0.9	171	134.5	4.1
Women	1,527,713	86.4	3.5	1,347,764	86.7	3.7	129,826	90.3	2.3	6,652	48.7	3.2	22,332	99.5	2.8	1,943	96.8	4.0
65-74	483,283	59.1	5.1	410,040	57.9	5.4	52,992	74.9	3.2	2,705	35.0	4.4	10,119	77.0	3.6	1,006	85.9	4.4
75-84	652,230	101.8	3.7	583,593	102.2	3.8	49,885	102.3	2.2	2,858	61.7	2.8	8,922	122.4	2.7	666	107.1	3.8
85+	392,200	130.7	1.2	354,131	133.2	1.3	26,949	112.4	0.6	1,089	89.0	1.4	3,291	171.1	0.9	271	127.0	3.3

NOTES:
Admitted 1/1/97 or later and discharged on or before 12/31/97.
[1]Rates adjusted for part-year FFS eligibility.
[2]Rates per 1,000 Medicare eligibles.
[3]Percent of IHD admissions that were transfers to another short stay acute care hospital.

SOURCE: HER analysis of 1997 100% Denominator and MedPAR files.

Table 5.A-2

Replication of CMS' Table 1
Number of Medicare Aged Beneficiaries with a Short-Stay Hospital Admission with Any Diagnosis of IHD by Age, Gender, and Race/Ethnicity: 1997

	All Persons		White		Black		Asian		Hispanic		Native American/ Alaska Native		Other	
	Count	Rate[1,2]	Count	Rate[1,2]	Count	Rate[1,2]	Count	Rate[1,2]	Count	Rate[1,2]	Count	Rate[1,2]	Count	Rate[1,2]
All persons	2,011,080	67.1	1,806,920	68.3	56,393	60.4	5,132	41.2	12,926	65.7	1,150	65.1	10,558	45.3
65-74	744,942	49.7	656,104	50.3	61,170	49.4	4,303	30.9	13,008	52.6	1,300	57.4	9,057	31.5
75-84	848,200	80.0	771,616	81.3	53,973	70.1	4,449	51.0	10,273	81.1	824	75.3	7,065	58.0
85+	417,938	98.8	379,200	101.2	26,783	80.2	1,558	71.1	3,292	114.7	290	83.8	6,815	71.7
Men	979,401	80.3	896,093	83.0	54,365	60.3	5,781	51.4	12,118	67.7	1,173	69.2	9,871	53.2
65-74	428,764	63.3	387,633	65.2	26,491	50.2	2,499	40.5	6,575	56.9	684	62.8	4,882	40.9
75-84	412,492	99.2	381,837	102.0	20,436	73.3	2,499	61.6	4,498	84.5	387	82.0	2,835	73.2
85+	138,145	115.7	126,623	119.9	7,438	81.4	783	83.4	1,045	112.1	102	76.8	2,154	82.0
Women	1,031,679	58.0	910,827	58.3	87,561	60.4	4,529	32.9	14,455	64.1	1,241	61.7	13,066	40.7
65-74	316,178	38.5	268,471	37.8	34,679	48.8	1,804	23.3	6,433	48.8	616	52.4	4,175	24.9
75-84	435,708	67.7	389,779	68.0	33,537	68.4	1,950	41.9	5,775	78.7	437	70.3	4,230	51.1
85+	279,793	92.4	252,577	94.1	19,345	79.8	775	62.3	2,247	115.9	188	87.9	4,661	67.9

Race/Ethnicity spans White through Other.

NOTES:
Admitted 1/1/97 or later and discharged on or before 12/31/97.
[1]Rates adjusted for part-year FFS eligibility.
[2]Rates per 1,000 Medicare eligibles.

SOURCE: HER analysis of 1997 100% Denominator and MedPAR files.

Appendix 5.B

ESRD Readmission Rates

Table 5.B-1

Readmission Rates (in percent) of IHD Patients with ESRD by Age, Gender, and Race/Ethnicity: 1997

All Ages

	Total (age/sex adjusted)			Men (age adjusted)			Women (age adjusted)		
Race/Ethnicity	30-day	90-day	One-Year	30-day	90-day	One-Year	30-day	90-day	One-Year
Total (race adjusted)	35.8	61.6	86.6	34.7	59.4	85.0	36.4	62.8 †	87.6 †
White	36.2	62.2	86.9	35.1	59.9	85.5	36.8	63.5	87.9 †
Black	31.4 *	55.4 *	84.0 *	29.4	53.9	81.5	33.0	56.5	85.8
Asian	31.6	58.9	81.7	31.2	58.5	76.8	31.6	59.7	85.7
Hispanic	40.8	65.0	89.7	39.7	60.1	83.9	40.4	67.5	92.8
Native American/Alaska Nativ	19.3 NR	49.7	80.5	33.2 NR	41.6	86.4 NR	8.6 NR	53.6	75.5
Other	33.0	57.7	81.3	33.6	60.3	76.9	32.0	55.5	83.8

Ages 65-74

	Total (sex adjusted)			Men			Women		
Race/Ethnicity	30-day	90-day	One-Year	30-day	90-day	One-Year	30-day	90-day	One-Year
Total (race adjusted)	35.3	60.6	85.9	35.6	59.8	83.8	35.1	61.1	87.4 †
White	35.8	61.3	86.3	36.2	60.7	84.2	35.5	61.8	87.7 †
Black	30.8	53.8 *	84.2	27.1 *	51.2 *	81.2	33.3	55.5 *	86.3
Asian	32.3	62.6	80.9	32.4	56.0	70.4	32.2	67.2	88.1
Hispanic	35.8	60.3	87.4	39.6	58.2	83.6	33.2	61.8	90.0
Native American/Alaska Nativ	30.3 NR	60.2	87.6	50.0 NR	75.0	100.0 NR	16.7 NR	50.0 NR	79.0
Other	33.1	52.2	78.2	40.6	57.6	80.2	27.9	48.5	76.9

Table 5.B-1 (Continued)

Readmission Rates (in percent) of IHD Patients with ESRD by Age, Gender, and Race/Ethnicity: 1997

	Ages 75-84								
	Total (sex adjusted)			**Men**			**Women**		
Race/Ethnicity	30-day	90-day	One-Year	30-day	90-day	One-Year	30-day	90-day	One-Year
Total (race adjusted)	37.2	61.7	86.7	34.6	59.6	86.4	39.0	63.2	86.9
White	37.8	62.4	87.1	35.1	59.9	87.2	39.7	64.0	87.0
Black	32.4	55.9	82.7	31.5	56.1	80.2 *	33.0	55.7 *	84.4
Asian	34.7	57.8	77.9	36.8	65.5	80.1	33.2 NR	52.5	76.4
Hispanic	41.4	62.0	93.1	42.4	60.3	91.5	40.7	63.2	94.3
Native American/Alaska Nativ	8.6 NR	50.7	100.0 NR	21.1 NR	8.2 NR	100.0 NR	0.0 NR	80.0	100.0 NR
Other	30.1	58.6	81.4	21.5 NR	58.5	68.6	36.0	58.6	90.3
	Ages 85+								
	Total (sex adjusted)			**Men**			**Women**		
Race/Ethnicity	30-day	90-day	One-Year	30-day	90-day	One-Year	30-day	90-day	One-Year
Total (race adjusted)	33.2	63.9	88.5	31.1	57.2	85.4	34.7	68.6	90.7
White	33.1	63.9	88.8	31.0	56.7	85.7	34.6	68.8 †	90.9
Black	32.0	60.6	86.8	32.7	58.2	86.0	31.4	62.2	87.4
Asian	19.9 NR	50.0 NR	96.9	12.5 NR	50.0 NR	92.4	25.0 NR	50.0 NR	100.0 NR
Hispanic	53.1 NR	86.4	86.1	33.3 NR	66.7 NR	65.9 NR	66.7 NR	100.0 NR	100.0 NR
Native American/Alaska Nativ	0.0 NR	0.0 NR	0.0 NR	0.0 NR	0.0 NR	0.0 NR	n/a	n/a	n/a
Other	37.5 NR	74.6	90.2	37.5 NR	75.0	86.1	37.5 NR	74.3	93.1

NOTES:
Based on age as of December 31, 1997.
Adjusted by the number of days alive in readmission period.
Intervals based on days after discharge from the index admission.
NR = Not statistically reliable.
* Statistically significant difference at the .01 level compared to whites.
† Statistically significant difference at the .01 level compared to men.

SOURCE: 100% 1997 Denominator File and 100% MedPAR file.

Appendix 5.C

ESRD Average Lengths of Stay

Table 5.C-1

Average Length of Stay (in days) During the Index IHD Admission - ESRD Patients by Age, Gender, and Race/Ethnicity: 1997

	All Ages			Ages 65-74[a]		
Race/Ethnicity	Total[1]	Men[2]	Women[2]	Total[4]	Men	Women
Total (race adjusted)	7.4	7.2	7.5	7.4	7.1	7.6
White	7.4	7.2	7.5	7.4	7.1	7.6 †
Black	7.3	7.3	7.3	7.4	7.3	7.5
Asian	8.4 NR	8.1 NR	8.3 NR	8.4 NR	8.9	8.0
Hispanic	7.0	6.9 NR	7.0 NR	6.0	6.2	5.8 *
Native American/Alaska Native	5.7 NR	6.2 NR	5.4 NR	5.7 NR	4.8	6.3
Other	7.9	7.2 NR	8.4 NR	8.2	7.1	8.9

	Ages 75-84[a]			Ages 85+[a]		
Race/Ethnicity	Total[3]	Men	Women	Total[3]	Men	Women
Total (race adjusted)	7.3	7.4	7.3	7.6	7.2	7.9
White	7.3	7.4	7.3	7.7	7.4	7.9
Black	7.3	7.8	7.0	6.8 NR	6.1	7.3
Asian	7.8 NR	8.6	7.2	8.6 NR	3.8 *	12.0 NR
Hispanic	7.7 NR	7.8	7.7	9.0 NR	7.7 NR	10.0 NR
Native American/Alaska Native	6.8 NR	9.5 NR	5.0 NR	3.0 NR	3.0 NR	n/a
Other	8.1 NR	8.3	8.0	6.1 NR	4.5 *	7.2

NOTES:

[a]Based on age as of December 31, 1997.

[1]Age/sex adjusted.

[2]Age adjusted.

[3]Sex adjusted.

NR = Not statistically reliable.

* Statistically significant difference at the .01 level compared to whites.

† Statistically significant difference at the .01 level compared to men.

SOURCE: HER analysis of 1997 100% Denominator and MedPAR files.

Appendix 6.A

Procedure Rates by Principal Diagnosis

Table 6.A-1

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients with a Principal Diagnosis of AMI by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native American Alaska Native	Other/ Unknown
Diagnostic Procedures												
Right or Left Heart Catheterization, with angiography	54.3	67.9	48.9 *	17.0 *	56.8	52.7 *	55.4	44.5 *	45.1 *	54.0	44.3	51.1
Right or Left Heart Catheterization, without angiography	0.4	0.4	0.4	0.2	0.4	0.3 *	0.3	0.6	0.0 NR	0.7 NR	0.0 NR	0.4 NR
Selective venous and/or arterial angiography without cardiac catheterization	1.7	2.1	1.7	0.6 *	1.8	1.7	1.7	1.4	3.6 NR	1.9	0.0 NR	1.7 NR
Treadmill or Bicycle Stress Test or pharmacological stress/Ergonovine Provocation Test	10.6	11.7	11.1	5.6 *	11.4	10.2 *	10.7	9.0 *	10.0	9.7	11.0 NR	11.2
ECG -- resting	91.7	92.6	91.6	88.5 *	91.6	91.8	92.0	89.6 *	87.9	91.0	83.9	88.5
Telephonic transmission of post-symptom ECG strips	1.8	2.1	1.6 *	1.2 *	1.9	1.8	1.8	2.4	0.8 NR	1.1 NR	0.0 NR	1.2 NR
Signal averaged ECG	0.8	1.0	0.7	0.4 *	0.9	0.7	0.8	0.5	1.5 NR	1.3 NR	0.0 NR	0.9 NR
ECG Monitoring for 24 hours	1.7	1.5	1.9	1.8	1.7	1.7	1.6	2.2	2.1 NR	1.9	0.8 NR	1.5 NR
Intracardiac Electrophysiological Procedures	0.9	1.1	0.9	0.2 *	1.3	0.6 *	0.9	0.9	0.2 NR	0.3 NR	0.0 NR	0.4 NR
2D or M-mode echocardiogram	59.9	58.7	61.9 *	60.0	58.8	60.9 *	59.7	61.9	58.7	61.4	60.3	59.0
Doppler echocardiogram	54.2	52.5	56.5 *	55.5 *	52.7	55.4 *	54.0	56.8	52.6	53.2	52.6	53.9
Doppler color velocity flow mapping	45.7	44.2	47.5 *	47.1 *	44.2	46.9 *	45.4	48.3	43.9	44.8	46.2	46.4
Myocardial Perfusion	9.2	9.7	10.2	5.2 *	9.5	9.1	9.2	9.7	10.6	8.1	10.5 NR	9.7
Myocardial Imaging	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2 NR	0.3 NR	0.3 NR	0.0 NR	0.3 NR
Cardiac blood pool imaging, rest or stress, gated equilibrium or planar, single or multiple, including MUGA	1.4	1.6	1.4	1.1 *	1.5	1.4	1.4	1.4	1.3 NR	0.9 NR	2.5 NR	1.0 NR
CT of Thorax	2.7	2.7	3.0	1.9 *	2.9	2.5	2.6	3.5	2.8 NR	1.7 NR	1.5 NR	3.5

Table 6.A-1

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients with a Principal Diagnosis of AMI by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native American Alaska Native	Other/ Unknown
Severity Indicators												
Non-imaging CV Hemodynamics: Arterial or Venous Central Line for Pressure Monitoring, including Swan-Ganz and ej with probe technique	21.0	25.2	19.7 *	8.0 *	22.7	19.7 *	21.1	18.7 *	22.8	24.3	8.4 NR	23.6
Ventilation Support, including CPAP and CNP	5.3	6.2	5.0 *	2.4 *	5.7	5.0 *	5.3	4.6	7.7	7.5	4.1 NR	5.1
Cardiac Assist Device -- prolonged extracorporeal, intra-aortic balloon (open or percutaneous insertion), ventricular assist device	7.7	9.2	7.5 *	2.2 *	8.1	7.3	7.9	4.6 *	8.2	8.4	9.1 NR	7.9
Insertion of Temporary Pacing Wires or Temp. Transcutanous Pacing	4.4	4.7	4.5	3.2 *	4.3	4.6	4.4	4.2	4.7	5.6	2.6 NR	4.1
Cardiopulmonary Resuscitation	3.3	3.4	3.4	2.2 *	3.3	3.2	3.2	3.4	5.0 NR	4.3	7.6 NR	3.9
Cardioversion	1.8	1.9	2.0	1.1 *	2.2	1.6 *	1.9	1.1 *	1.7 NR	1.5 NR	0.0 NR	1.7
ICU	33.4	34.5	33.7	29.0 *	33.4	33.5	33.3	31.5	38.6	42.6 *	29.4	37.0
Consults During Admission												
Cardiology	77.7	82.4	76.6 *	62.9 *	78.6	77.1 *	78.1	73.3 *	80.6	75.2	70.9	76.8
Cardiothoracic surgeon	7.4	9.2	6.8 *	2.2 *	8.2	6.8 *	7.4	5.8 *	12.4	11.5 *	1.8 NR	9.8
Pulmonary consult	11.4	12.1	11.7	8.2 *	12.2	10.9 *	11.3	11.1	16.5	13.9	6.4 NR	13.5
Neurology consult	6.7	6.7	7.5	4.9 *	7.1	6.6	6.6	8.2 *	6.8	8.1	1.8 NR	7.3
Renal consult	5.4	5.5	5.7	4.4 *	5.6	5.3	4.9	9.5 *	9.4	8.0 *	8.7 NR	6.7
Infectious diseases consult	2.5	2.7	2.6	1.9 *	2.7	2.4	2.5	2.9	5.2	3.3	1.8 NR	1.9

NOTES:
* = Significant at the .01 level.
NR = Not statistically reliable.
n = 58,444
[1]Age, Sex, and Race Adjusted; [2]Sex and Race Adjusted; [3]Age and Race Adjusted; [4]Age and Sex Adjusted

Significance tests were conducted:
a. by age using the 65-74 age group as the reference group; b. by gender using males as the reference group; c. by race using whites as the reference group.

SOURCE: HER analysis of 100% 1997 Denominator, MedPAR, Physician/Supplier, and OPD files.

Table 6.A-2

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients with a Principal Diagnosis of Subendocardial Infarction by Age, Gender, and Race/Ethnicity

		Age Group[2]			**Gender[3]**		**Race/Ethnicity[4]**					
Diagnostic Procedures	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native American Alaska Native	Other/ Unknown
Right or Left Heart Catheterization, with angiography	44.4	57.1	38.7 *	10.9 *	46.6	42.9 *	45.3	34.9 *	44.0	43.3	36.6	41.8
Right or Left Heart Catheterization, without angiography	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.4	0.8 NR	1.4 NR	0.0 NR	0.3 NR
Selective venous and/or arterial angiography without cardiac catheterization	1.5	1.9	1.4 *	0.4 *	1.6	1.5	1.6	1.0 *	0.7 NR	1.1 NR	0.0 NR	1.3 NR
Treadmill or Bicycle Stress Test or pharmacological stress/Ergonovine Provocation Test	10.2	11.5	10.4 *	4.7 *	10.4	10.1	10.2	10.1	12.4	9.5	11.1 NR	8.1
ECG -- resting	90.2	91.0	90.1	87.7 *	90.2	90.3	90.5	87.7 *	89.9	91.5	74.3 *	85.9 *
Telephonic transmission of post-symptom ECG strips	1.4	1.5	1.4	1.1	1.4	1.4	1.4	2.2 *	0.8 NR	0.9 NR	2.6 NR	0.9 NR
Signal averaged ECG	0.4	0.5	0.5	0.2 *	0.6	0.4	0.4	0.4	1.0 NR	0.9 NR	0.0 NR	0.6 NR
ECG Monitoring for 24 hours	1.9	1.7	2.1	2.2	1.8	2.0	1.8	3.1 *	1.1 NR	3.0	0.0 NR	1.8
Intracardiac Electrophysiological Procedures	0.9	1.1	0.8 *	0.1 *	1.3	0.5 *	0.9	0.9	0.0 NR	0.3 NR	0.0 NR	0.8 NR
2D or M-mode echocardiogram	56.3	55.3	58.6 *	55.3 *	54.2	58.0 *	56.1	57.7	59.6	61.3	43.9	55.8
Doppler echocardiogram	50.9	49.6	53.2 *	51.1	48.9	52.6 *	50.7	53.1	54.5	53.5	40.3	51.3
Doppler color velocity flow mapping	43.0	41.9	45.0 *	42.9	41.4	44.4 *	42.8	45.4 *	44.8	43.2	36.1	43.4
Myocardial Perfusion	9.4	10.5	9.7	4.5 *	9.3	9.5	9.3	10.3	10.3	11.1	9.8 NR	8.1
Myocardial Imaging	0.2	0.2	0.3	0.3	0.2	0.3	0.2	0.3	0.3 NR	0.6 NR	0.0 NR	0.4 NR
Cardiac blood pool imaging, rest or stress, gated equilibrium or planar, single or multiple, including MUGA	1.4	1.6	1.4	1.0 *	1.5	1.3	1.4	1.4	1.2 *	1.6	2.6 *	1.4 *
CT of Thorax	2.9	3.1	2.8	2.1 *	3.2	2.7	2.8	3.1	1.9 NR	2.5	3.0 NR	3.2

Table 6.A-2 (continued)

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients with a Principal Diagnosis of Subendocardial Infarction by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Intervention Procedures	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native American Alaska Native	Other/ Unknown
Coronary Artery Bypass Graft												
CABG: Single Vein Graft	0.2	0.2	0.2	0.0 NR	0.2	0.2	0.2	0.2 NR	0.0 NR	0.6 NR	0.0 NR	0.4 NR
CABG: 2 or 3 Vein Grafts	2.3	2.7	2.6	0.6 *	2.2	2.5	2.4	1.7 *	2.6 NR	2.2	1.9 NR	3.3
CABG: 4, 5 or 6 or More Vein Grafts	1.5	1.6	1.6	0.4 *	1.7	1.3 *	1.5	1.2	2.5 NR	1.8	2.3 NR	1.1 NR
CABG: Single Arterial Graft	0.2	0.3	0.2	0.1 NR	0.3	0.2	0.3	0.1 NR	0.0 NR	0.4 NR	0.0 NR	0.4 NR
CABG: 2 or More Arterial Grafts	0.2	0.3	0.2	0.0 NR	0.2	0.2	0.2	0.1 NR	0.0 NR	0.0 NR	0.0 NR	0.1 NR
CABG: 1 Arterial Graft and 1 Vein Graft	0.8	1.2	0.6 *	0.1 *	0.8	0.9	0.9	0.4 *	0.3 NR	0.5 NR	0.0 NR	0.6 NR
CABG, One or More Arterial Grafts and any number of Venous Grafts	8.7	12.1	6.5 *	0.8 *	10.6	7.3 *	9.1	4.9 *	8.0	8.4	4.9 NR	7.9
CABG or Valve Reoperation more than 1 month after original procedure	0.9	1.2	0.7 *	0.1 NR	1.4	0.5 *	1.0	0.3 *	0.3 NR	0.2 NR	0.0 NR	0.3 NR
Coronary Endarterectomy	0.3	0.4	0.2	0.0 NR	0.3	0.3	0.3	0.3	0.5 NR	0.7 NR	0.0 NR	0.4 NR
Thrombolysis by intracoronary infusion	0.2	0.3	0.2 *	0.0 NR	0.3	0.2	0.3	0.2 NR	0.0 NR	0.0 NR	0.0 NR	0.1 NR
Thrombolysis by intravenous infusion	0.4	0.5	0.3 *	0.2	0.5	0.3	0.4	0.3	0.3 NR	0.0 NR	0.0 NR	0.8 NR
Percutaneous Single Vessel Stent	10.0	13.1	8.3 *	2.6 *	10.4	9.7	10.5	6.0 *	6.3 *	7.4 *	9.4 NR	6.9 *
Percutaneous Multiple Vessel Stent	0.8	1.1	0.7 *	0.2 *	0.9	0.7	0.9	0.4 *	0.2 M	0.1 NR	1.3 NR	0.8 NR
Percutaneous Single Vessel Balloon Angioplasty	6.6	8.5	5.7 *	1.8 *	6.9	6.5	6.7	5.0 *	7.3	8.4	7.4 NR	6.2
Percutaneous Multiple Vessel Balloon Angioplasty	0.6	0.8	0.6	0.2 *	0.8	0.5	0.7	0.4	0.8 NR	1.0 NR	0.9 NR	0.7 NR
Percutaneous Single or Multiple Vessel Atherectomy, Mechanical or other method, with or without balloon angioplasty	0.6	0.8	0.6	0.2 *	0.6	0.7	0.7	0.5	0.6 NR	0.2 NR	2.0 NR	0.8 NR
Aortic, Mitral, Triscuspid, Pulmonary Valvuloplasty, Valvectomy, Valvotomy, and other valvular-related repairs/Aortic, mitral, pulmonary valve percutaneous balloon valvulplasty	1.0	1.2	0.9	0.3 *	0.9	1.0	1.0	0.5 *	0.8 NR	0.6 NR	0.0 NR	1.0 NR
Permanent Pacemaker or Implantable Cardioverter-defibrillator	1.8	1.7	2.1	1.6	2.2	1.6 *	1.9	1.4	0.9 NR	1.5 NR	2.6 NR	1.6

Table 6.A-2 (continued)

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients with a Principal Diagnosis of Subendocardial Infarction by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native American Alaska Native	Other/ Unknown
Severity Indicators												
Non-imaging CV Hemodynamics: Arterial or Venous Central Line for Pressure Monitoring, including Swan-Ganz and ej with probe technique	17.8	22.1	16.1 *	5.7 *	19.2	16.7 *	18.0	14.8 *	16.7	19.4	16.6	18.4
Ventilation Support, including CPAP and CNP	4.5	5.3	4.3 *	2.1 *	4.6	4.5	4.5	4.1	4.9	6.1	2.3 NR	4.2
Cardiac Assist Device -- prolonged extracorporeal, intra-aortic balloon (open or percutaneous insertion), ventricular assist device	3.1	4.0	2.7 *	0.7 *	3.5	2.9 *	3.3	1.6 *	2.3 NR	4.9	0.9 NR	2.6
Insertion of Temporary Pacing Wires or Temp. Transcutanous Pacing	1.7	1.9	1.8	1.0 *	1.6	1.8	1.7	1.4	2.2 NR	2.8	1.3 NR	1.3 NR
Cardiopulmonary Resuscitation	1.7	1.6	1.9	1.3	1.8	1.6	1.6	2.5	2.7 NR	2.9	2.3 NR	2.0
Cardioversion	1.1	1.2	1.2	0.5 *	1.4	0.9 *	1.2	0.6 *	0.9 NR	0.5 NR	0.9 NR	1.0 NR
ICU	22.1	22.7	22.3	19.6 *	22.0	22.2	21.9	20.9	27.6	32.5 *	19.3	27.5 *
Consults During Admission												
Cardiology	73.6	78.2	72.5 *	59.5 *	75.2	72.5 *	74.2	67.5 *	76.1	74.0	57.7 *	70.1
Cardiothoracic surgeon	6.8	8.3	6.3 *	1.9 *	7.7	6.1 *	6.9	4.6 *	8.0	9.8	6.4 NR	7.7
Pulmonary consult	12.1	12.8	12.4	9.4 *	12.5	11.9	12.1	11.7	12.6	15.4	10.6 NR	14.4
Neurology consult	6.5	6.4	7.1	5.5	6.4	6.7	6.3	8.4 *	8.4	8.9	6.9 NR	6.9
Renal consult	7.1	7.9	6.9 *	5.0 *	7.6	6.9	6.4	12.4 *	12.8 *	11.6 *	3.8 NR	10.4 *
Infectious diseases consult	2.6	2.8	2.6	1.8 *	2.6	2.6	2.6	2.8	2.9 NR	3.9	0.0 NR	3.3

NOTES:
* = Significant at the .01 level.
NR = Not statistically reliable.
n = 66,551
[1]Age, Sex, and Race Adjusted; [2]Sex and Race Adjusted; [3]Age and Race Adjusted; [4]Age and Sex Adjusted

Significance tests were conducted:
a. by age using the 65-74 age group as the reference group; b. by gender using males as the reference group; c. by race using whites as the reference group.

SOURCE: HER analysis of 100% 1997 Denominator, MedPAR, Physician/Supplier, and OPD files.

Table 6.A-3

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients with a Principal Diagnosis of Unstable Angina by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Diagnostic Procedures	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native American Alaska Native	Other/ Unknown
Right or Left Heart Catheterization, with angiography	29.1	36.8	25.7 *	8.0 *	32.1	26.9 *	30.4	16.5 *	29.0	22.4 *	21.1	26.0
Right or Left Heart Catheterization, without angiography	0.3	0.4	0.2	0.1 NR	0.3	0.3	0.3	0.2 NR	0.0 NR	0.7 NR	0.0 NR	0.1 NR
Selective venous and/or arterial angiography without cardiac catheterization	0.8	0.9	0.9	0.3 *	1.0	0.7	0.8	0.4 *	1.1 NR	0.5 NR	1.2 NR	0.4 NR
Treadmill or Bicycle Stress Test or pharmacological stress/Ergonovine Provocation Test	20.4	23.5	19.9 *	10.5 *	20.3	20.6	20.1	23.8 *	18.3	20.2	9.4 NR	20.9
ECG -- resting	85.9	86.1	86.1	84.7	85.9	85.8	86.3	82.0 *	89.2	86.1	56.2 *	82.6
Telephonic transmission of post-symptom ECG strips	1.1	1.2	0.9	0.8	1.0	1.1	1.1	1.7	1.1 NR	0.5 NR	0.0 NR	0.1 NR
Signal averaged ECG	0.2	0.2	0.2	0.1 NR	0.2	0.2	0.2	0.4 NR	0.6 NR	0.0 NR	0.0 NR	0.4 NR
ECG Monitoring for 24 hours	1.8	1.7	1.9	2.1	1.7	1.9	1.5	4.9 *	1.4 NR	2.7	1.1 NR	1.1 NR
Intracardiac Electrophysiological Procedures	0.3	0.4	0.3	0.1 NR	0.5	0.2 *	0.3	0.2 NR	0.0 NR	0.1 NR	0.0 NR	0.2 NR
2D or M-mode echocardiogram	33.2	32.3	35.0 *	32.2	32.1	34.0 *	32.7	37.4 *	37.9	38.4 *	22.1	34.2
Doppler echocardiogram	29.0	27.7	30.8 *	29.3	27.9	29.8 *	28.6	31.6 *	32.3	30.5	19.9	31.2
Doppler color velocity flow mapping	24.1	23.0	25.7 *	24.2	23.6	24.5	23.8	26.6 *	27.5	26.1	14.9	24.8
Myocardial Perfusion	17.6	19.7	17.9 *	9.7 *	17.1	18.1	17.3	22.1 *	12.1	17.4	11.6	16.2
Myocardial Imaging	0.2	0.2	0.2	0.1 NR	0.2	0.2	0.2	0.2 NR	0.8 NR	0.2 NR	0.0 NR	0.3 NR
Cardiac blood pool imaging, rest or stress, gated equilibrium or planar, single or multiple, including MUGA	0.9	0.9	0.9	0.7	0.9	0.9	0.9	1.0	0.4 NR	0.7 NR	0.0 NR	1.3 NR
CT of Thorax	2.0	2.1	2.1	1.6	2.3	1.8	2.0	2.0	2.8 NR	1.8	1.1 NR	2.1 NR

Table 6.A-3 (continued)

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients with a Principal Diagnosis of Unstable Angina by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Intervention Procedures	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native American Alaska Native	Other/ Unknown
Coronary Artery Bypass Graft												
CABG: Single Vein Graft	0.1	0.2	0.1	0.0 NR	0.1	0.1	0.1	0.1 NR	0.0 NR	0.1 NR	0.0 NR	0.0 NR
CABG: 2 or 3 Vein Grafts	1.0	1.0	1.2	0.4 *	1.2	0.9	1.1	0.3 NR	0.0 NR	1.2 NR	1.2 NR	0.7 NR
CABG: 4, 5 or 6 or More Vein Grafts	0.6	0.5	0.8 *	0.3	0.8	0.4 *	0.6	0.2 NR	0.4 NR	0.7 NR	0.0 NR	0.9 NR
CABG: Single Arterial Graft	0.2	0.2	0.2	0.1 NR	0.2	0.2	0.2	0.1 NR	0.4 NR	0.0 NR	0.0 NR	0.0 NR
CABG: 2 or More Arterial Grafts	0.1	0.2	0.1	0.0 NR	0.2	0.1	0.2	0.1 NR	0.0 NR	0.0 NR	0.0 NR	0.2 NR
CABG: 1 Arterial Graft and 1 Vein Graft	0.6	0.7	0.5	0.1 NR	0.7	0.5	0.6	0.3 NR	0.4 NR	0.1 NR	0.0 NR	0.4 NR
CABG, One or More Arterial Grafts and any number of Venous Grafts	4.7	6.1 *	3.9 *	0.6	7.0	2.9 *	5.0	1.4 *	6.4	2.6 *	2.2 NR	3.6
CABG or Valve Reoperation more than 1 month after original procedure	0.5	0.6	0.4	0.0 NR	0.8	0.2 *	0.5	0.1 NR	0.4 NR	0.3 NR	0.0 NR	0.5 NR
Coronary Endarterectomy	0.1	0.2	0.1 NR	0.0 NR	0.2	0.1	0.1	0.0 NR	0.0 NR	0.1 NR	0.0 NR	0.2 NR
Thrombolysis by intracoronary infusion	0.1	0.1	0.1	0.0 NR	0.1	0.1	0.1	0.0 NR	0.4 NR	0.0 NR	0.0 NR	0.0 NR
Thrombolysis by intravenous infusion	0.1	0.1	0.1	0.0 NR	0.1	0.1	0.1	0.0 NR	0.0 NR	0.2 NR	0.0 NR	0.4 NR
Percutaneous Single Vessel Stent	5.9	7.5	5.0 *	1.6 *	7.4	4.7 *	6.4	1.5 *	4.6	3.0 *	4.8 NR	5.3
Percutaneous Multiple Vessel Stent	0.4	0.5	0.4 NR	0.2	0.6	0.3	0.5	0.1 NR	0.0 NR	0.3 NR	0.0 NR	0.9 NR
Percutaneous Single Vessel Balloon Angioplasty	3.3	3.9	3.1 *	1.1 *	4.3	2.6 *	3.5	1.4 *	0.8 NR	3.5	2.5 NR	3.1
Percutaneous Multiple Vessel Balloon Angioplasty	0.4	0.5	0.3	0.1 NR	0.5	0.2 *	0.4	0.3 NR	0.0 NR	0.1 NR	0.0 NR	0.9 NR
Percutaneous Single or Multiple Vessel Atherectomy, Mechanical or other method, with or without balloon angioplasty	0.5	0.6	0.5	0.2 NR	0.7	0.4 *	0.5	0.2 NR	1.1 NR	0.4 NR	0.0 NR	0.4
Aortic, Mitral, Triscuspid, Pulmonary Valvuloplasty, Valvectomy, Valvotomy, and other valvular-related repairs/Aortic, mitral, pulmonary valve percutaneous balloon valvulplasty	0.3	0.3	0.4	0.1 NR	0.4	0.3	0.3	0.1 NR	0.0 NR	0.2 NR	1.1 NR	0.4 NR
Permanent Pacemaker or Implantable Cardioverter-defibrillator	0.7	0.6	0.9	0.8	0.9	0.5 *	0.7	0.3 NR	0.0 NR	0.7 NR	0.0 NR	1.0 NR

NR

Table 6.A-3 (continued)

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients with a Principal Diagnosis of Unstable Angina by Age, Gender, and Race/Ethnicity

		Age Group[2]			**Gender[3]**		**Race/Ethnicity[4]**					
	Total[1]	65-74	75-84	85+	Male	Female	White	Black NR	Asian	Hispanic	Native American Alaska Native	Other/ Unknown
Severity Indicators												
Non-imaging CV Hemodynamics: Arterial or Venous Central Line for Pressure Monitoring, including Swan-Ganz and ej with probe technique	7.2	8.6	6.9 *	1.9 *	9.9	5.1 *	7.6	2.7 *	8.2	5.3	5.8 NR	6.6
Ventilation Support, including CPAP and CNP	1.3	1.5	1.3	0.5 *	1.9	0.9 *	1.4	0.7 *	0.4 NR	1.4 NR	1.2 NR	1.1 NR
Cardiac Assist Device -- prolonged extracorporeal, intra-aortic balloon (open or percutaneous insertion), ventricular assist device	1.0	1.2	0.9	0.3 *	1.3	0.7 *	1.1	0.2 NR	1.1 NR	1.0 NR	0.0 NR	0.9 NR
Insertion of Temporary Pacing Wires or Temp. Transcutanous Pacing	0.6	0.6	0.6	0.2 *	0.7	0.5	0.6	0.3 NR	0.7 NR	0.9 NR	0.0 NR	0.3 NR
Cardiopulmonary Resuscitation	0.2	0.2	0.2	0.1 NR	0.2	0.2	0.2	0.1 NR	0.4 NR	0.1 NR	1.2 NR	0.0 NR
Cardioversion	0.3	0.3	0.3	0.2 NR	0.4	0.2	0.3	0.1 NR	0.0 NR	0.3 NR	1.2 NR	0.0 NR
ICU	8.9	9.3	9.0	7.1 *	9.8	8.3 *	8.9	7.9	12.3	11.2	3.4 NR	10.6
Consults During Admission												
Cardiology	57.7	61.5	56.7 *	45.8 *	59.5	56.4 *	58.2	51.7 *	61.4	58.1	39.6 *	59.0
Cardiothoracic surgeon	3.4	4.0	3.4	0.9 *	4.5	2.5 *	3.5	1.4 *	4.2	4.0	0.0 NR	4.1
Pulmonary consult	4.1	4.3	4.5	2.7 *	4.5	3.9	4.3	3.2	3.4 NR	4.8	2.4 NR	3.0
Neurology consult	2.4	2.2	2.9 *	2.0	2.6	2.2	2.5	2.1	0.8 NR	2.7	0.0 NR	2.0 NR
Renal consult	2.7	2.8	2.7	2.1	3.0	2.4	2.4	4.7 *	3.7 NR	4.2	3.5 NR	4.0
Infectious diseases consult	0.8	0.8	0.9	0.6	1.0	0.7	0.8	0.9	1.1 NR	1.0 NR	1.2 NR	0.6 NR

NOTES:
* = Significant at the .01 level.
NR = Not statistically reliable.
n = 39,301
[1]Age, Sex, and Race Adjusted; [2]Sex and Race Adjusted; [3]Age and Race Adjusted; [4]Age and Sex Adjusted

Significance tests were conducted:
a. by age using the 65-74 age group as the reference group; b. by gender using males as the reference group; c. by race using whites as the reference group.

SOURCE: HER analysis of 100% 1997 Denominator, MedPAR, Physician/Supplier, and OPD files.

Table 6.A-4

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients with a Principal Diagnosis of Chronic Stable Angina by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Diagnostic Procedures	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native American Alaska Native	Other/ Unknown
Right or Left Heart Catheterization, with angiography	51.8	58.3	52.2 *	27.6 *	53.7	50.9 *	52.5	45.3 *	50.3	48.4 *	45.6	51.4
Right or Left Heart Catheterization, without angiography	0.5	0.6	0.5	0.2 *	0.6	0.5 *	0.5	0.7	0.3 NR	0.5	0.7 NR	0.7
Selective venous and/or arterial angiography without cardiac catheterization	2.3	2.6	2.4	1.0 *	2.5	2.2 *	2.4	1.4 *	1.3	2.1	1.3 NR	2.0
Treadmill or Bicycle Stress Test or pharmacological stress/Ergonovine Provocation Test	13.4	13.7	14.2	11.2 *	12.3	14.4 *	13.1	17.7 *	13.0	13.4	13.0	13.2
ECG -- resting	85.3	84.5	86.0 *	86.5 *	84.2	86.0 *	85.6	84.2 *	81.7	85.4	77.8	80.4 *
Telephonic transmission of post-symptom ECG strips	1.1	1.1	1.1	1.0	1.1	1.1	1.0	1.8	0.9 NR	0.4 *	0.8 NR	0.8
Signal averaged ECG	0.3	0.3	0.3	0.2	0.4	0.2 *	0.3	0.3	0.2 NR	0.2 NR	0.0 NR	0.2 NR
ECG Monitoring for 24 hours	1.7	1.4	1.9 *	2.5 *	1.7	1.8	1.6	3.4 *	1.8 NR	1.9	0.4 NR	1.5
Intracardiac Electrophysiological Procedures	0.7	0.7	0.7	0.4 *	1.0	0.5 *	0.7	0.7	0.4 NR	0.4	0.0 NR	0.3 NR
2D or M-mode echocardiogram	27.2	24.6	29.4 *	32.2 *	25.5	28.5 *	26.7	32.4 *	26.7	30.7 *	26.9	28.3
Doppler echocardiogram	22.8	20.0	24.9 *	28.7 *	21.0	24.2 *	22.3	27.9 *	22.9	24.4	24.5	23.9
Doppler color velocity flow mapping	19.2	16.9	20.9 *	23.9 *	17.6	20.4 *	18.8	23.8 *	19.3	19.6	22.2	20.5
Myocardial Perfusion	12.5	12.4	13.4 *	11.1 *	11.0	13.6 *	11.9	18.1 *	12.7	14.1 *	14.9	11.9
Myocardial Imaging	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1 NR	0.2 NR	0.4	0.0 NR	0.4 NR
Cardiac blood pool imaging, rest or stress, gated equilibrium or planar, single or multiple, including MUGA	0.8	0.8	0.9	0.8	0.9	0.8	0.8	1.2 *	0.3 NR	0.8	1.2 NR	0.7
CT of Thorax	1.8	1.7	2.1 *	1.8	2.0	1.7 *	1.8	2.2	1.1 NR	1.6	3.5 NR	1.6

Table 6.A-4 (continued)

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients with a Principal Diagnosis of Chronic Stable Angina by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Intervention Procedures	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native American/ Alaska Native	Other/ Unknown
Coronary Artery Bypass Graft												
CABG: Single Vein Graft	0.4	0.5	0.4	0.2	0.4 *	0.5	0.5	0.3	0.4 NR	0.3 NR	0.0 NR	0.5 NR
CABG: 2 or 3 Vein Grafts	3.5	3.3	4.3	2.3	3.6	3.4	3.6	2.2 *	3.9	3.2	1.5 NR	3.7
CABG: 4, 5 or 6 or More Vein Grafts	2.0	1.8	2.6	1.1 *	2.3	1.7 *	2.0	1.6	2.4	2.2	3.3 NR	2.4
CABG: Single Arterial Graft	0.7	0.9	0.6 *	0.3 *	0.8	0.7	0.7	0.5 *	0.7 NR	0.4	0.8 NR	0.6
CABG: 2 or More Arterial Grafts	0.5	0.6	0.4 *	0.1 *	0.5	0.4	0.5	0.3 *	0.2 NR	0.2 NR	0.0 NR	0.2 NR
CABG: 1 Arterial Graft and 1 Vein Graft	1.9	2.5	1.6 *	0.4 *	2.0	1.8	2.0	1.2 *	0.6 NR	1.4	1.1 NR	1.5
CABG, One or More Arterial Grafts and any number of Venous Grafts	15.3	19.5	13.6 *	3.0 *	19.7	12.0 *	15.9	9.0 *	13.2	13.3 *	12.8	14.5
CABG or Valve Reoperation more than 1 month after original procedure	1.8	2.2	1.7 *	0.4 *	2.8	1.1 *	1.9	0.7 *	1.4	1.1 *	0.7 NR	1.9
Coronary Endarterectomy	0.4	0.5	0.4 *	0.1 *	0.6	0.3 *	0.4	0.4	0.4 NR	0.5	1.6 NR	0.3 NR
Thrombolysis by intracoronary infusion	0.2	0.3	0.2	0.1 *	0.3	0.2 *	0.2	0.2	0.2 NR	0.1 NR	0.0 NR	0.2 NR
Thrombolysis by intravenous infusion	0.2	0.2	0.2	0.1	0.2	0.1	0.2	0.1 NR	0.1 NR	0.1 NR	0.0 NR	0.3 NR
Percutaneous Single Vessel Stent	17.1	20.2	16.0 *	8.6 *	18.2	16.4 *	17.7	11.4 *	16.4	12.2 *	10.1 *	16.6
Percutaneous Multiple Vessel Stent	1.5	1.7	1.4 *	0.9 *	1.6	1.3 *	1.5	1.0 *	0.6 NR	1.4	0.4 NR	1.6
Percutaneous Single Vessel Balloon Angioplasty	10.7	12.2	10.5 *	6.0 *	11.0	10.6	10.8	9.2 *	15.8	12.3	5.5 NR	10.8
Percutaneous Multiple Vessel Balloon Angioplasty	1.2	1.4	1.2	0.8 *	1.3	1.1 *	1.2	1.2	2.0	1.7	0.4 NR	1.2
Percutaneous Single or Multiple Vessel Atherectomy, Mechanical or other method, with or without balloon angioplasty	2.1	2.4	2.0 *	1.3 *	2.1	2.1	2.2	1.4 *	3.1	1.8	1.1 NR	2.4
Aortic, Mitral, Triscuspid, Pulmonary Valvuloplasty, Valvectomy, Valvotomy, and other valvular-related repairs/Aortic, mitral, pulmonary valve percutaneous balloon valvulplasty	1.2	1.1	1.4 *	0.7 *	1.3	1.0 *	1.2	0.7 *	1.2	0.7	0.0 NR	0.9
Permanent Pacemaker or Implantable Cardioverter-defibrillator	1.2	1.0	1.4 *	1.3 *	1.5	0.9 *	1.2	0.9	0.8 NR	0.8	0.4 NR	0.9

Table 6.A-4 (continued)

Rates of Cardiac Procedures and Diagnostic Tests Per 100 IHD Patients with a Principal Diagnosis of Chronic Stable Angina by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native American/ Alaska Native	Other/ Unknown
Severity Indicators												
Non-imaging CV Hemodynamics: Arterial or Venous Central Line for Pressure Monitoring, including Swan-Ganz and ej with probe technique	22.7	26.8	22.3 *	8.0 *	27.5	19.4 *	23.5	14.9 *	21.4	19.8 *	18.4	21.8
Ventilation Support, including CPAP and CNP	4.0	4.5	4.1	1.5 *	4.8	3.4 *	4.1	2.2 *	2.8	4.6	5.4 NR	3.7
Cardiac Assist Device -- prolonged extracorporeal, intra-aortic balloon (open or percutaneous insertion), ventricular assist device	2.0	2.1	2.2	1.0 *	2.4	1.7 *	2.1	1.0 *	1.0 *	2.1	0.4 NR	2.6
Insertion of Temporary Pacing Wires or Temp. Transcutanous Pacing	1.6	1.7	1.6	1.0 *	1.7	1.5	1.6	1.5	2.9	1.6	1.5 NR	1.9
Cardiopulmonary Resuscitation	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.5 NR	0.2 NR	0.0 NR	0.3 NR
Cardioversion	0.7	0.7	0.7	0.4 *	0.9	0.5 *	0.7	0.4 *	0.7 NR	0.3 NR	0.4 NR	0.4 NR
ICU	8.0	7.8	8.5 *	7.6	8.0	8.0	7.7	8.7 *	10.8 *	13.2 *	6.8 NR	11.1 *
Consults During Admission												
Cardiology	72.0	73.9	73.2	62.8 *	72.9	71.6 *	72.5	67.3 *	73.5	69.0 *	56.9 *	69.7
Cardiothoracic surgeon	7.6	8.4	7.9 *	3.7 *	8.6	6.9 *	7.7	4.9 *	9.3	10.9 *	6.7	9.1
Pulmonary consult	6.0	6.3	6.3	4.5 *	6.5	5.8 *	6.1	5.4	4.8	6.3	5.5 NR	6.0
Neurology consult	3.6	3.4	4.3 *	2.9	3.8	3.5	3.6	3.9	4.1	3.5	3.5 NR	3.9
Renal consult	3.5	3.6	3.8	2.8 *	3.8	3.4 *	3.2	6.8 *	5.0	5.6 *	3.4 NR	4.3
Infectious diseases consult	1.2	1.2	1.3	1.0	1.4	1.1 *	1.2	1.4	1.5 NR	1.9	0.4 NR	1.2

NOTES:
* = Significant at the .01 level.
NR = Not statistically reliable.
n = 186,287
[1]Age, Sex, and Race Adjusted; [2]Sex and Race Adjusted; [3]Age and Race Adjusted;

Significance tests were conducted:
a. by age using the 65-74 age group as the reference group; b. by gender using males as the reference group; c. by race using whites as the reference group.

SOURCE: HER analysis of 100% 1997 Denominator, MedPAR, Physician/Supplier, and OPD files.

Appendix 6.B

Procedure Rates 6-Months Prior to Admission

Table 6.B-1

Rates of Cardiac Procedures and Diagnostic Tests Provided During the 6 Month Period Prior to Hospitalization Per 100 Medicare FFS Beneficiaries Admitted with a Principal Diagnosis of Ischemic Heart Disease by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Procedure	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native American/ Alaska Native	Other/ Unknown
Coronary Artery Bypass Graft	0.53	0.66	0.49 *	0.11 *	0.57	0.50	0.54	0.35 *	0.60	0.84	0.53 NR	0.50
Angioplasty	3.32	4.05	3.04 *	1.26 *	3.53	3.18 *	3.4	2.5 *	3.61	2.83	3.76	3.18
Non-imaging CV Hemodynamic Monitoring	2.71	3.08	2.68 *	1.5 *	2.75	2.7	2.65	3.26 *	3.43	3.07	2.4 NR	2.7
Cardiac Rehab Physician Services	1.24	1.64	1.04 *	0.33 *	1.36	1.17 *	1.34	0.54 *	0.91	0.42 *	0.44 NR	0.58 *
Ventilator Support	2.48	2.70	2.45 *	1.84 *	2.49	2.50	2.43	2.90 *	2.24	4.04 *	1.78 NR	2.12
Right or Left Heart Catheterization and/or Angiography	14.23	17.83	12.74 *	4.17 *	16.57	12.55 *	14.61	10.36 *	16.39	12.93 *	9.60 *	12.96 *
Echocardiogram/Doppler Flow Mapping	23.34	23.66	24.35 *	19.97 *	23.49	23.33	22.99	25.95 *	27.69 *	28.52 *	19.13	23.33
Electrocardiogram	60.54	60.65	61.58 *	57.99 *	60.54	60.64	60.38	61.47 *	62.89	66.57 *	50.15 *	59.91
24 Hour ECG Monitoring	7.11	6.94	7.57 *	6.83	7.00	7.24	6.98	8.35 *	7.14	9.76 *	4.77	6.35
Diagnostic Imaging	18.29	21.95	17.16 *	7.36 *	20.30	16.90 *	18.62	15.55 *	15.56 *	18.36	14.29	15.79 *
ICU Admissions	3.95	3.89	4.10	3.85	3.64	4.18 *	3.78	5.24 *	4.83	6.70 *	2.31	4.23
Renal, Neurology or Respiratory Consult	6.84	6.57	7.34 *	6.89	6.52	7.13 *	6.44	10.57 *	7.83	10.18 *	6.15	7.11
Cardiology Consult	16.91	16.95	17.44	15.67 *	16.71	17.12	16.74	18.43 *	17.37	19.39 *	12.46	16.65
Cardiothoracic Surgical Consult	1.31	1.53	1.21 *	0.67 *	1.46	1.19 *	1.30	1.19 *	1.97	2.13 *	1.05 NR	1.50
Permanent or Temporary Pacemaker	1.54	1.43	1.72 *	1.57	1.86	1.33 *	1.55	1.43	1.73	1.64	0.34 NR	1.22
Stress Test	21.49	26.96	19.15 *	6.40 *	24.87	19.06 *	22.05	15.63 *	24.35 *	20.01 *	15.38 *	19.89 *

NOTES:
* = Significant at the .01 level.
NR = Not statistically reliable.
n = 350,704
[1]Age, Sex, and Race Adjusted; [2]Sex and Race Adjusted; [3]Age and Race Adjusted;[4] Age and Sex Adjusted

Significance tests were conducted:
a. by age using the 65-74 age group as the reference group; b. by gender using males as the reference group; c. by race using whites as the reference group.

SOURCE: HER analysis of 100% 1997 Denominator, MedPAR, Physician/Supplier, and OPD files.

Table 6.B-2

Rates of Cardiac Procedures and Diagnostic Tests Provided During the Hospitalization Per 100 Medicare FFS Beneficiaries Admitted with a Principal Diagnosis of Ischemic Heart Disease by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Procedure	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native American/ Alaska Native	Other/ Unknown
Coronary Artery Bypass Graft	17.39	21.73	16.09 *	3.59 *	21.54	14.35 *	18.10	10.16 *	16.70	15.26 *	11.32 *	16.75
Angioplasty	23.30	28.62	21.27 *	8.51 *	24.77	22.33 *	24.13	15.39 *	22.63	19.77 *	15.27 *	21.52 *
Non-imaging CV Hemodynamic Monitoring	19.83	23.88	18.86 *	6.43 *	23.67	17.03 *	20.43	13.66 *	19.27	17.93 *	13.98 *	19.57
Cardiac Rehab Physician Services	0.06	0.07	0.05	0.03	0.06	0.05 *	0.05	0.05	0.21 NR	0.11 NR	0.00 NR	0.16 NR
Ventilator Support	3.98	4.57	3.98 *	1.70 *	4.66	3.50 *	4.09	2.72 *	3.51	4.68	3.45	3.63
Right or Left Heart Catheterization and/or Angiography	48.41	57.95	46.50 *	17.77 *	51.11	46.69 *	49.39	38.95 *	46.07 *	45.00 *	39.44 *	46.64 *
Echocardiogram/Doppler Flow Mapping	38.88	35.42	41.65 *	45.53 *	37.33	40.11 *	38.40	43.66 *	38.40	40.96	35.69 *	39.77
Electrocardiogram	87.14	86.83	87.72 *	87.04	86.60	87.56 *	87.44	85.29 *	84.71 *	87.16	73.03 *	82.95 *
24 Hour ECG Monitoring	3.29	3.16	3.44 *	3.42 *	3.34	3.27	3.12	5.50 *	2.63	3.07	1.34 NR	2.68
Diagnostic Imaging	14.37	14.98	15.36	10.08 *	13.68	14.99 *	13.98	18.59 *	13.94	15.42	15.38	13.95
ICU Admissions	14.79	14.15	15.49 *	15.74 *	14.99	14.72	14.63	14.57	17.98 *	19.97 *	12.68	18.54 *
Renal, Neurology or Respiratory Consult	14.89	14.70	16.01 *	13.27 *	15.84	14.36 *	14.48	18.50 *	16.46	17.66 *	12.03	16.54 *
Cardiology Consult	71.29	74.34	71.65 *	59.46 *	72.77	70.41 *	71.86	65.75 *	73.54	69.18	55.45 *	69.31 *
Cardiothoracic Surgical Consult	6.85	7.99	6.85 *	2.44 *	7.90	6.11 *	6.99	4.37 *	8.74	9.58 *	4.51	8.16
Permanent or Temporary Pacemaker	4.17	4.20	4.54 *	3.14 *	4.93	3.65 *	4.27	3.27 *	4.14	3.60	2.67	3.77
Stress Test	13.01	14.14	13.52 *	7.89 *	12.27	13.64 *	12.77	15.60 *	12.98	13.17	11.99	12.65

NOTES:
* = Significant at the .01 level.
NR = Not statistically reliable.
n = 350,704
[1]Age, Sex, and Race Adjusted; [2]Sex and Race Adjusted; [3]Age and Race Adjusted;[4] Age and Sex Adjusted

Significance tests were conducted:
a. by age using the 65-74 age group as the reference group; b. by gender using males as the reference group; c. by race using whites as the reference group.

SOURCE: HER analysis of 100% 1997 Denominator, MedPAR, Physician/Supplier, and OPD files.

Table 6.B-3

Rates of Cardiac Procedures and Diagnostic Tests During Hospitalization and the 6 Month Period Prior to Admission Per 100 Medicare FFS Beneficiaries Admitted with a Principal Diagnosis of Acute Myocardial Infarction by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Procedure	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native American/ Alaska Native	Other/ Unknown
Coronary Artery Bypass Graft	13.73	18.05	11.74 *	2 *	16.03	12.03 *	14.16	8.88 *	14.7	14.61	7.57 *	13.74
Angioplasty	23.38	30.15	19.9 *	6.73 *	23.82	23.1	24.22	15.85 *	19.5 *	21.77	20.44	19.38 *
Non-imaging CV Hemodynamic Monitoring	21.3	25.92	19.71 *	7.74 *	22.86	20.18 *	21.42	19.08 *	23.47	23.72	15.35	22.91
Cardiac Rehab Physician Services	0.62	0.77	0.54 *	0.24 *	0.74	0.53 *	0.66	0.25 *	0.66 NR	0.14 NR	0 NR	0.32 NR
Ventilator Support	7.03	8.17	6.67 *	3.74 *	7.31	6.88	7	7.03	7.86	10.05 *	3.08 NR	5.88
Right or Left Heart Catheterization and/or Angiography	52.3	66.16	46.54 *	14.89 *	54.81	50.65 *	53.33	42.3 *	48.66	52.28	43.4	48.91 *
Echocardiogram/Doppler Flow Mapping	65.79	64.34	68.47 *	65.42	64.18	67.16 *	65.41	69.15 *	67.48	70.79 *	56.09	64.54
Electrocardiogram	94.89	95.34	94.96	93.26 *	94.76	95.03	95.09	93.45 *	93.86	95.55	86.49 *	91.67 *
24 Hour ECG Monitoring	7.89	7.68	8.29	7.88	7.94	7.91	7.67	10.43 *	8.05	9.25	4.82 NR	6.51
Diagnostic Imaging	19.57	21.39	20.24 *	11.53 *	20.62	18.99 *	19.5	20.6	19.42	19.25	19.56	18.68
ICU Admissions	30.05	31.42	29.99 *	25.6 *	29.85	30.32	29.93	27.96 *	36.15 *	41.16 *	27.48	34.78 *
Renal, Neurology or Respiratory Consult	24.9	25.24	26.16	21.23 *	25.36	24.79	24.09	31.42 *	30.81 *	32.62 *	17.16	27.56 *
Cardiology Consult	77.37	81.91	76.36 *	63.39 *	78.62	76.62 *	77.88	72.53 *	79.14	76.95	65.78 *	74.73
Cardiothoracic Surgical Consult	7.68	9.37	7.14 *	2.49 *	8.54	7.06 *	7.72	5.83 *	11.11	11.65 *	5.18 NR	9.56
Permanent or Temporary Pacemaker	6.96	7.26	7.33	4.92 *	7.72	6.43 *	7.09	5.75 *	6.99	7.06	4.34 NR	5.83
Stress Test	16.67	19.16	16.57 *	7.65 *	18.01	15.8 *	16.84	15.02 *	17.63	16.07	15.08	15.03

NOTES:
* = Significant at the .01 level.
NR = Not statistically reliable.
n = 124,995
[1]Age, Sex, and Race Adjusted; [2]Sex and Race Adjusted; [3]Age and Race Adjusted; [4] Age and Sex Adjusted

Significance tests were conducted:
a. by age using the 65-74 age group as the reference group; b. by gender using males as the reference group; c. by race using whites as the reference group.

SOURCE: HER analysis of 100% 1997 Denominator, MedPAR, Physician/Supplier, and OPD files.

Table 6.B-4

Rates of Cardiac Procedures and Diagnostic Tests During Hospitalization and the 6 Month Period Prior to Admission Per 100 Medicare FFS Beneficiaries Admitted with a Principal Diagnosis of Unstable Angina by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Procedure	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native American/ Alaska Native	Other/ Unknown
Coronary Artery Bypass Graft	6.98	8.48	6.65 *	1.55 *	9.83	4.86 *	7.43	2.35 *	7.65	5.45	3.48 NR	6.06
Angioplasty	10.18	12.59	9.15 *	3.04 *	12.61	8.34 *	10.86	3.54 *	7.89	7.85 *	8.31 NR	8.93
Non-imaging CV Hemodynamic Monitoring	9.05	10.58	8.98 *	2.95 *	12	6.87 *	9.43	4.86 *	10.31	7.46	6.96 NR	9.47
Cardiac Rehab Physician Services	0.86	1.08	0.79	0.13 *	1.04	0.71	0.93	0.38 *	0.4 NR	0.53 NR	0 NR	0 NR
Ventilator Support	3.8	4.23	3.69	2.51 *	4.61	3.25 *	3.86	3.1	1.55 NR	5.67	4.38 NR	3.68
Right or Left Heart Catheterization and/or Angiography	33.37	41.75	30.09 *	9.7 *	37.12	30.69 *	34.71	20.08 *	33.78	27.66 *	25.6	30.73
Echocardiogram/Doppler Flow Mapping	46.82	45.29	49.49 *	46.32	45.91	47.58 *	46.07	52.73 *	50.5	56.43 *	32.42	50.05
Electrocardiogram	93.29	93.17	93.69	92.93	93.34	93.28	93.53	91.35 *	93.91	93.62	70.93 *	92.23
24 Hour ECG Monitoring	9.41	9.2	9.71	9.6	8.99	9.77	8.98	13.76 *	7.83	13.91 *	3.37 NR	9.24
Diagnostic Imaging	29.4	32.7	29.59 *	17.11 *	30.14	29.05	29.14	33.31 *	22.96	30.08	22.07	28.46
ICU Admissions	11.48	11.96	11.53	9.45 *	12.23	10.92 *	11.41	11.14	13.47	16.62 *	3.37 NR	13.38
Renal, Neurology or Respiratory Consult	13.22	12.84	14.63 *	11.25	14.11	12.64 *	12.89	16.01 *	12.07	17.13 *	11.63	15.26
Cardiology Consult	61.34	64.74	60.71 *	50.12 *	63.24	60.03 *	61.77	56.72 *	64.86	61.42	43.06 *	61.26
Cardiothoracic Surgical Consult	4.04	4.62	4.12	1.45 *	5.31	3.11 *	4.17	2.13 *	4.26	5.33	1.24 NR	5.21
Permanent or Temporary Pacemaker	2.88	2.72	3.25 *	2.67 *	3.68	2.36 *	2.97	1.99 *	2.11 NR	2.37	1.18 NR	3.02
Stress Test	30.83	35.89	29.71 *	14.91 *	31.97	30.13 *	30.76	32.08	29.81	29.42	23.13	30.66

NOTES:
* = Significant at the .01 level.
NR = Not statistically reliable.
n = 39,301
[1]Age, Sex, and Race Adjusted; [2]Sex and Race Adjusted; [3]Age and Race Adjusted;[4] Age and Sex Adjusted

Significance tests were conducted:
a. by age using the 65-74 age group as the reference group; b. by gender using males as the reference group; c. by race using whites as the reference group.

SOURCE: HER analysis of 100% 1997 Denominator, MedPAR, Physician/Supplier, and OPD files.

Table 6.B-5

Rates of Cardiac Procedures and Diagnostic Tests During Hospitalization and the 6 Month Period Prior to Admission Per 100 Medicare FFS Beneficiaries Admitted with a Principal Diagnosis of Chronic Stable Angina by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Procedure	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native American/ Alaska Native	Other/ Unknown
Coronary Artery Bypass Graft	22.66	27.03	22.14 *	7.10 *	27.60	19.15 *	23.50	14.13 *	21.06 *	19.80 *	18.70 *	22.26 *
Angioplasty	29.58	34.48	28.14 *	15.50 *	30.88	28.89 *	30.33	21.95 *	32.56	25.03 *	22.89 *	29.28
Non-imaging CV Hemodynamic Monitoring	25.02	29.37	24.54 *	9.66 *	29.69	21.76 *	25.76	17.64 *	24.31	22.52 *	20.15	23.83
Cardiac Rehab Physician Services	1.77	2.27	1.53 *	0.63 *	1.86	1.73	1.89	0.88 *	1.61	0.70 *	0.97 NR	1.21
Ventilator Support	6.41	7.08	6.61	3.50 *	7.15	5.93 *	6.51	5.07 *	5.81	8.74 *	7.34	5.98
Right or Left Heart Catheterization and/or Angiography	69.10	79.01	68.39 *	34.59 *	73.97	66.04 *	70.18	58.42 *	70.14	63.26 *	60.23 *	67.25 *
Echocardiogram/Doppler Flow Mapping	50.64	48.59	53.34 *	52.22 *	49.23	51.78 *	49.91	57.48 *	53.57	55.99 *	46.07	51.30
Electrocardiogram	95.93	95.80	96.38	95.47	95.64	96.16 *	96.04	95.16 *	95.52	96.08	86.79 *	94.98
24 Hour ECG Monitoring	11.47	10.75	12.24 *	12.51 *	11.37	11.60	11.18	14.74 *	11.32	13.66	6.99	10.22
Diagnostic Imaging	38.69	42.53	38.91	24.45	40.08	37.92	38.63	40.79	34.89	39.20	38.02	34.48
ICU Admissions	11.16	10.86	11.74 *	10.99	10.85	11.41	10.80	12.96 *	14.52 *	17.37 *	8.92	14.18 *
Renal, Neurology or Respiratory Consult	16.60	16.26	17.85 *	15.32	17.06	16.42	16.11	21.24 *	17.93	20.56 *	14.25	16.65
Cardiology Consult	76.10	77.82	77.27	67.44 *	76.86	75.78 *	76.49	72.67 *	77.54	73.94	58.44 *	73.91
Cardiothoracic Surgical Consult	9.16	10.26	9.36 *	4.60 *	10.34	8.36 *	9.33	6.18 *	11.28	13.23 *	7.68	10.22
Permanent or Temporary Pacemaker	5.39	5.18	5.91 *	5.09 *	6.60	4.61 *	5.48	4.71 *	5.83	5.01	2.71 NR	4.49
Stress Test	43.91	50.49	42.57 *	22.87 *	47.41	41.57 *	44.26	40.66 *	47.83	41.18 *	36.50	42.17

NOTES:
* = Significant at the .01 level.
NR = Not statistically reliable.
n = 186,287
[1]Age, Sex, and Race Adjusted; [2]Sex and Race Adjusted; [3]Age and Race Adjusted;[4] Age and Sex Adjusted

Significance tests were conducted:
a. by age using the 65-74 age group as the reference group; b. by gender using males as the reference group; c. by race using whites as the reference group.

SOURCE: HER analysis of 100% 1997 Denominator, MedPAR, Physician/Supplier, and OPD files.

Table 6.B-6

Rates of Cardiac Procedures and Diagnostic Tests Provided During the 6 Month Period Prior to Hospitalization Per 100 Medicare FFS Beneficiaries Admitted with a Principal Diagnosis of Acute Myocardial Infarction by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Procedure	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native American/ Alaska Native	Other/ Unknown
Coronary Artery Bypass Graft	0.32	0.39	0.31	0.05 *	0.36	0.29	0.33	0.2	0.09 NR	0.54 NR	0 NR	0.17 NR
Angioplasty	1.31	1.57	1.25 *	0.44 *	1.44	1.21	1.32	1.19	1.48 NR	1.51	1.71 NR	1.21
Non-imaging CV Hemodynamic Monitoring	2.55	2.93	2.47 *	1.36 *	2.5	2.6	2.43	3.59 *	3.94	2.99	3.43 NR	2.42
Cardiac Rehab Physician Services	0.57	0.71	0.49 *	0.2 *	0.68	0.48 *	0.61	0.19 *	0.66 NR	0.14 NR	0 NR	0.17 NR
Ventilator Support	2.36	2.66	2.27 *	1.63 *	2.38	2.39	2.3	3.06	1.81 NR	3.56	0.45 NR	1.6
Right or Left Heart Catheterization and/or Angiography	4.13	4.94	3.95 *	1.52 *	4.53	3.87 *	4.11	4.36	4.56	4.53	4.27 NR	3.53
Echocardiogram/Doppler Flow Mapping	15.29	14.34	16.61 *	16.03 *	14.85	15.73 *	14.85	19.09 *	17.95	20.43 *	16.81	14.18
Electrocardiogram	46.76	44.35	49.13 *	50.49 *	45.88	47.52 *	46.23	51.22 *	48.05	55.38 *	46.47	45.17
24 Hour ECG Monitoring	4.35	3.97	4.76 *	4.96 *	4.27	4.46	4.24	5.59 *	4.99	5.25	3.51 NR	3.73
Diagnostic Imaging	7.67	8.6	7.63 *	4.3 *	8.38	7.21 *	7.68	7.71	6.84	7.92	7.16 NR	6.99
ICU Admissions	4.19	4.22	4.32	3.77	3.95	4.37	4.01	5.3 *	6.32	7.97 *	3.51 NR	4.51
Renal, Neurology or Respiratory Consult	6.82	6.67	7.27	6.55	6.4	7.19 *	6.37	10.95 *	8.24	10.66 *	5.27 NR	6.87
Cardiology Consult	11.79	11.49	12.32	11.8	11.71	11.93	11.54	13.99	13.01	14	11.87	11.25
Cardiothoracic Surgical Consult	0.71	0.77	0.71	0.46 *	0.71	0.71	0.67	0.87	1.64	1.19	0.84 NR	1.09
Permanent or Temporary Pacemaker	1.05	0.96	1.2	1.07	1.26	0.92 *	1.04	1.17	1.82 NR	1.1	0.45 NR	0.78 NR
Stress Test	6.93	8.3	6.49 *	2.81 *	7.96	6.21 *	7.02	5.96 *	7.52	7.33	3.86 NR	6
Preadmission physician direction of EMS or use of ER	32.14	29.65	33.55 *	38.37 *	29.21	34.27 *	31.21	41.65 *	26.84 *	40.19	43.12	30.62
Cardiac Laboratory Tests	27.87	27.15	28.91 *	28.2	26.19	29.14 *	27.38	31.3 *	29.6	34.15 *	27.29	29.2
Pulse oximetry	9.07	9.12	9.19	8.98	8.81	9.35	8.95	9.9	9.32	11.8 *	6.92 NR	9.03
Physical Therapy	1.09	1.17	1.1	0.76 *	0.95	1.19 *	1.1	0.57 *	2.46	2.27 *	0 NR	1.28
Observation Bed Admission	3.28	3.23	3.34	3.4	3.07	3.45	3.36	2.96	1.06 NR	2.38	4.81 NR	2.12
Office Services after Hours	1.02	0.92	1.06	1.29 *	0.88	1.12 *	0.92	1.5 *	3.04 *	2.49 *	0.86 NR	1.89

NOTES:
* = Significant at the .01 level.
NR = Not statistically reliable.
n = 124,995
[1]Age, Sex, and Race Adjusted; [2]Sex and Race Adjusted; [3]Age and Race Adjusted; [4] Age and Sex Adjusted

Significance tests were conducted:
a. by age using the 65-74 age group as the reference group; b. by gender using males as the reference group; c. by race using whites as the reference group.

SOURCE: HER analysis of 100% 1997 Denominator, MedPAR, Physician/Supplier, and OPD files.

Table 6.B-7

Rates of Cardiac Procedures and Diagnostic Tests Provided During the 6 Month Period Prior to Hospitalization Per 100 Medicare FFS Beneficiaries Admitted with a Principal Diagnosis of Chronic Stable Angina by Age, Gender, and Race/Ethnicity

		Age Group[2]			Gender[3]		Race/Ethnicity[4]					
Procedure	Total[1]	65-74	75-84	85+	Male	Female	White	Black	Asian	Hispanic	Native American/ Alaska Native	Other/ Unknown
Coronary Artery Bypass Graft	0.68	0.85	0.62 *	0.22 *	0.71	0.67	0.7	0.49	0.87 NR	0.96	0.42 NR	0.68
Angioplasty	4.88	5.64	4.64 *	2.79 *	5.08	4.78	4.98	3.97 *	5.04	3.67 *	8.29	4.98
Non-imaging CV Hemodynamic Monitoring	2.97	3.34	2.93 *	1.9 *	3.01	2.99	2.94	3.37	3.75	3.28	1.81 NR	2.85
Cardiac Rehab Physician Services	1.73	2.22	1.49 *	0.61 *	1.82	1.69	1.85	0.84 *	1.21	0.5 *	0.97 NR	0.98 *
Ventilator Support	2.57	2.73	2.6	2.1 *	2.54	2.63	2.52	2.97	3.08	4.4 *	1.98 NR	2.3
Right or Left Heart Catheterization and/or Angiography	21.99	26.37	20.59 *	9.11 *	25.24	19.76 *	22.52	16.59 *	25.96	19	18.56	20.81
Echocardiogram/Doppler Flow Mapping	29.59	29.66	30.93 *	26.39 *	29.7	29.62	29.19	32.61 *	35.92 *	33.6 *	24.18	30.23
Electrocardiogram	70.31	70.24	71.32 *	68.69 *	70.48	70.32	70.22	70.48	74.21	74.74 *	56.67 *	70.36
24 Hour ECG Monitoring	9	8.48	9.68 *	9.5 *	8.85	9.17	8.83	10.6 *	8.99	11.96 *	5.84	8.14
Diagnostic Imaging	26.11	30.37	25.28 *	12.48 *	28.65	24.45 *	26.55	22.78 *	22.19 *	25.57	21.21	22.65 *
ICU Admissions	4.01	3.86	4.13	4.35	3.58	4.33 *	3.83	5.5 *	4.59	6.03 *	2.48 NR	4.42
Renal, Neurology or Respiratory Consult	7.07	6.67	7.47 *	7.77 *	6.63	7.43 *	6.68	10.89 *	8.51	10.33 *	6.82	6.6
Cardiology Consult	21.24	20.6	21.96 *	22.21 *	20.59	21.78 *	21.03	23.36 *	20.93	23.47	13.47 *	21.52
Cardiothoracic Surgical Consult	1.78	2.06	1.67 *	1.02 *	1.99	1.63 *	1.78	1.53	2.68	2.75	0.97 NR	1.96
Permanent or Temporary Pacemaker	1.93	1.71	2.13 *	2.38 *	2.33	1.68 *	1.95	1.79	1.74	2.2	0.36 NR	1.58
Stress Test	32.03	38.66	29.89 *	12.44 *	36.61	28.87 *	32.76	24.54 *	36.24	29.09 *	24.58 *	30.87
Preadmission physician direction of EMS or use of ER	35.99	32.77	37.05 *	45.83 *	31.99	38.85 *	34.97	47.16 *	27.51 *	41.72 *	37.12	36.39
Cardiac Laboratory Tests	38.73	40.48	38.5 *	33.31 *	38.36	39.14	38.69	38.96	37.7	41.5 *	31.32	38.05
Pulse oximetry	12.94	12.97	13.33	12.34	12.85	13.1	12.86	13.59	13.72	15.32 *	11.91	12.98
Physical Therapy	1.37	1.41	1.45	1.1	1.3	1.44	1.4	0.92 *	2.8	1.6	1.14 NR	1.06
Observation Bed Admission	5.88	6.01	5.82	5.61	5.94	5.86	6.04	4.82 *	3.19 *	4.57 *	4.65 NR	4.5 *
Office Services after Hours	1.17	1.11	1.13	1.52 *	1.02	1.29 *	1.1	1.58 *	1.43	2.44 *	0 NR	1.83

NOTES:
* = Significant at the .01 level.
NR = Not statistically reliable.
n = 186,287
[1]Age, Sex, and Race Adjusted; [2]Sex and Race Adjusted; [3]Age and Race Adjusted; [4] Age and Sex Adjusted

Significance tests were conducted:
a. by age using the 65-74 age group as the reference group; b. by gender using males as the reference group; c. by race using whites as the reference group.

SOURCE: HER analysis of 100% 1997 Denominator, MedPAR, Physician/Supplier, and OPD files.

Appendix 6.C

Step-Wise Multinomial Revascularization Models

Table 6.C-1

Multinomial Logisitic Regression Models of Likelihood of Angiolpasty or CABG Relative to Medical Treatment During Admission for Ischemic Heart Disease for Medicare Fee-for-Service Beneficiaries

Angioplasty	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
Black	0.503 ***	0.575 ***	0.624 ***	0.664 ***	0.660 ***	0.671 ***	0.683 ***
Asian	0.974	1.147 *	1.034	1.018	0.996	1.025	1.030
Hispanic	0.802 ***	0.958	0.981	0.989	0.980	1.015	1.019
AI/NA	0.534 ***	0.636 **	0.634 **	0.653 **	0.657 **	0.687 **	0.719 *
Age 75 -84		0.577 ***	0.615 ***	0.649 ***	0.672 ***	0.671 ***	0.658 ***
Age 85 +		0.164 ***	0.180 ***	0.207 ***	0.230 ***	0.231 ***	0.215 ***
Male		1.263 ***	1.252 ***	1.277 ***	1.252 ***	1.203 ***	1.213 ***
Rural		0.897 ***	0.784 ***	0.792 ***	0.806 ***	0.841 ***	0.843 ***
Dual Medicare/Medicaid		0.526 ***	0.582 ***	0.599 ***	0.618 ***	0.624 ***	0.618 ***
Patient Lives in Low Income Area		0.894 ***	0.879 ***	0.903 ***	0.916 ***	0.912 ***	0.905 ***
Family history of housing, economic, or psychosocial circumstances		0.579 **	0.618 *	0.612 *	0.630 *	0.667 *	0.698
Preadmission history of surgical or other procedure not carried out because of patient's decision		0.934	1.002	0.947	0.933	0.923	0.909
Unavailability of other medical facilities for care		0.585 *	0.600 *	0.531 *	0.555 *	0.560 *	0.546 *
Charlson Co-moribidity Index			0.874 ***	0.866 ***	0.863 ***	0.876 ***	0.872 ***
Admission from ER			0.336 ***	0.373 ***	0.424 ***	0.443 ***	0.442 ***
History of unstable angina				1.389 ***	1.196 ***	1.224 ***	1.201 ***
History of chronic stable angina				1.127 ***	0.958 ***	0.899 ***	0.879 ***
History of lipip metabolism disorder				1.359 ***	1.281 ***	1.284 ***	1.299 ***
History of obesity				1.224 ***	1.222 ***	1.232 ***	1.245 ***
History of fluid, electrolyte, and acid-base imbalance				0.690 ***	0.698 ***	0.698 ***	0.691 ***
History of anemias and other blood diseases				0.812 ***	0.805 ***	0.808 ***	0.804 ***
Family history of cardiovascular or heart disease				2.110 ***	1.990 ***	1.993 ***	1.998 ***
Preadmission history of surgical or other procedures not carreied out because of contraindication				1.535 ***	1.340 **	1.307 **	1.297 **
History of CABG				0.743 ***	0.751 ***	0.733 ***	0.735 ***
History of prior Angioplasty				2.084 ***	1.978 ***	1.901 ***	1.914 ***
Preadmission non-invasive diagnostic testing (echocardiogram, doppler, EKG, 24 hour monitoring, imaging)					1.044 ***	1.045 ***	1.041 **
Preadmission stress testing					2.304 ***	2.221 ***	2.138 ***
Preadmission Unstable Angina Guideline Testing					1.053 ***	1.040 ***	1.033 ***
Principal Diagnosis of AMI						0.915 ***	0.828 ***
Principla Diagnosis of Unstable Angina						0.240 ***	0.240 ***
Cardiac Arrest						0.643 ***	0.612 ***
Cardiogenic Shock						1.418 ***	1.331 ***
Congestive Heart Failure						0.583 ***	0.571 ***
Index Admission non-invasive diagnostic testing (echocardiogram, doppler, EKG, 24 hour monitoring, imaging)							1.799 ***
Index Admission stress testing							0.380 ***

* p<0.05; ** p<0.01; ***p<0.001

NOTE: Number of observations = 336, 301

SOURCE: RTI International analysis of 1997 MedPAR claims data.

Table 6.C-2

Multinomial Logistic Regression Models of Likelihood of Angiolpasty or CABG Relative to Medical Treatment During Admission for Ischemic Heart Disease for Medicare Fee-for-Service Beneficiaries

CABG	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Black	0.422172 ***	0.504 ***	0.542 ***	0.540 ***	0.538 ***	0.550 ***	0.562 ***
Asian	0.938605	1.156 *	1.038	0.991	0.969	1.000	1.018
Hispanic	0.816417 ***	1.026	1.033	1.019	1.009	1.042	1.050
AI/NA	0.546527 ***	0.620 **	0.610 ***	0.656 **	0.663 **	0.705 *	0.759
Age 75 -84		0.575 ***	0.613 ***	0.635 ***	0.659 ***	0.663 ***	0.645 ***
Age 85 +		0.089 ***	0.101 ***	0.106 ***	0.119 ***	0.124	0.114 ***
Male		1.713 ***	1.670 ***	1.833 ***	1.793 ***	1.736	1.762 ***
Rural		0.959 ***	0.827 ***	0.829 ***	0.845 ***	0.890	0.894 ***
Dual Medicare/Medicaid		0.461 ***	0.492 ***	0.491 ***	0.508 ***	0.516	0.509 ***
Patient Lives in Low Income Area		0.949 ***	0.931 ***	0.948 ***	0.965 **	0.959	0.952 ***
Family history of housing, economic, or psychosocial circumstances		0.887	0.909	0.881	0.918	0.945	0.996
Preadmission history of surgical or other procedure not carried out because of patient's decision		1.100	1.096	1.006	0.986	0.988	0.997
Unavailability of other medical facilities for care		0.787	0.746	0.756	0.796	0.850	0.821
Charlson Co-moribidity Index			0.944 ***	0.951 ***	0.947 ***	0.943 ***	0.936 ***
Admission from ER			0.261 ***	0.303 ***	0.348 ***	0.385 ***	0.377 ***
History of unstable angina				1.680 ***	1.441 ***	1.424 ***	1.402 ***
History of chronic stable angina				1.231 ***	1.037 ***	0.927 ***	0.907 ***
History of lipip metabolism disorder				1.462 ***	1.373 ***	1.366 ***	1.380 ***
History of obesity				1.420 ***	1.414 ***	1.431 ***	1.445 ***
History of fluid, electrolyte, and acid-base imbalance				0.608 ***	0.618 ***	0.628 ***	0.620 ***
History of anemias and other blood diseases				0.708 ***	0.702 ***	0.711 ***	0.707 ***
Family history of cardiovascular or heart disease				2.181 ***	2.050 ***	2.040 ***	2.042 ***
Preadmission history of surgical or other procedures not carreied out because of contraindication				1.689 ***	1.467 ***	1.415 ***	1.415 ***
History of CABG				0.261 ***	0.264 ***	0.255 ***	0.255 ***
History of prior Angioplasty				0.874 ***	0.830 ***	0.790 ***	0.796 ***
Preadmission non-invasive diagnostic testing (echocardiogram, doppler, EKG, 24 hour monitoring, imaging)					1.042 ***	1.017	1.013
Preadmission stress testing					2.343 ***	2.179 ***	2.116 ***
Preadmission Unstable Angina Guideline Testing					1.071 ***	1.065 ***	1.058 ***
Principal Diagnosis of AMI						0.651 ***	0.573 ***
Principla Diagnosis of Unstable Angina						0.211 ***	0.209 ***
Cardiac Arrest						0.963	0.915 *
Cardiogenic Shock						1.502 ***	1.399 ***
Congestive Heart Failure						0.990	0.962
Index Admission non-invasive diagnostic testing (echocardiogram, doppler, EKG, 24 hour monitoring, imaging)							2.973 ***
Index Admission stress testing							0.334 ***

* p<0.05; ** p<0.01; ***p<0.001

NOTE: Number of observations = 336, 301

SOURCE: RTI International analysis of 1997 MedPAR claims data.

Appendix 7.A

Description of Variables Used in the Mortality Multivariate Analyses

Table 7.A-1

Description of Variables Used in the Mortality Multivariate Analyses

Variable	Description
All variables are equal to 1 if the condition is met, otherwise it equals 0 unless otherwise indicated.	
Models 1 - 3: Demographic and SES variables	
BLACK	Patient was black
ASIAN	Patient was Asian
HISPANIC	Patient was Hispanic
NANATIVE	Patient was AI/AN
AGE7584	Patient was 75-84 years of age
AGE85P	Patient was 85 years of age or older
MALE	Patient was male
RURAL	Patient lives in a rural area
JDUALM	Patient was dually enrolled in Medicaid the month of their IHD admission
LOWINC	Patient lived in a low income zip code as measured by median income in the lowest quartile
Model 4a: Severity at Time of Admission	
JCHARLSON	A weighted sum of previous diagnoses (occuring within 6 months of index admission) including prior myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, senile and presnile organic psychotic conditions, chronic pulmonary diseases, rheumatologic disease, peptic ulcer disease, mild liver disease, diabetes without organ manifestations, diabetes with chronic complications, hemiplegia or paraplegia, chronic renal failure, any malignancy, including leukemia and lymphoma, but excluding skin cancer, moderate of severe liver disease, secondary malignant neoplasm of lymph nodes and other organs, and AIDS
EMERGENT	Status of Admission is Emergent
ER	Source of Admission is Emergency Department
Model 4b: Pre-existing Comorbid Conditions	
PREDIABETES	Diabetes without organ manifestations, diabetes with chronic complications
PREARRHY	Previous history of cardiac arrhythmias
PREAMI	Previous history of acute myocardial infarction, including dressler's syndrome
PREUNANGINA	Previous history of unstable angina
PRECHRANGINA	Previous history of chronic stable angina
PREVALVEDX	Previous history of valvular disease, including rheumatic heart disease
PREHBP	Previous history of essential and secondary hypertension
PREHHD	Previous history of hypertensive heart/renal/heart and renal disease
PREMYOPATHY	Previous history of cardiomyopathy
PREPVD	Previous history of vascular disease
PRECVD	Previous history of Cerebrovascular disease

Table 7.A-1 (continued)

Description of Variables Used in the Mortality Multivariate Analyses

Variable	Description
Model 4b: Pre-existing Comorbid Conditions (continued)	
PRECHFCOPD	Previous history of heart failure or COPD, including asthma
PRELIVER	Previous history of liver disease
PRERENAL	Previous history of acute or chronic renal failure
PRELIPID	Previous history of lipid metabolism disorder
PREOBESITY	Previous history of obesity
PREIMBALANCE	Previous history of fluid, electrolyte and acid-base imbalance
PREANEMIA	Previous history of anemias and other related blood diseases
PREFAMILYHX	Family history of cardiovascular or heart disease
PREFAMPROB	Family history of housing, household, economic or psychosocial circumstances
PREUNAVAIL	Unavailability of other medical facilities for care
PRECONTRA	Preadmission history of surgical or other procedure not carried out because of contraindication
PRENOGO	Preadmission history of surgical or other procedure not carried out because of patient's decision
PRECABG	Previous history of CABG
PREPTCA	Previous history of Percutaneous balloon angioplasty, intracoronary or intravenous thrombolysis, stent, or percutaneous atherectomy
Model 4c: Severity During Hospitalization	
ALLAMI	Principal Diagnosis of acute myocardial infarction
UNSTABLE	Principal Diagnosis of unstable angina
IAARRHY	Significant (potentially life-threatening arrhythmias during hospitalization)
IAARREST	Cardiac Arrest
IASHOCK	Cardiogenic Shock
IARUPTURE	Rupture of vasculartnre
IASTROKE	Stroke (occlusive or hemorrhage)
IACHF	Heart Failure
IARESP	Respiratory Distress
IARENAL	Acute renal failure, including nephritis, with no previous history of renal disease
IAIMBALANCE	Acute bout of fluid, electrolyte or acid-base imbalance
IAANEMIA	Acute posthemorrhagic anemia
IAFAILOP	Surgery-related cardiac complications
IASEPTIC	Septicemia
IAPNEUMONIA	Viral and Bacterial Pneumonia
IAINFECTION	Infection due to internal prosthetic device, implant and graft

Table 7.A-1 (continued)

Description of Variables Used in the Mortality Multivariate Analyses

Variable	Description
Models 5a - 5d: Procedures received with 6 months prior to index IHD admission	
PRE_CABG[1]	CABG
PRE_PTCA[1]	PTCA
PRE_CVHEMO[1]	Non-imaging CV Hemodynamics: Arterial or Venous Central Line for Pressure Monitoring, including Swan-Ganz and ej with probe technique
PRE_REHAB[1]	Cardiac Rehab - Physician Services
PRE_VENT[1]	Ventilation Support, including CPAP and CNP
PRE_CATHANGIOT[1]	Right or Left Heart Catheterization and/or Selective venous and/or arterial angiography without cardiac catheterization
PRE_ECHODOP[1]	2D or M-mode echocardiogram, Doppler echocardiogram, Doppler color velocity flow mapping
PRE_ECG[1]	ECG -- resting
PRE_HOLTERT[1]	Telephonic transmission of post-symptom ECG strips, Patient demand single or multiple event recording, Single averaged ECG, or ECG Monitoring for 24 hours
PRE_IMAGE[1]	Cardiac MRI, CT of Thorax, Myocardial Perfusion and Imaging, Cardiac blood pool imaging, nuclear medicine blood flow c-vhemodynamics and cardiac shunt detection, and assessment of cardiac output by electrical bioimpedence
PRE_ICUVISITS[1]	ICU visit prior to index admission
PRE_CONOTHER[1]	Renal, neurology, pulmonary, or infectious diseases consult prior to index admission
PRE_CONCARD[1]	Cardiology consult prior to index admission
PRE_CONBLADE[1]	Cardiothoracic surgeon consult prior to index admission
PRE_PACE[1]	Insertion of pacemaker, cardioverter, or Intracardiac Electrophysiological Procedures
PRE_STRESSPRO[1]	Treadmill or Bicycle Stress Test or pharmacological stress, Ergonovine Provocation Test
PRE_EREMS	Preadmission physician direction of EMS, advanced life support
PRE_LAB	PTT, Hemoglobin and Hematocrit monitoring, Dignoxin Assay, and Creatine Phosphokinase
PRE_PT	Physical therapy, including ADLs and work hardening
PRE_OBSBED	Observation Bed Admission prior to index admission
PRE_OFFHRS	Office services after hours, odd locations, or as an emergency
PRE_O2	Pulse oximetry or oxygen saturation monitoring

[1]These same variables were created during the index admission time period and are reported in Model 4c without

Variable	Description
Model 6: Hospital Characteristics	
COTH	Member of the Council of Teaching Hospitals
OTEACH	Other teaching hospital
CCU	Cardiac Care Unit
OPENHRT	Provides Open Heart Surgery Services

Appendix 7.B

IHD 30-Day Mortality Logistic Results by Vendor

Table 7.B-1

IHD 30-Day Mortality Logistic Results by Vector

Model 1

Variable	Odds Ratio	P-Value
Intercept (estimate)	-2.42	<.0001
BLACK	0.98	0.439
ASIAN	0.96	0.5777
HISPANIC	0.78	<.0001
NANATIVE	0.91	0.605
No. Observations	346,325	
Overall Chi-Square	0.00	n/a

Model 2

Variable	Odds Ratio	P-Value
	-3.01	<.0001
AGE7584	1.95	<.0001
AGE85P	4.17	<.0001
MALE	1.03	0.0142
	346,325	
	22.05	<.0001

Model 3

Variable	Odds Ratio	P-Value
	-2.47	<.0001
RURAL	1.04	0.0071
JDUALM	1.31	<.0001
LOWINC	0.99	0.5386
	336,301	
	12.31	0.0064

Model 4a

Variable	Odds Ratio	P-Value
Intercept (estimate)	-3.01	<.0001
JCHARLSON	1.05	<.0001
EMERGENT	1.47	<.0001
ER	1.50	<.0001
No. Observations	346,325	
Overall Chi-Square	1,237.83	<.0001

Model 4b

Variable	Odds Ratio	P-Value
	-2.68	<.0001
EMERGENT	1.35	<.0001
ER	1.32	<.0001
PREDIABETES	1.08	<.0001
PREARRHY	1.12	<.0001
PREAMI	1.03	0.0477
PREUNANGINA	0.59	<.0001
PRECHRANGINA	0.73	<.0001
PREVALVEDX	1.16	<.0001
PREHBP	0.89	<.0001
PREHHD	0.86	<.0001
PREMYOPATHY	1.14	<.0001
PREPVD	1.19	<.0001
PRECVD	1.31	<.0001
PRECHFCOPD	1.37	<.0001
PRELIVER	1.09	0.2517
PRERENAL	2.26	<.0001
PRELIPID	0.66	<.0001
PREOBESITY	0.52	<.0001
PREIMBALANCE	1.40	<.0001
PREANEMIA	1.19	<.0001
PREFAMILYHX	0.38	<.0001
PREPROB	1.18	0.085
PRECABG	0.62	<.0001
PREPTCA	0.46	<.0001
	346,325	
	57.42	<.0001

Model 4c

Variable	Odds Ratio	P-Value
	-4.00	<.0001
ALLAMI	5.62	<.0001
UNSTABLE	0.90	0.0059
IAARRHY	1.42	<.0001
IAARREST	16.85	<.0001
IASHOCK	8.83	<.0001
IARUPTURE	1.20	<.0001
IASTROKE	4.17	<.0001
IACHF	1.80	<.0001
IARESP	2.37	<.0001
IARENAL	1.97	<.0001
IAIMBALANCE	1.80	<.0001
IAANEMIA	0.66	<.0001
IAFAILOP	1.03	0.508
IASEPTIC	2.45	<.0001
IAPNEUMONIA	1.92	<.0001
IAINFECTION	0.99	0.9017
	346,325	
	586.54	<.0001

Table 7.B-1 (continued)

IHD 30-Day Mortality Logistic Results by Vector

Model 5a			Model 5b			Model 5c		
Variable	Odds Ratio	P-Value	Variable	Odds Ratio	P-Value	Variable	Odds Ratio	P-Value
Intercept (estimate)	-2.25	<.0001		-2.08	<.0001		-1.88	<.0001
PRE_CABG	0.62	<.0001	CABG	0.13	<.0001	PRE_CABG	0.73	0.0117
PRE_PTCA	0.80	0.0002	PTCA	0.39	<.0001	PRE_PTCA	1.30	<.0001
PRE_CVHEMO	1.60	<.0001	CVHEMO	3.42	<.0001	PRE_CVHEMO	1.46	<.0001
PRE_REHAB	0.66	<.0001	REHAB	0.66	0.2573	PRE_REHAB	0.76	0.0033
PRE_VENT	0.98	0.6765	VENT	1.82	<.0001	PRE_VENT	0.91	0.0201
PRE_CATHANGIOT	0.51	<.0001	CATHANGIOT	0.43	<.0001	PRE_CATHANGIOT	0.41	<.0001
PRE_ECHODOP	1.10	<.0001	ECHODOP	1.18	<.0001	PRE_ECHODOP	1.09	<.0001
PRE_ECG	0.74	<.0001	ECG	0.98	0.3169	PRE_ECG	0.81	<.0001
PRE_HOLTERT	0.81	<.0001	HOLTERT	0.63	<.0001	PRE_HOLTERT	0.84	<.0001
PRE_IMAGE	1.11	<.0001	IMAGE	0.64	<.0001	PRE_IMAGE	1.13	<.0001
PRE_ICUVISITS	1.35	<.0001	ICUVISITS	2.99	<.0001	PRE_ICUVISITS	1.02	0.6249
PRE_CONOTHER	1.53	<.0001	CONOTHER	2.30	<.0001	PRE_CONOTHER	1.05	0.0681
PRE_CONCARD	1.03	0.2085	CONCARD	0.72	<.0001	PRE_CONCARD	1.07	0.003
PRE_CONBLADE	1.31	<.0001	CONBLADE	1.14	<.0001	PRE_CONBLADE	1.14	0.0389
PRE_PACE	1.00	0.9548	PACE	1.84	<.0001	PRE_PACE	1.02	0.7869
PRE_STRESSPRO	0.33	<.0001	STRESSPRO	0.23	<.0001	PRE_STRESSPRO	0.48	<.0001
PRE_EREMS	1.27	<.0001				PRE_EREMS	1.14	<.0001
PRE_LAB	1.15	<.0001				PRE_LAB	1.07	<.0001
PRE_PT	0.68	<.0001				PRE_PT	0.72	<.0001
PRE_OBSBED	0.95	0.093				PRE_OBSBED	0.96	0.221
PRE_OFFHRS	1.10	0.0892				PRE_OFFHRS	1.07	0.2473
PRE_O2	1.05	0.0215				PRE_O2	0.99	0.5098
						CABG	0.20	<.0001
						PTCA	0.55	<.0001
						CVHEMO	3.68	<.0001
						REHAB	0.77	0.4807
						VENT	1.82	<.0001
						CATHANGIOT	0.36	<.0001
						ECHODOP	1.06	<.0001
						ECG	0.96	0.0204
						HOLTERT	0.64	<.0001
						IMAGE	0.63	<.0001
						ICUVISITS	2.81	<.0001
						CONOTHER	2.23	<.0001
						CONCARD	0.75	<.0001
						CONBLADE	1.04	0.2432
						PACE	1.86	<.0001
						STRESSPRO	0.23	<.0001
No. Observations	346,325			346,325			346,325	
Overall Chi-Square	59.33	<.0001		697.42	<.0001		223.05	<.0001

Table 7.B-1 (Continued)

IHD 30-Day Mortality Logistic Results by Vector

Model 5d			Model 6		
Variable	Odds Ratio	P-Value	Variable	Odds Ratio	P-Value
Intercept (estimate)	-1.85	<.0001		-2.18	<.0001
ALL_CABG	0.31	<.0001	COTH	0.86	<.0001
ALL_PTCA	0.63	<.0001	OTEACH	0.99	0.553
ALL_CVHEMO	3.10	<.0001	CCU	0.95	0.0026
ALL_REHAB	0.75	0.0016	OPENHRT	0.71	<.0001
ALL_VENT	1.45	<.0001			
ALL_CATHANGIO	0.35	<.0001			
ALL_ECHODOP	1.04	0.0052			
ALL_ECG	0.86	<.0001			
ALL_HOLTER	0.72	<.0001			
ALL_IMAGE	0.77	<.0001			
ALL_ICUVISITS	2.59	<.0001			
ALL_CONOTHER	2.06	<.0001			
ALL_CONCARD	0.77	<.0001			
ALL_CONBLADE	1.03	0.2903			
ALL_PACE	1.69	<.0001			
ALL_STRESS	0.37	<.0001			
No. Observations	346,325			345,257	
Overall Chi-Square	162.76	<.0001		6.92	0.14

NOTES:
***indicates significance at the .01 level, ** at the .05 level, and 8 at the .10 level.

Appendix 7.C

Hazard Ratios by Race/Ethnic Group

Table 7.C-1

Multivariate Cox Proportional Hazards Regression Analysis of Survival within 2 - 2.5 years of Admission for Ischemic Heart Disease for Medicare Beneficiaries

	Asian		Black		Hispanic		Native American		White	
Parameter	Hazard Ratio	p<	Hazard Ratio	p<	Hazard Ratio	p<	Hazard Ratio	p<	Hazard Ratio	p<
Sociodemographic										
Age 75 to 84	1.71	***	1.35	***	1.40	***	1.54	**	1.58	***
Age 85 and older	2.84	***	1.92	***	2.19	***	0.78		2.37	***
Male	1.00		1.20	***	1.08		1.15		1.13	***
Rural	0.94		0.99		0.92		1.22		0.98	*
Dual Medicaid/Medicare	0.80	**	1.12	***	1.02		0.63	**	1.17	***
Low Income Zip Code	1.26		1.06	**	0.97		0.86		1.03	***
Family Problem	-	+	0.98		0.00		1.06		1.12	
Comorbidity										
Charlson Index	1.17	***	1.15	***	1.14	***	1.16	***	1.16	***
Admission From ER	1.08		1.03		1.08		1.18		1.04	***
Severity During Admission										
Principal Diagnosis of AMI	2.62	***	2.26	***	1.98	***	3.06	***	2.08	***
Principal Diagnosis of Unstable Angina	0.87		0.74	***	0.86		0.59		0.88	***
Cardiac Arrest/Cardiogenic Shock	3.27	***	3.74	***	4.53	***	2.18	**	3.81	***
Arrhythmia, Imbalance, Pneumonia, Stroke	1.87	***	1.47	***	1.53	***	1.20		1.53	***
Vas. Rupture, CHF, Renal Failure	1.57	***	1.17	***	1.35	***	0.83		1.27	***
CV Hemodynamic Support, ICU, Consults	1.36		1.41	***	1.39	***	1.59	*	1.33	***
Procedures										
Catheterization/Angiography, Stress Test	0.58	***	0.62	***	0.51	***	0.43	*	0.59	***
Echocardiogram, Holter, Imaging, Cardiology Consul	0.68	***	0.83	***	0.84	***	1.14		0.84	***
CABG	0.62	***	0.55	***	0.55	***	0.46	*	0.44	***
PTCA	0.67	**	0.65	***	0.66	***	0.64		0.59	
Number of Cases	1,941		21,229		4,764		378		307,989	

NOTES: * p<0.10; ** p<0.05; *** p<0.01, + Dropped due to collinearity

SOURCE: RTI/HER analysis of 1997-1999 100% Denominator and MedPAR files.

Appendix 8.A

Procedure Decision Diagrams for Index and Transfer IHD Admissions: 1997

Figure 8.A-1

Procedure Decision Diagram for Index and Transfer IHD Admissions, 1997: Whites

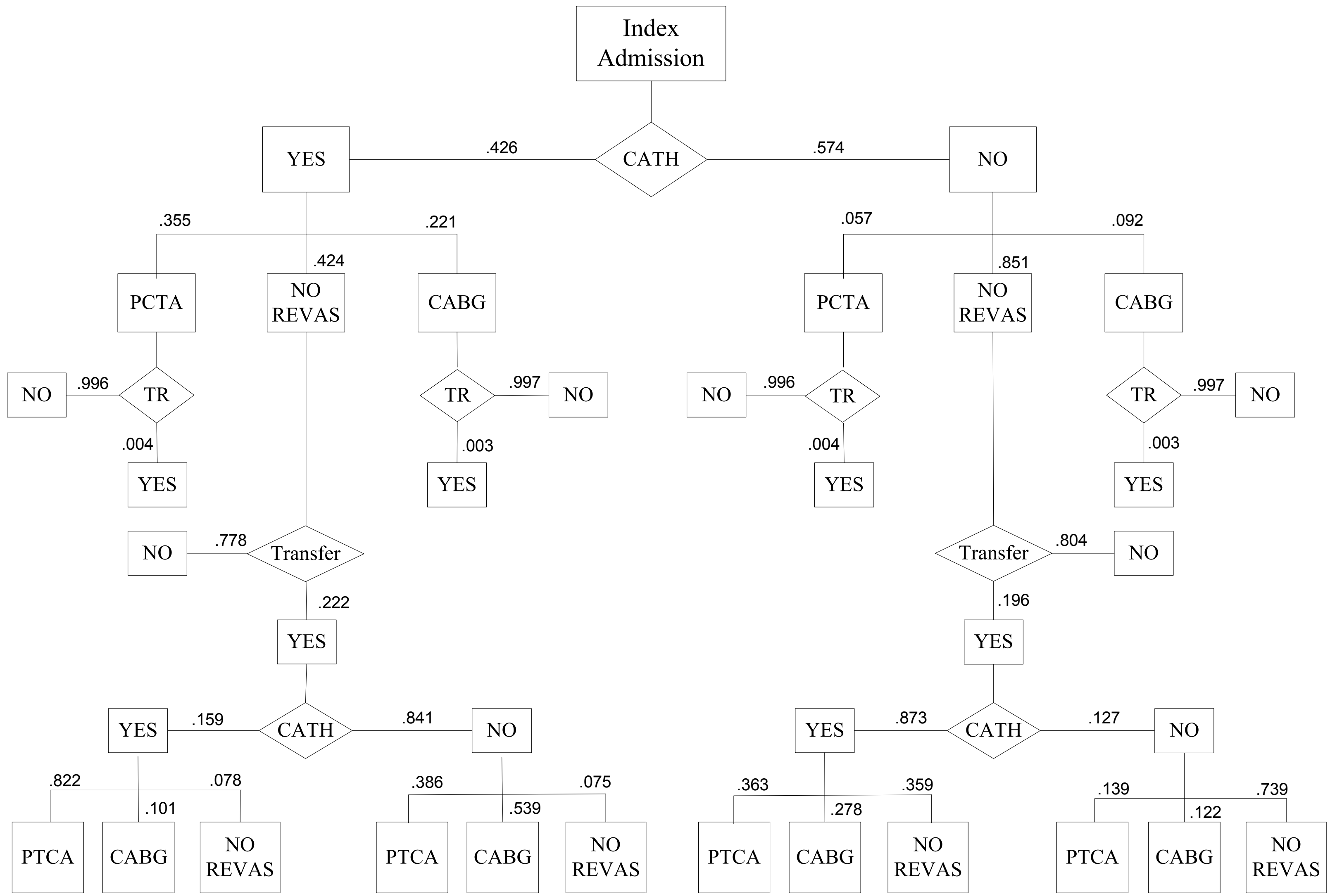


Figure 8.A-2

Procedure Decision Diagram for Index and Transfer IHD Admissions, 1997: Blacks

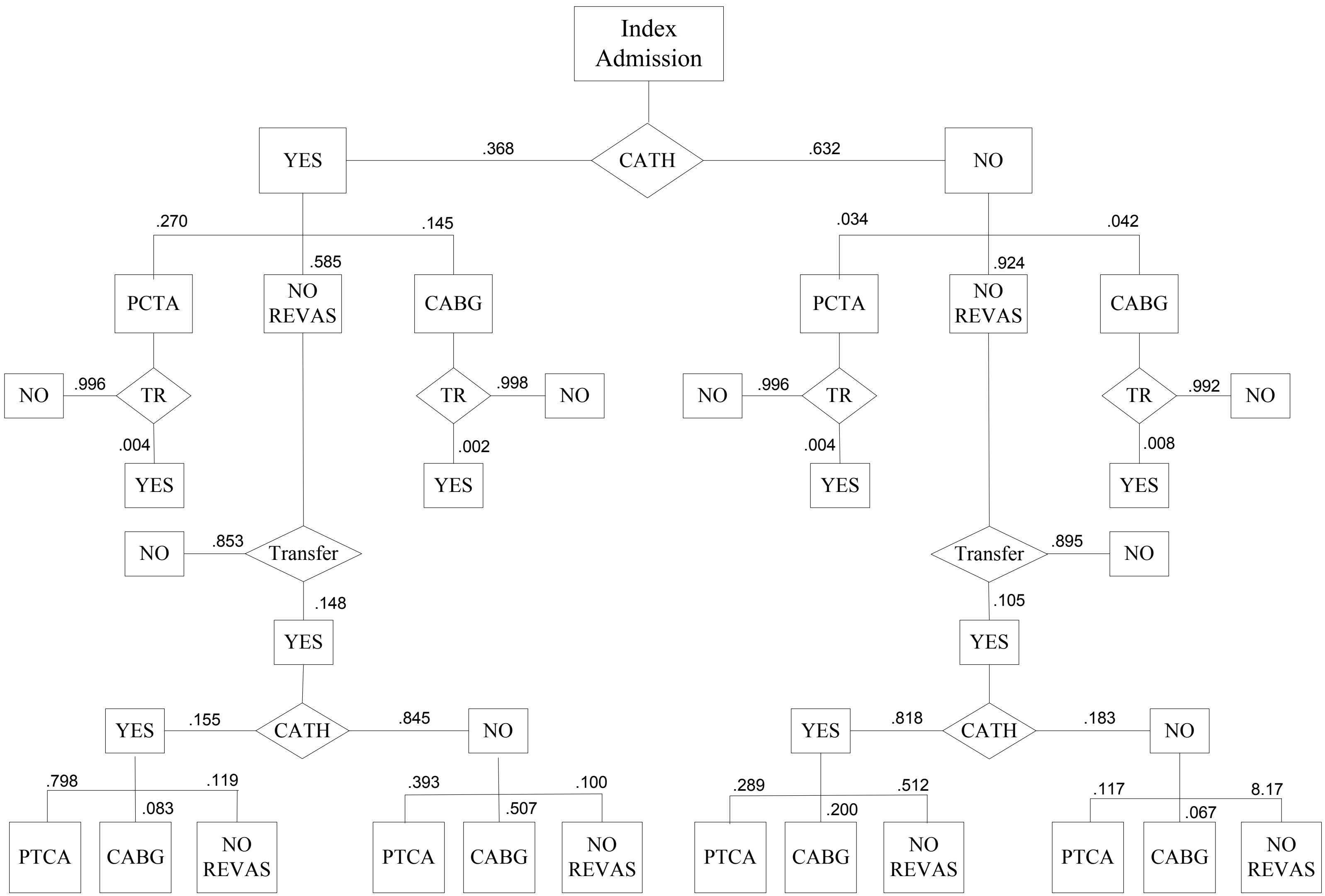


Figure 8.A-3

Procedure Decision Diagram for Index and Transfer IHD Admissions, 1997: Asians

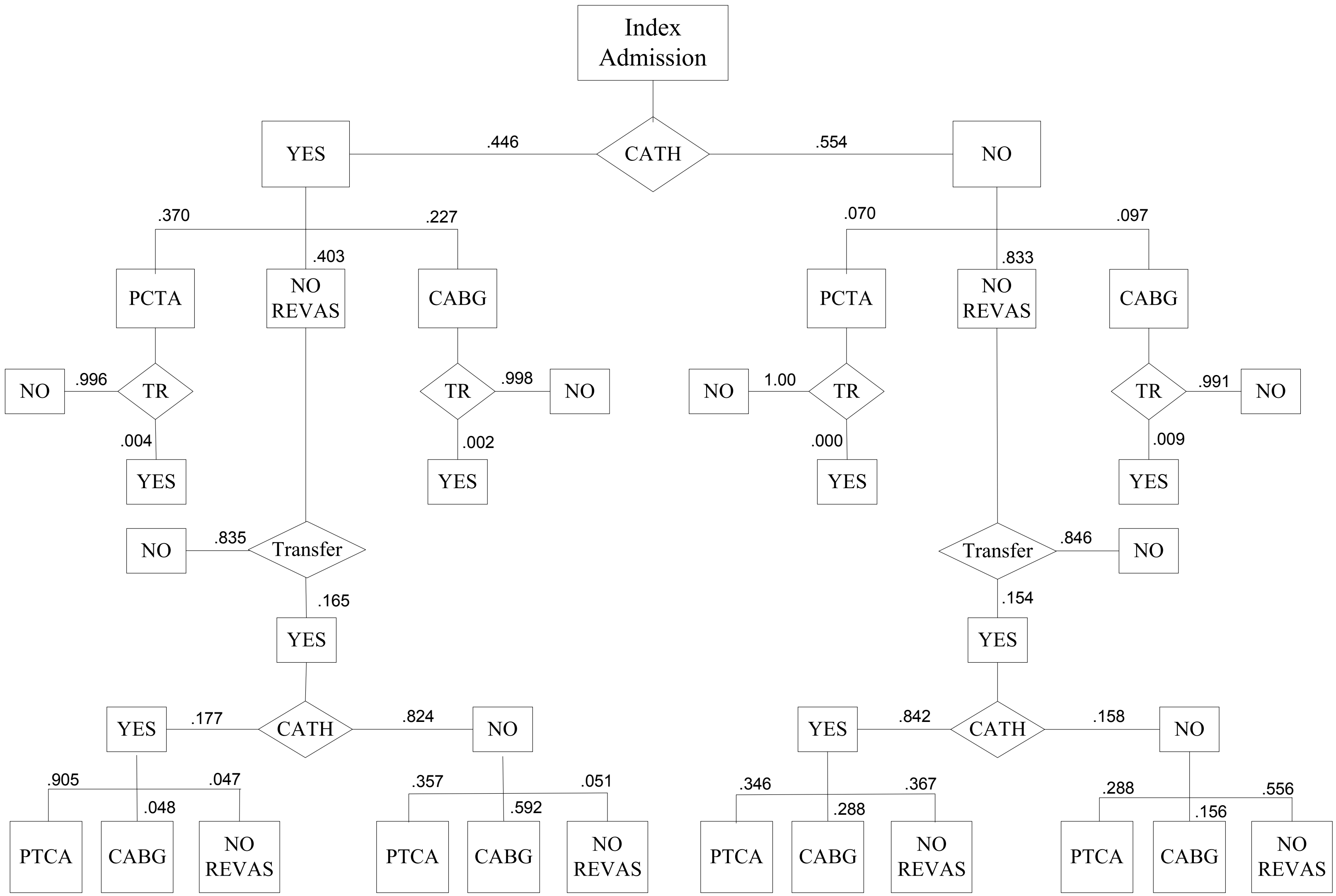


Figure 8.A-4

Procedure Decision Diagram for Index and Transfer IHD Admissions, 1997: Hispanics

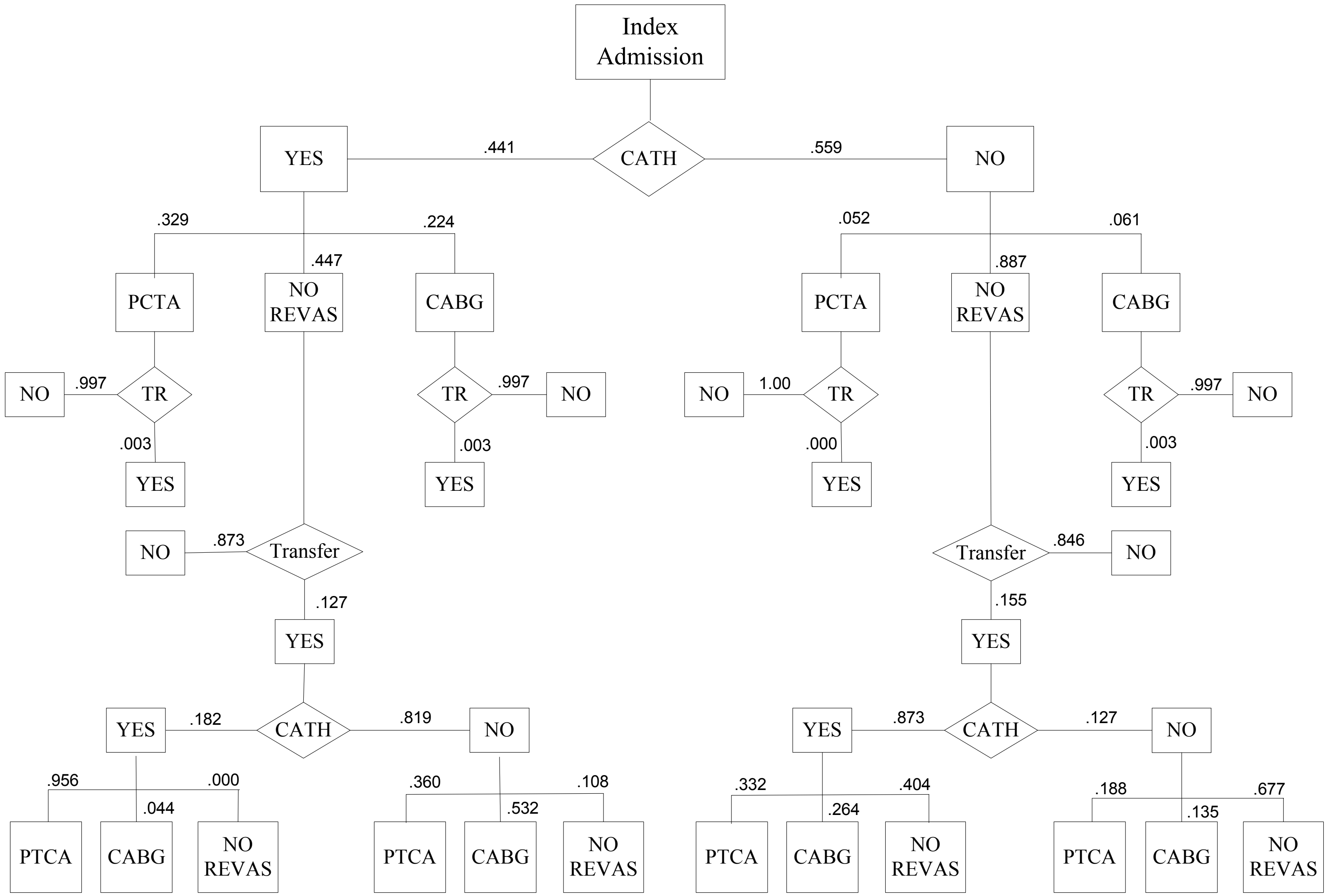


Figure 8.A-5

Procedure Decision Diagram for Index and Transfer IHD Admissions, 1997: Native Americans

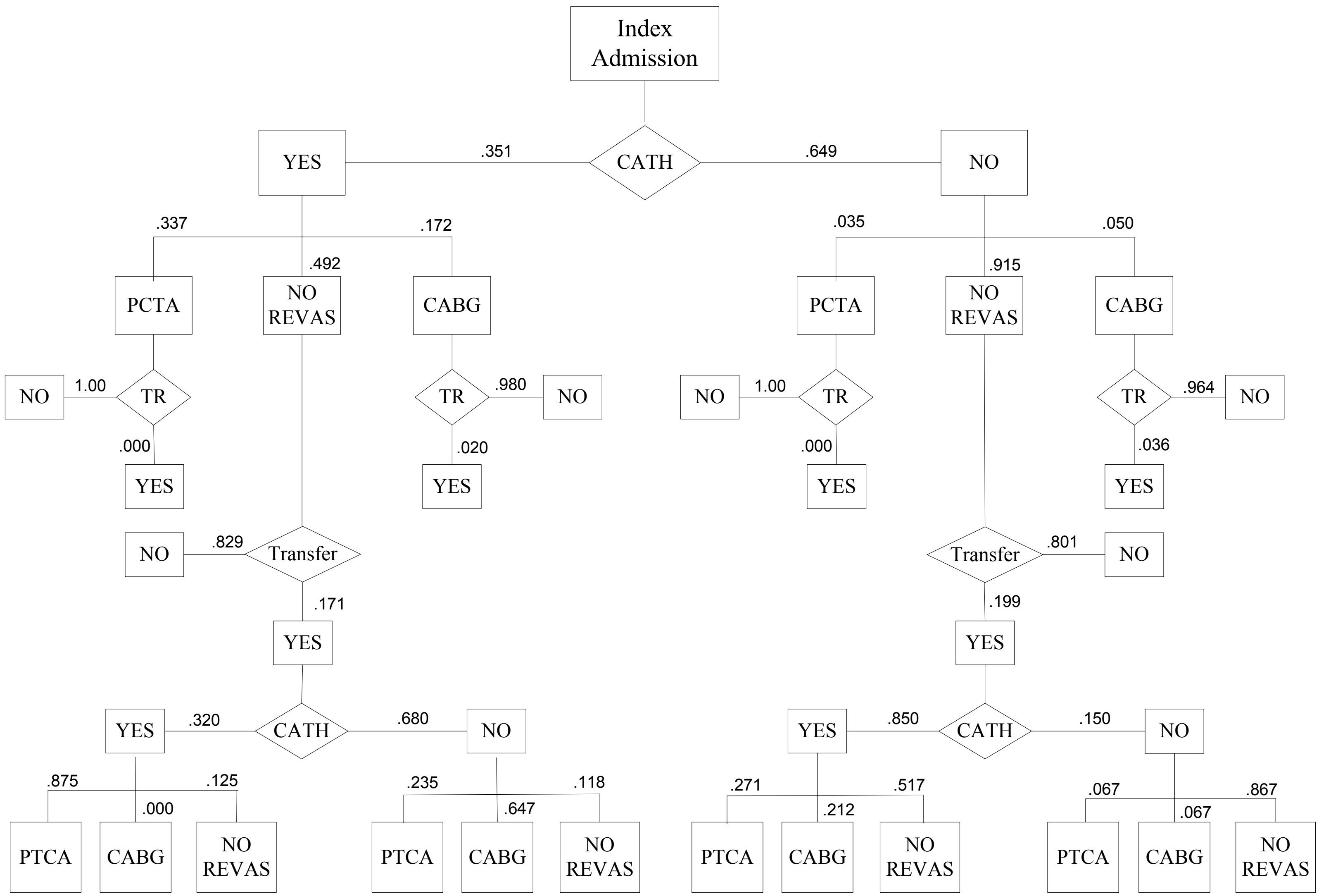
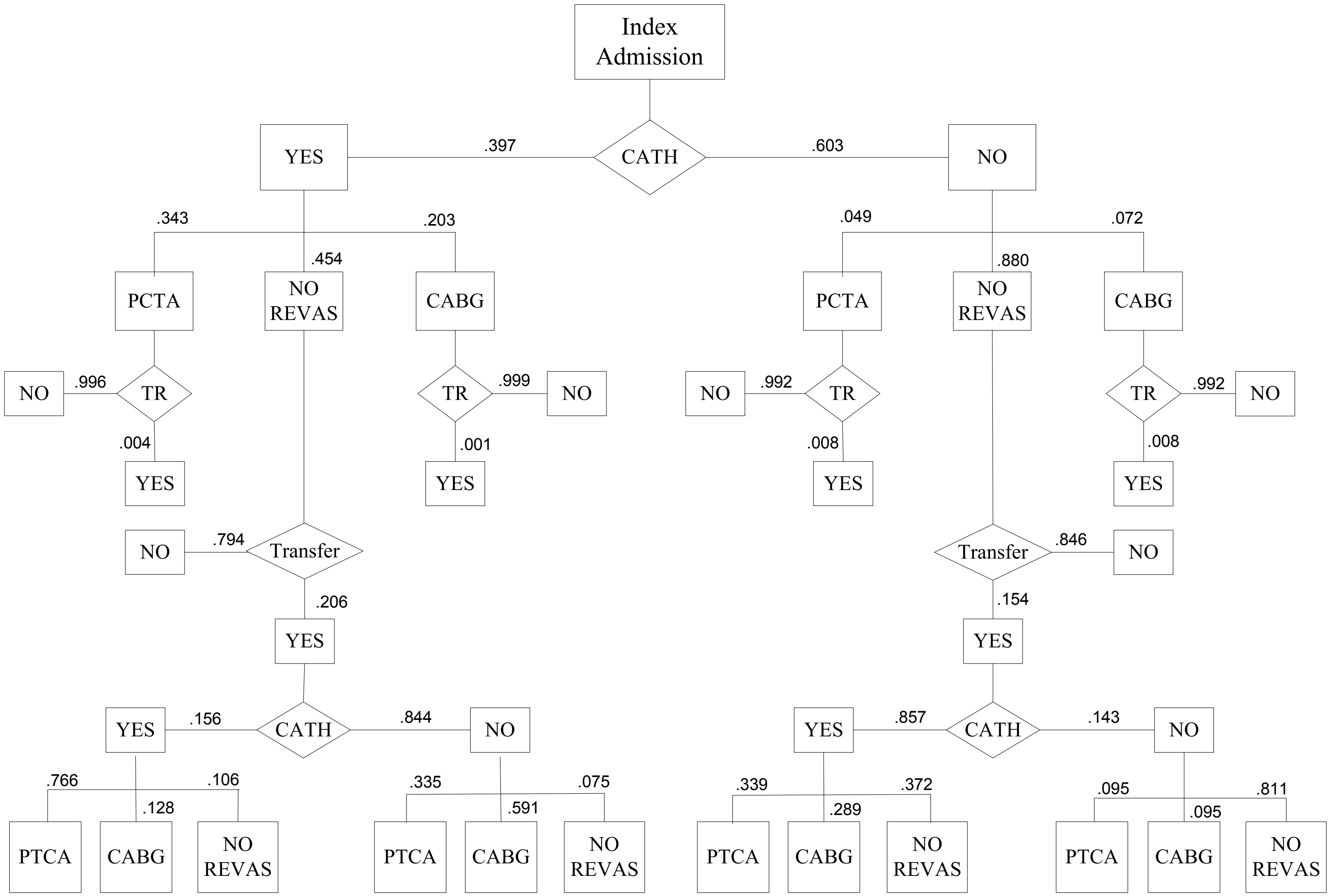


Figure 8.A-6

Procedure Decision Diagram for Index and Transfer IHD Admissions, 1997: Unknown



Appendix 8.B

Algorithm for Calculating Patient-Hospital Travel Distances Using Latitude and Longitude

Appendix 8.B

Algorithm for Calculating Patient-Hospital Travel Distances Using Latitude and Longitude

```
LATMR = (((LAT_A + LAT_B) / 2)) / 57.2958;

    W = 1 – (0.006768658*SIN (LATMR) * SIN (LATMR));

    N = 3963.225785 / SQRT (W);

    R = (N* (1-0.006768658)) / W

    EAST = ((LONG_A / 57.2958) – (LONG_B / 57.2958)) * N * COS (LATMR);

    NORTH = ((LAT_A / 57.2958) – LAT_B . 57.2958)) * R

    DISTANCE = SQRT (EAST * EAST = NORTH * NORTH);

    DIST = ROUND (DISTANCE, .00001);
```

where:

LATMR = Average latitude between zipcodes A and B (in degrees)

EAST = Longitudinal difference between two zipcodes in miles along fixed latitude

NORTH = Latitudinal difference between two zipcodes in miles along fixed longitude

DIST = Straight-line distance in miles between two zipcodes