Do Racial Differences in Revascularization Procedures after Acute Myocardial Infarction Lead to Racial Disparities in Mortality between Black and White Patients: A Qualitative Systematic Review

By

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Abstract

Background Several previous studies have shown that black patients receive coronary reperfusion procedures less often than white patients after acute myocardial infarction (AMI). Despite this well documented difference, no evidence has shown a decisive difference in morality rates between black and white AMI patients.

Purpose The purpose of this review is to systematically collect and analyze the current evidence that evaluates racial differences in mortality caused by racial differences in revascularization procedure use between black and white patients presenting with AMI.

Methods A systematic review was conducted by a single reviewer using a MEDLINE literature search to identify observational studies that evaluate black and white patient differences in revascularization procedures and mortality after AMI. A total of 86 citations were reviewed, 42 articles were retrieved, and 11 articles were included from the MEDLINE search. An additional 3 articles were included following a reference list review. Included studies were evaluated for design quality using an abbreviated form of the Scottish Intercollegiate Guidelines Network (SIGN) methodological checklist for cohort studies.

Results 8 of 10 studies evaluating PTCA rates showed that black patients with AMI receive PTCA less often than white patients. 9 of 10 studies evaluating coronary artery bypass graft surgery (CABG) rates showed that black patients with AMI receive CABG less often than white patients. No studies within the review showed a statistically significant difference between black and white patients for in-hospital, 30-day, 1-year, 2-year, 3-year, or 5-year mortality rates. 1 study showed a statistically significant difference of age-adjusted mortality rate per 100 person years for black men (HR 1.34 95% CI 1.18-1.52) and black women (HR 1.22 95% CI 1.06-1.40) compared to white men.
**Conclusion** Despite evidence to support racial differences in revascularization procedures after AMI, the collection of evidence within this review does not indicate a racial difference in mortality. The similarities in mortality despite differences in standards of care may be explained by a process of selection of healthier black patients secondary to higher rates of out of hospital AMI death among black patients.

**Introduction**

**Background and Epidemiology**

An estimated 565,000 first-time myocardial infarctions and 300,000 recurrent attacks occur each year in the United States (US), leading to an estimated 157,559 deaths annually.\(^1\) Acute ST segment elevation myocardial infarction (STEMI) occurs when a thrombus forms on a ruptured coronary atheromatous plaque, leading to the occlusion of a coronary artery.\(^2\) Myocardial infarction occurs when the resultant myocardial ischemia is sufficient to cause cell death.\(^2\) The primary goal of treatment is to reestablish the patency of the occluded coronary artery, strong evidence shows that expeditious restoration of flow in the obstructed infarct artery is a key determinant of short-term and long-term outcomes.\(^3\)

Primary percutaneous transluminal coronary angioplasty (PTCA) and coronary artery bypass graft surgery (CABG) are both available treatment options to reestablish coronary blood flow, and have been shown to improve survival and decrease symptoms in appropriate patients.\(^3-7\) PTCA compared to fibrinolytic therapy has been shown to provide better short-term (4-6 weeks) outcomes including lower rates of death (7% vs 9%), non-fatal reinfarction (3% vs 7%), stroke (1% vs 2%) and the combined endpoint of death, reinfarct, and stroke (8% vs 24%) for patients presenting with AMI.\(^7\) These differences were maintained at long term follow up (6-18
months). CABG for primary reperfusion during STEMI has largely been superseded by fibrinolysis and PTCA, however, CABG is beneficial in AMI patients with associated valve disease, mechanical complications, left main or three-vessel coronary disease, coronary anatomy unsuitable for other forms of therapy, or ischemia refractory to non-surgical intervention.

The American College of Cardiology and American Heart Association (ACC/AHA) Task Force found sufficient evidence from multiple randomized trials that the benefits of percutaneous coronary intervention (PCI) for STEMI patients greatly outweigh risk when performed under appropriate conditions (Class I level of evidence A). According to the official ACC/AHA recommendation, PCI is favored over thrombolytics when the procedure is not contraindicated, immediately available, completed within 12 hours of symptom onset, performed in a timely fashion, and performed by skilled persons in an appropriate laboratory environment. The task force found limited evidence that showed that the benefits of emergency CABG greatly outweigh risk for patients with persistent or recurrent ischemia refractory to medical therapy and who have appropriate coronary anatomy and are not candidates for PCI or fibrinolytic therapy. According to the official ACC/AHA recommendation, CABG should be performed for patients under these conditions (Class I level of evidence B). Other conditions for which CABG is recommended include patients who suffer AMI complicated with cardiogenic shock who are under the age of 75 and develop shock within 36 hours of STEMI, have severe multivessel or left main disease, and are capable of receiving the procedure within 18 hours of shock onset and patients with life-threatening ventricular arrhythmias in the presence of >50% left main stenosis or triple vessel disease.
**Racial Differences in AMI Care**

Despite the documented benefits of revascularization procedures after AMI, several studies have shown racial differences in the use of both PTCA and CABG between black and white patients presenting with AMI.\textsuperscript{10-17} Blacks are less likely than whites, in some studies nearly half as likely, to receive revascularization procedures when presenting with similar acute cardiac symptoms (*Table 1: Studies Indicating Racial Differences in PTCA and CABG Use after AMI*). This procedural difference has been reported in surveys of databases consisting of Medicare cohorts, Veterans Affairs Medical Center cohorts, single center cohorts, and in state-based registries.\textsuperscript{18} The difference in rates has been shown to persist after adjusting for disease severity and socioeconomic indicators,\textsuperscript{19} supporting the existence of a true racial difference in revascularization procedure use.

A racial *difference* in health care is an observed racial variation in health care use by race.\textsuperscript{20} The terms racial *difference* and racial *disparity* are commonly used interchangeably within the medical literature, however, the 2 terms are not synonymous. A racial *disparity* of care is a *difference* in appropriate treatment use that is associated with poorer outcomes and is not attributable solely to patient factors including disease burden and treatment preference.\textsuperscript{20} A racial difference in care may or may not be associated with different outcomes or attributable to patient factors.
Data supporting racial differences in procedural rates alone must be interpreted carefully. Equal or unequal procedural use is not considered an appropriate measure for which to judge racial differences in health care because it presupposes equal need, preferences, and benefit across racial groups. Increasing procedural use of one population to equal that of another assumes that higher rates of health care use will improve patient outcomes, which is not always true.

A more appropriate goal of care is the establishment of clinical equity. Clinical equity allows measured racial differences and inequalities in health care to be evaluated within a

<table>
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* = OR adjusted for patient age, cardiac complications coded, number of secondary diagnoses coded, hospitalization in previous year, characteristics of index hospital, and year of discharge.  
** = OR adjusted for age, sex, payer status, history, chest pain on presentation, ST elevation, MI location, MI type, symptom onset to hospital arrival, Killip class, pulse, systolic blood pressure, absolute and relative contraindications to thrombolysis, US census region, and hospital characteristics.  
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clinical context. An “equitable distribution of health care” can be defined as a distribution in which clinical need is the primary determinant of equal opportunities for patients to use health care resources. Within this framework, other determinants of health care opportunity including social, political, cultural, historical, and environmental factors may unjustifiably alter opportunity, leading to an inequitable distribution of care.

The distinction between inequality and inequity requires examination of the various determinants of health care access. This distinction is an important step in evaluating the significance of a health care difference, and is vital toward developing further research and interventional targets. Racial inequalities in care found to be consistent with patient preference or needs may be seen as acceptable differences in the distribution of health care. Racial inequities in healthcare distribution indicate unjust patterns of treatment opportunity and allocation, and consequently, would require necessary intervention to assure appropriate access to care.

**Purpose of Paper**

The evidence discussed thus far suggests that prompt PTCA produces better clinical outcomes than non-invasive therapies, CABG in select patient populations is beneficial as a reperfusion strategy post-MI, and that black patients presenting with AMI are less likely to receive revascularization procedures compared to whites. The conclusion that blacks suffer worst outcomes after AMI because they are less likely to receive PTCA or CABG would reasonably follow from this evidence, however, studies conducted to directly measure outcome differences within this population have not consistently shown any exist. Currently no decisive outcome difference can be attributed to the difference in revascularization procedure use between blacks and whites. Conversely, despite several studies, no decisive evidence exists that has proven that no real difference exists either.
The lack of scientific consensus on the racial differences in revascularization use and related outcomes has denied the ability to evaluate this racial difference within a clinical context. This racial difference cannot be truly classified as a racial disparity in health care without evidence of related adverse health consequences, and therefore, the necessity of intervention cannot be accurately assessed. The purpose of this review is to systematically collect and analyze the current evidence that evaluates racial differences in outcomes caused by racial differences in revascularization procedure use between black and white patients presenting with AMI. The direction of future research and interventional efforts will be greatly benefited if more is known about the clinical significance of this topic.

Methods

The focus populations for this review are Black/African American and White/Caucasian American patients suffering AMI in the United States between 1990 and 2007. The interventions of interest are coronary revascularization procedures (PTCA and CABG) performed as initial treatment for AMI. The time period 1990-2007 was selected because it coincides with the development and spread of primary PTCA as a common treatment option for AMI patients in the United States. The primary outcome of interest for the review is patient death/mortality. Reviewed studies will include prospective and retrospective cohort studies written in English and published between 1990 and 2007. Cohort studies were selected because the primary focus of the review is racial differences in procedure use and resulting effects on health outcomes in actual practice. Randomized trials were not included because experimental procedural rates would not be reflective of actual rates according to race, and thus produce population outcomes inconsistent with those seen in clinical practice.
A MEDLINE search was conducted on May 14, 2007 with the assistance of a systematic literature review specialist made available through the University of North Carolina at Chapel Hill Health Science Library. The population keyterms used for the search were African-Americans or African Continental Ancestry or Black. The population was further specified using the keyterms heart attack or “myocardial infarct” or AMI. The intervention keyterms used for the search were percutaneous transluminal coronary angioplasty, angioplasty[ti], revascularization[ti], ptca[ti], coronary artery bypass and CABG[ti]. To identify studies that focused on race, the keyterms race[ti], racial[ti], “racial differences”, “racial disparities”, “racial disparity”, “racial variation”, “racial variations”, and “race-specific models” were used. To identify studies that focused on treatment mortality outcomes, the key terms treatment outcomes, outcome assessment, outcome[ti], mortality, survival[ti], and death[ti] were used.

No previous reviews specifically evaluating racial differences in coronary procedure utilization and mortality were identified. The reference lists of the primary studies that were ultimately included in this review were reviewed for potential articles of interest.

Discussions were held regarding the handsearching of medical journals as well as the searching of results of studies published in formats not indexed in major databases (“grey literature”). After consultation with an experienced research expert, it was concluded that this topic has a fairly extensive history of published peer reviewed studies accessible through electronic indexes, and further searching of published journals and “grey literature” for this review would be provide a low yield of contributory studies.

Following the completion of the search for relevant research articles, a single reviewer selected studies to be included in the review based on predefined inclusion and exclusion criteria. Selection criteria were applied during an initial title and abstract review. The full text of articles
found relevant during the initial title and abstract review were collected and reviewed for possible inclusion. It is recognized that the use of a single reviewer increases the risk of bias in the selection of articles; however, the work force and time limitations of the review did not permit more than one reviewer to work on this project. The inclusion and exclusion criteria were discussed in detail with an experienced researcher prior to the selection process, and were precisely defined to help decrease the chance of selection bias.

**Inclusion Criteria**

**Population:** Studies focusing on Black/African-American and White/Caucasian patients diagnosed with AMI.

**Intervention:** Studies focusing on coronary revascularization procedures (PTCA and CABG) used as initial management of AMI.

**Outcome:** Studies comparing death/mortality between Black/African-American and White/Caucasian patients diagnosed with AMI.

**Study Design:** Prospective cohort studies and retrospective cohort studies.

**Exclusion Criteria**

**Population:** Studies with non-black patient populations, patients not presenting with AMI, patients presenting with angina or unstable angina. Studies that do not directly compare Black/African-American and White/Caucasian patient characteristics, procedure use, and outcomes.

**Intervention:** Studies of non-coronary revascularization treatments.

**Outcome:** Studies whose outcomes are not related to death/mortality. Outcomes that are not compared to White/Caucasian patients with AMI.
Study design: Trials that are not prospective or retrospective cohort studies. Randomized control trials, non-English language studies, studies of non-US populations, and studies before Jan. 1990.

Content Review and Quality Assessment

Studies included in the review were individually assessed for content and design quality. Work force and time limitations allowed only a single reviewer with support from a research expert to assess design quality. It is recognized that the use of a single reviewer may lower the validity and reliability of the results.

Each study was evaluated for potential selection bias, potential measurement bias, potential confounding, internal validity, and external validity. Analysis included assessment of group selection and comparison, distribution of prognostic factors, reliability of intervention measurements, reliability of outcome measurements, masked outcome assessment, drop out rates, and overall internal validity of outcomes. Special consideration toward the validity and reliability of measures of race/ethnicity and mortality were taken within the review.

An abbreviated form of the Scottish Intercollegiate Guidelines Network (SIGN) methodological checklist for cohort studies was used to assess the comparability of subjects, exposure or intervention, outcome measurement, and statistical analysis. These four domains have been previously selected by the Agency for Healthcare Research Quality as essential for high performing quality assessment tools of observational studies. An additional domain was added to the checklist to evaluate the validity and reliability of race/ethnicity measures.
Results

Study Search and Selection

The MEDLINE search identified 86 articles. The initial title and abstract review led to the exclusion of 44 articles. The full references and reasons for exclusion of these articles are provided in the Catalog of Articles Excluded after Title and Abstract Review (Appendix A). The full texts of the remaining 42 articles were reviewed. This review led to the exclusion of 31 articles. The full references and reasons for exclusion of these articles are provided in the Catalog of Articles Excluded after Full Text Review (Appendix B). A reference list review led to the selection of 3 additional studies. Full references of the selected articles from the electronic database and reference list search are provided in the Catalog of Selected Articles (Appendix C). The selection process is summarized in Figure 1.
Methodological Quality Assessment

Full article reviews containing detailed descriptions of study populations, measurement tools and databases, potential selection bias, potential measurement bias, potential confounding, statistical analysis and results are included in Appendix D. Quality assessment results are listed in the Quality Assessment Table.

The studies selected for this review consisted of 11 retrospective and 3 prospective cohort studies. Black and white comparison groups within all 14 studies differed significantly according to several variables other than revascularization procedures. The primary outcomes for all studies were well defined. There were 2 studies (Ding 2003; Iribarren 2005) that described the validity and reliability of appropriate race/ethnicity measures. The remaining 12 studies did not sufficiently describe these measures. There was 1 study (Petersen 2002) that reported the reliability of measures of exposure (revascularization procedures). There were 2 studies (Conigliaro 2000; Iribarren 2005) that adequately provided evidence from other sources that demonstrated that the measures of outcome (mortality) assessment are valid and reliable. The main potential confounders (age, sex, comorbidity, disease severity, hospital characteristics, and socioeconomic status) were adequately identified and considered in 4 studies (Conigliaro 2000; Petersen 2002; Gregory 1999; Peterson 1994). Confidence intervals during statistical analysis were sufficiently provided in 9 studies (Barnhart 2006; Ford 2000; Conigliaro 2000; Maynard 1997; Petersen 2002; Gregory 1999, Palmeri 2005; Iribarren 2005; Ding 2003; Peterson 1994). There were 10 studies (Barnhart 2006; Ford 2000; Conigliaro 2000; Maynard 1997; Maynard 1991; Mickelson 1997; Taylor 1998; Palmeri 2005; Giles 1995; Ding 2003) that were rated poorly for the ability to minimize risk of bias or confounding, and received the “-” coding on the SIGN scale used to complete the Quality Assessment Table. There were 4 studies (Petersen
2002; Gregory 1999; Iribarren 2005; Peterson 1994) that were given an intermediate grade between poor/adequate for ability to minimize bias and confounding, and received the “-/+” coding on the SIGN scale. No studies received the “+” or “++” grading for the ability to minimize bias and confounding. None of the reviewed studies, after considering clinical context and methodology, were judged to show a certain overall effect on mortality due to specific differences in cardiac revascularization procedure exposure.

**PTCA Procedure Rates**

There were 10 articles (Barnhart 2006; Ford 2000; Conigliaro 2000; Maynard 1997; Maynard 1991; Mickelson 1997; Petersen 2002; Taylor 1998; Giles 1995; Peterson 1994) that evaluated individual procedural rates for PTCA for both black and white patient populations. Of these 10 articles, a total of 8 (Barnhart 2006; Ford 2000; Conigliaro 2000; Maynard 1997; Maynard 1991; Giles 1995; Ding 2003; Taylor 1998) showed a statistically significant difference between black and white patients in the use of PTCA. The remaining 2 articles showed no statistically significant difference in PTCA rates according to race (Mickelson 1997; Petersen 2002). It is worth noting that the Mickelson et al. study did show a trend toward a racial difference, but a small black and white patient population of 316 patients may have limited the ability to achieve statistical significance.

**CABG Procedure Rates**

There were 10 articles that evaluated individual CABG rates according to race (Barnhart 2006; Ford 2000; Conigliaro 2000; Maynard 1997; Maynard 1991; Mickelson 1997; Petersen 2002; Taylor 1998; Giles 1995; Peterson 1994). Whites were shown to receive CABG at statistically significant higher rates than blacks in 9 of these studies (Barnhart 2006; Ford 2000; Conigliaro 2000; Maynard 1997; Maynard 1991; Petersen 2002; Taylor 1998; Giles 1995; Peterson 1994). The Mickelson study showed a trend toward a difference in procedure use that
did not achieve statistical significance. The Mickelson study enrolled only a small number of black and white patients, and may not have had the power to detect a statistically significant difference.

**Combined Revascularization Rates**

There were 4 studies (Gregory 1999; Palmeri 2005; Iribarren 2005; Ding 2003) that evaluated combined revascularization rates (PTCA and CABG) between black and white patients presenting with AMI. All 4 showed that white patients received revascularization procedures more often than black patients. The measured difference in each study achieved statistical significance.

**In-Hospital Mortality**

In-hospital mortality was evaluated by six studies (Barnhart 2006; Maynard 1997; Maynard 1991; Taylor 1998; Palmeri 2005; Giles 1995) within the review. All 6 articles were rated poorly within this review on study group comparability, describing validity and reliability of measurements, identification and consideration of main confounders, and ability to minimize the risk of bias or confounding. All 6 studies did use regression models to control for those potential confounders measured, and did clearly define outcomes.

A trend toward lower mortality among black patients was shown by 3 studies (Barnhart 2006; Maynard 1991; Giles 1995), but this difference was not shown to be statistically significant in any of the studies. The Barnhart study consisted of 11,011 black and white patients with AMI, and produced a fairly narrow 95% CI (OR 0.83 95% CI 0.69-1.00) suggesting a reasonably precise estimate. The study had sufficient power to suggest a mortality difference between the groups, but was not strong enough to satisfy standards of statistical significance. The Maynard study (black mortality 7.4% vs. white mortality 13.1%, p = 0.07) consisted of 2,870
patients. The small study size and lack of reported confidence intervals decreases the interpretation of the power and precision of the study and its findings. The results of the Giles study showed a difference in mortality between black and white patients, but did not provide any means to interpret the statistical significance of this difference.

There were 2 studies (Maynard 1997; Taylor 1998) that showed no mortality difference between groups. The Maynard study (OR 1.05 95% CI 0.72-1.54) consisted of 11,254 patients. The relatively wide 95% CI indicates a fairly imprecise odds ratio estimate. It is possible that the study did not have sufficient power to detect a difference between the groups. The Taylor study consisted of 275,046 patients. The study reported no statistical difference in hospital mortality between the groups within the text of the results, but did not provide actual numerical data to support or interpret these claims.

There was 1 study (Palmeri 2005) that showed a trend toward higher mortality in blacks compared to whites, but the difference did not achieve statistical significance (OR 1.82 95% CI 0.84-3.94). It should be noted that the Palmeri study focused on patients with cardiogenic shock complicating AMI, and therefore the study population and likely benefit from intervention differ for this study compared to the others in the review. The study consisted of 538 patients, and had sufficient power to suggest a mortality difference between the groups, but was not strong enough to satisfy standards of statistical significance.

30-Day Mortality

30-day mortality was evaluated by 2 studies (Ford 2000; Petersen 2002) in the review. Neither study showed a statistically significant difference between black and white patients for 30-day mortality. The studies were rated poorly according to study group comparisons and describing validity and reliability of race/ethnicity and mortality measures. Both studies clearly
defined outcomes and used regression models to control for those potential confounders measured. The Petersen article was one of the stronger studies in the review, it was evaluated to have an adequate description of exposure measures, adequate identification and consideration of confounders, and received an intermediate “-/+” grade on ability to limit bias and confounding. The study consisted of 4,611 black and white patients. The 95% CI (OR 0.99 95% CI 0.74-1.3) suggests a moderately precise estimate that evenly straddles an odds ratio suggesting no difference in mortality. The Ford study consisted of 10,016 black and white patients. The 95% CI (OR 0.87 95% CI 0.59-1.27) suggests the study may not have been powered sufficiently to generate a precise estimate of difference between the groups.

1-Year Mortality

1-year mortality was evaluated by 3 studies (Conigliaro 2000; Petersen 2002; Gregory 1999). All 3 studies were rated poorly according to study population comparison. There were 2 studies (Petersen 2002; Gregory 1999) that adequately identified and considered main confounders and also received intermediate grades for ability to limit potential bias and confounding.

2 of the 3 studies (Petersen 2002; Gregory 1999) suggested a slight trend toward lower mortality rates among black patients. Both studies were among highest rated in the review for identifying main potential confounders and minimizing bias. The Petersen study (OR 0.86 95% CI 0.68-1.09) suggested a trend toward lower mortality among all black and white patients with AMI. The Gregory study suggested a trend toward lower mortality among black and white patients under the age of 65 (RR 0.85 95% CI 0.66-1.09), but no real difference for patients over the age of 65 (RR 1.03 95% CI 0.89-1.19).
The Conigliaro study reported a black mortality rate of 5.2% and a white mortality rate of 7.4%, but no p-values or confidence intervals were included with the data to evaluate the significance of the data.

2-Year Mortality

2-year mortality was evaluated by 1 study (Mickelson 1997). This study was graded poorly according to study group comparisons and the describing of validity and reliability of measures. The study was graded poorly on identification of confounders and ability to minimize bias and confounding. The study did clearly define outcomes, and used regression models to control for those potential confounders that were measured. No statistically significant difference was seen in 22-month mortality in the Mickelson study (black mortality 30.9% vs. white mortality 23.3%, p>0.05). The study consisted of 316 black and white patients, and may have been insufficiently powered to detect a real statistically significant difference.

3-Year Mortality

3-year mortality was evaluated by 2 studies (Petersen 2002; Ding 2003). Both studies were graded poorly according to study group comparisons and the describing of the validity and reliability of measures for interventions and mortality. The Ding study did use patient self-report to measure race. The Petersen study adequately addressed confounding and had some ability to limit bias and confounding. Neither study showed a statistically significant difference between black and white patients, though the Petersen study showed a slight trend toward lower mortality in blacks (OR 0.93 95% CI 0.76-1.15) and the Ding study suggested a higher mortality rate (OR 1.31 95% CI 0.83-2.00). It should be noted that the 3-year mortality calculation in the Ding study did not control for patient comorbidities, and may suggest a larger difference due to group variation in comorbidity status.
5- Year Mortality

5-year mortality was evaluated by 1 study (Conigliaro 2000). The study was graded poorly according to study group comparison, describing validity and reliability of race/ethnicity and intervention measurements, identification and consideration of potential confounders, and its ability to minimize bias and confounding. The study did adequately demonstrate a valid and reliable measure of mortality and used regression models to control for those potential confounders that were measured. The study results showed similar black and white mortality rates (23.3% vs. 26.2%), but no p-values or confidence intervals were included to evaluate the significance of the difference.

Other Measures of Mortality

The Iribarren 2005 study measured mortality according to age-adjusted mortality rate per 100 person years. The study was graded poorly according to study group comparison, describing of validity and reliability of measures of interventions and mortality, and identification and consideration of potential confounders. The study was interpreted to have some ability to minimize the risk of bias, adequately addressed the validity and reliability of measures of race, clearly defined outcomes, and used regression models to control for measured confounders. The study showed that black men (HR 1.34 95% CI 1.18-1.52) and black women (HR 1.22 95% CI 1.06-1.40) compared to white men had higher mortality rates. The difference in mortality rates achieved statistical significance for both comparisons. It should be noted that these calculations did not adjust for patient comorbidity, and that the observed difference may be partly due to variation between groups according to medical comorbidity.
**Survival**

Survival was evaluated by 2 studies (Peterson 2002; Maynard 1997). The Peterson study was one of the stronger studies in the review. The study was evaluated to have adequate identification and consideration of confounders and received an intermediate grade of “-/+” on ability to limit bias and confounding. The study showed that blacks had higher 30-day survival compared to whites (OR 1.18 95% CI 1.07-1.31), a difference that achieved statistical significance. The study showed a trend toward higher 1 year survival in black patients, but the difference narrowly missed achieving statistical significance (OR 1.07 95% CI 0.99-1.16). There was no statistical significant difference for 2 year survival (OR 1.01 95% CI 0.92-1.07).

The Maynard study showed no statistically significant difference in 2 year survival between black and white patients (HR 0.93 95% CI 0.73-1.18). This study was rated poorly as far as group comparability, reporting of the validity and reliability of key measurements, and the ability to limit potential confounders and bias. The study did clearly define measured outcomes and used regression models to control for measured confounders.

**Discussion**

This systematic review included 14 studies. The collection of evidence within this review strongly supports that black patients presenting with AMI receive both PTCA and CABG less often than white patients. This is finding is consistent with previously completed primary studies and reviews. Despite this difference in procedure rates, the evidence collected in this review suggests that black patients have equal, and potentially lower, mortality rates after AMI compared to white patients.
Only 1 study (Iribarren 2005) reported that blacks suffered statistically significant higher mortality rates compared to whites. The Iribarren study did not provide a regression model that adjusted for medical comorbidity without controlling for revascularization procedures. A model controlling for age, insurance, and sociodemographic factors showed a statistically significant difference in mortality between blacks and whites. A second model adjusting for age, insurance, sociodemographic factors, comorbidities, and revascularization procedures showed no difference in mortality. Similarly, the Ding study showed a trend toward higher mortality in black patients, but did not control for medical comorbidities. From the provided models and results alone, it is not possible to discern if the mortality difference is primarily attributable to differences in comorbidity status or differences in revascularization rates.

The Palmeri study showed a strong trend toward a racial difference in mortality (OR 1.82 95% CI 0.84-3.94) that missed achieving statistical significance. The cohort for this study consisted of patients who all experienced AMI complicated by cardiogenic shock. Previous studies have shown that urgent revascularization for AMI complicated by shock can increase 1-year survival by 14.1% (95% CI 2.9%-25.2%; \( P < .02 \)). Considering this added survival benefit, it is possible that racial differences in revascularization procedures lead to differences in mortality in the presence cardiogenic shock, but not for patients with uncomplicated AMI.

The overwhelming majority of the evidence in this review indicates that black patients have lower or equal mortality rates compared to white patients after AMI despite lower rates of revascularization procedures. This conclusion is surprising given the evidence that exists to support the mortality benefits of revascularization procedures post-AMI. The following is a discussion of 3 separate factors that may contribute to the paradoxical conclusion of this review.
Do the studies within this review use specialized patient populations not representative of national trends?

4 of the studies included in this review used data made available through Veteran Affairs medical registries. VA specific medical data may differ from more general national sources due to a more homogenous patient base with fewer limitations on health care access, and may suggest mortality trends not representative of more national trends. 10 studies included in this review sampled patients from national, state, county, city, or hospital registries. The conclusions from the VA studies did not differ from the studies using these other data sources. Based on these findings, it does not appear that the use of specialized patient populations contributed to the review conclusion that there is no difference in black and white patient mortality after AMI despite differences in procedure use.

Do differences exist in revascularization procedure efficacy based on patient race?

A difference in the efficacy of revascularization procedures between racial groups could theoretically explain the mortality paradox. If revascularization procedures were more effective in preventing mortality when performed on black AMI patients, a smaller number of procedures within this population could produce similar mortality benefits compared to a larger number of less efficacious procedures performed on white patients. This theory would require that blacks be either biologically more favorable to revascularization, or that they receive higher quality procedures. No evidence exists that supports either claim. Several studies have shown that blacks and whites have similar short term mortality outcomes after PCI,\textsuperscript{24-29} though some evidence suggests higher black mortality at 1-year\textsuperscript{25} and 2-years.\textsuperscript{26} Many studies have also looked at racial differences in post-operative CABG outcomes, and have shown that blacks compared to whites have similar\textsuperscript{30-32} or lower survival rates after CABG.\textsuperscript{33-35} Concerning the possibility that blacks
receive higher quality procedures, there is a significant amount of evidence throughout the
literature that blacks and other minorities have less health care access, and overall receive lower
standards of care compared to white patients. Based on the extensive minority associated
inequalities present within healthcare, it is very unlikely that black patients are receiving higher
quality revascularization procedures and that these differences account for the paradoxical
conclusion of this review.

Do more black patients with severe infarctions die before arriving at the hospital compared to
white patients?

If a higher proportion of black patients with more severe infarctions died before hospital
admission, the proportion of black patients with less severe infarctions would be greater than that
of white patients. Studies have shown that blacks have higher rates of out of hospital infarction
deaths, higher incidence of out of hospital cardiac arrest with lower rates of survival, and
longer pre-hospital delay times compared to whites. These factors could potentially lead to a
selection process producing a relatively healthier black AMI population with a baseline mortality
rate that is lower than that of the less healthy white AMI population. In this scenario, the higher
rate of revascularization procedures in the white AMI population would lead to a greater
mortality benefit for whites, and the less the healthy white AMI population could achieve an
overall mortality rate similar to the healthier black AMI population. Under these conditions, the
revascularization mortality paradox would no longer be paradoxical, in that those patients
receiving higher rates of revascularization procedures are achieving greater mortality benefits
consistent with the evidence that supports the use of revascularization procedures post-AMI.

This selection model appears promising as a potential explanation for the findings of this
review. Further data must be collected evaluating racial differences in severity of AMI at
presentation along with racial differences in prehospital death secondary to infarction. If this model is correct in its assessment, the underuse of revascularization procedures in black AMI patients is leading to poorer mortality outcomes for this population, and therefore would be clearly classified as a healthcare disparity. The model also emphasizes the intricacies of evaluating the equality and equity of healthcare, in that it creates a scenario where a healthcare disparity may exist in the presence of equivalent outcomes. It reinforces the idea that the primary determinant of true healthcare equity is clinical need.

**Study Limitations**

The overall methodologic quality of the included studies was poor. All 14 studies were affected by potential selection bias and confounding. Black and white comparison groups differed according to several measured, and very likely unmeasured, patient and clinical variables. The ability to select black and white comparison groups in the United States that differ only according to an intervention seems to be very unlikely considering historic, cultural, socioeconomic, health behavior, disease prevalence, and access to care differences that exist across these 2 populations. The fact that 11 of the 14 studies included in this review were retrospective and used previously collected data complicates the ability to accurately measure and adjust for all potential differences.

The reporting of validity and reliability for key measures including race, revascularization procedures, and mortality for studies within this review was poor. There were 2 studies that adequately addressed measures for race (Iribarren 2005; Ding 2003). Only 1 study (Petersen 2002) adequately described measures of revascularization procedures. Measures for mortality were adequately described in 2 studies (Conigliaro 2000; Iribarren 2005). This lack of
reporting may partially be caused by the use of previously collected data sources within retrospective studies, of which validity and reliability information is not available.

The reporting of the quality of race measures was also poor within the review. The classification, definitions, and terminology used for racial/ethnic identification are complex and are consistently changing. A 2007 systematic review evaluating race/ethnicity reporting in major medical journals over a four year period found a total of 13 terms reported to infer “black” and 16 terms used to infer “white” patients. Within this same review, only 159 of 1,152 articles (14%) described how racial/ethnic categories were assigned and 10 out of 1,152 articles (<1%) included mixed race/ethnicity as a separated category. The rate of reporting race/ethnicity assignment from the Ma et al. review is consistent with that found in my review (2 of 14 articles or 14%).

The use of older data based on previous classification schemes further complicates the ability to accurately and reliably identify race; and may in theory alter the generalizability of racial outcomes of previous older primary studies to current defined racial groups. Only 2 studies within this review (Iribarren 2005; Ding 2003) incorporated self report of racial identification, which currently serves as the “gold standard” measure for race..

The generalizability of the majority of the individual studies within this review is limited. Only 4 studies included a national sample of AMI patients (Peterson 1994; Petersen 2002; Giles 1995; Taylor 1998). The remaining 10 studies were limited to single medical centers, cities, counties or states. Patient populations from these limited areas may not reflect national trends in disease prevalence and severity, quality of medical care, socioeconomic systems, racial/ethnic composition, and race/ethnicity associated empowerment and social power structures. Of the 4 studies including a national sample, 2 studies (Peterson 1994; Petersen 2002) had populations
consisting of only men. Differences in revascularization and mortality between white men and black men have been shown to differ from differences observed between white men and black women.\textsuperscript{43} The findings of these studies may not be generalizable to black women.

A majority of the studies included in the review suffered from poor methodological quality and reporting, and future studies are needed to clarify the effects a well documented racial difference in revascularization procedures has on patient outcomes after AMI. The fact that differences in procedure suggested a difference in mortality between black and white patients presenting with AMI complicated by cardiogenic shock suggests that there are clinical situations where this racial difference in care does negatively affect outcomes. Further research must work to identify similar clinical presentations and situations that may lead to differences in mortality. Research must also be conducted to examine potential differences in other health outcomes associated with AMI and treatment including recurrent infarction, stroke, functional status, and quality of life. It is possible that a difference in treatment does not affect mortality, but does create differences in these other important outcomes.

To avoid the limitations of the previous studies included in this review, strong consideration should be taken to developing prospective studies of national samples to avoid the measurement, reporting, and generalizability limitations associated with using older regional data. The studies should be sufficiently powered to detect true difference if they exist. A systematic search for all potential confounders should be performed, and these variables should be measured and adjusted for to help limit the potential confounding created by the necessary comparison of racial/ethnic groups. Appropriate group measures should include socioeconomic indicators, medical comorbidity status, indicators of disease severity, and admission hospital
characteristics and treatment capabilities. Race should be measured by self-report, and valid and reliable measures of revascularization procedures and mortality should be used and reported.

**Review Limitations**

There are several limitations to this review. Articles were selected and analyzed by a single reviewer, creating the potential for both selection and measurement bias. Several steps were taken to help limit this potential for bias. Selection criteria were precisely defined and discussed with an experienced researcher before article selection. The electronic search was carried out with the direct assistance of a research specialist. Efforts were taken to explicitly describe the selection and review process, including detailed reference lists of excluded articles with reasons for exclusion and full length article reviews of included studies made available in the appendix section of this review. The use of MEDLINE as a primary source for this review creates a potential for publication bias. Studies published in “major” English medical journals may have been disproportionately represented. The use of alternative electronic databases and extensive hand searching may have helped limit publication bias, however, the limited research support for this review did not make this extended search strategy possible.
REFERENCES


2. Lilly L, ed. Pathophysiology of Heart Disease: A Collaborative Project of Medical Students and Faculty. 3rd ed. Lippincott Williams & Wilkins, US; 2002.


Appendix A: Catalog of Articles Excluded After Title and Abstract Review

   - Cohort consisted of black and white patients who all received PCI.
   - Outcomes assessed were post-procedural only.

   - Cohort consisted of patients treated for hypertrophic obstructive cardiomyopathy.
   - Intervention was the MRI imaging of cardiac structures post-PTCA septal myocardial ablation.
   - Outcomes assessed were MRI imaging findings only.

   - Cohort consisted of black and white patients who all received PCI.
   - Outcomes assessed were post-procedural only.

- Cohort consisted of black and white patients who all received PCI.
- Outcomes assessed were demographic and post-procedural only.

- Cohort consisted of patients who all received PCI.
- Outcomes assessed were post-procedural only.

- Cohort consisted of ESRD patients with PVD.
- Intervention of interest was lower extremity revascularization.
- Outcomes based on lower extremity procedure only.

- Cohort consisted of black and white patients who all received PCI.
- Outcomes assessed were demographic and post-procedural only.
   - Cohort consisted of patients who all received PCI.
   - Outcomes assessed were demographic and post-procedural only.

   - Intervention was not coronary revascularization procedures

    - Cohort consisted of black men and women who all received PCI.
    - Outcomes assessed were demographic and post-procedural only.

    - Cohort consisted of patients with PVD.
    - Intervention of interest was lower limb angioplasty
    - Outcomes assessed were related to lower limb angioplasty only.


- Cohort consisted of black and white patients who all received PCI.
- Outcomes assessed were demographic and post-procedural only.


- Cohort consisted of patients who all received PCI
- Outcomes assessed were demographic or post-procedural only.


- Cohort consisted of patients who all received CABG.
- Outcomes assessed were demographic, cost and post-procedural related only.


- Cohort consisted of patients who all received CABG.
- Outcomes assessed were demographic and post-procedural only
- Study was published before 1990.
   - Cohort consisted of patients who all received either CABG, PTCA, AAA, and CEA.
   - Outcomes assessed were demographic and post-procedural only.

   - Cohort consisted of patients who all received CABG.
   - Outcomes assessed were demographic and post-procedural only.

   - Cohort consisted of patients who all received CABG.
   - Outcomes assessed were demographic and post-procedural only.

   - Cohort consisted of patients who all received CABG.
   - Outcomes assessed were demographic and post-procedural only.
   - Cohort consisted of patients who all received CABG.
   - Outcomes assessed were demographic and post-procedural only.

   - Cohort consisted of patients who all received CABG.
   - Outcomes assessed were demographic and post-procedural only.

   - Cohort consisted of patients who all received CABG.
   - Outcomes assessed were demographic and post-procedural only.

   - Cohort consisted of patients who all received CABG.
   - Outcomes assessed were patient demographics, hospital demographics and post-procedural only.
- Cohort consisted of dialysis patients who all received CABG.
- Outcomes assessed were demographic and post-procedural only.

- Cohort consisted of patients who received 1 of 8 cardiovascular and cancer procedures.
- Outcomes assessed were demographic and post-procedural only.

- Cohort consisted of patients who all received CABG.
- Outcomes assessed were demographic and post-procedural only.

27. Maynard C, Fisher L, Passamani E. Survival of black persons compared with white persons in the Coronary Artery Surgery Study (CASS). The American Journal of Cardiology. 1987 Sep 1; 60(7): 513-518.
- Study published before 1990.
- Data collected from years 1974-1979.

- Cohort consisted of patients who all received CABG.
- Outcomes assessed were demographic and post-procedural only.
- Study design was a nested case-control study.


- Cohort consisted of patients who all received CABG.
- Outcomes assessed were demographic, procedural referral patterns post-procedural only.


- Cohort consisted of patients who all received CABG.
- Outcomes assessed were demographic and post-procedural only.


- Cohort consisted of patients who all received CABG.
- Outcomes assessed were demographic and post-procedural only.
- Study was published before 1990.
- Data collected from 1970-1978.

   - Cohort consisted of patients who all received CABG.
   - Outcomes assessed were demographic and surgical quality measures only.

   - Cohort consisted of patients who all received CABG.
   - Outcomes assessed were demographic and post-procedural only.

   - Cohort consisted of patients with pulmonary embolism.
   - Outcomes assessed were based on the diagnosis of pulmonary embolism.

   - Cohort consisted of patients who all received CABG.
- Cohort consisted of black patients only, no white comparison group.
- Outcomes assessed were demographic and post-procedural only.

- Cohort consisted of patients receiving mitral valve or aortic valve replacement.
- Outcomes assessed based on valve replacement surgery only.

- Cohort consisted of patients receiving aortic, mitral, or aortic plus mitral valve replacement.
- Outcomes assessed based on valve replacement surgery only.
- Study published before 1990.
- Data collected between 1973-1978.

- Cohort consisted of patients who all received CABG.
- Outcomes assessed were demographic and post-procedural only.
   - Cohort consisted of patients who all received CABG.
   - Outcomes assessed were demographic and post-procedural only.

   - Study published before 1990.

   - Study published before 1990.

   - Study published before 1990.

   - Study published before 1990.

- Cohort consisted of patients who all received CABG.
Appendix B: Catalog of Articles Excluded After Full Text Review

   - Outcome assessed is time to treatment only.

   - Cohort consists of only unstable angina and NSTEMI patients only.
   - Outcomes assessed are based only on unstable angina or NSTEMI diagnoses.

   - Outcomes assessed are procedural recommendation by race and procedure rates by race only.

   - Outcomes assessed are compared based only by socioeconomic status. No comparisons are made between outcomes based on race.
   - Cohort consisted of patients who all received PCI.
   - Outcomes assessed are post-procedural results only.

   - Outcomes assessing mortality are post-procedural only.

   - Cohort consisted of patients who all received PCI
   - Outcomes assessed are post-procedural results only.

   - Intervention was the use of BNP as a marker for acute coronary syndrome.
- Outcomes assessed are the testing characteristics of BNP along with associated acute coronary syndrome outcomes.

   - Cohort consisted of patients who all received PCI.
   - Outcomes assessed are the effects of anemia and renal insufficiency in post-procedural outcomes.

    - Cohort consisted of general ischemic heart disease patients including acute and chronic disease.
    - Outcomes assessed are revascularization rates and survival for all ischemic patients. No AMI specific outcome data is provided.

    - Outcomes assessed are racial differences in revascularization rates only.

- Cohort consisted of patients with general cardiovascular disease, including acute and chronic disease.
- Outcomes assessed are racial differences in procedure rates and survival based on a diagnoses of cardiovascular disease. No AMI specific outcome data is provided.


- Cohort consisted of patients who all received PCI.
- Outcomes assessed are post-procedural results only.


- Cohort consisted of Medicare patients receiving either PTCA or CABG.
- Outcomes assessed are post-procedural results only.

- Cohort consisted of patients who received cardiac catheterization for varying forms of heart disease including acute and chronic presentations.

- Outcomes assessed are race differences in procedural rates and mortality for heart disease patients as a whole. No AMI specific outcome data is provided.


- Cohort consisted of patients with coronary artery disease, including chronic and acute manifestations.

- Main outcome assessed is functional status only. No mortality data is provided.


- Cohort consisted of patients that received 1 of 17 hospital procedures (cardiac and non-cardiac procedures)

- Outcomes assessed are racial differences in procedural rates and post-procedural mortality only.

- Cohort consisted of general coronary heart disease patients (including chronic and acute disease.)

- Outcomes assessed are racial differences in coronary heart disease incidence, procedure rates, and survival. No AMI specific outcome data is provided.


   - Review of available literature on the contributory factors to differences in CABG use and post-procedural outcomes only.


   - Cohort consisted of patients who all received CABG.

   - Outcomes assessed are post-procedural results only.


   - Cohort consisted of black patients diagnosed AMI. There was no white comparison group included.

   - Outcomes assessed are primarily focused on disease presentation characteristics. No mortality data is provided.
   - Editorial article. Article is not a cohort study.

   - Cohort consisted of patients who underwent cardiac catheterization for suspected coronary disease (including UA, MI, angina, etc).
   - Outcomes assessed are primarily focused on the appropriateness of revascularization procedures of coronary disease patients. No specific AMI mortality data is provided.

   - Study assesses clinical treatment and outcomes after a hospital wide quality assurance program intervention.

   - Cohort consisted of patients who all received PTCA or CABG.
   - Outcomes assessed are post-procedural results only.
   - Review article discussing racial differences in procedural rates. No mortality outcome data is provided.

   - Cohort consists of all black patients with CAD. No white comparison group was included.
   - Outcome comparisons are based on sex only. There is no outcome data describing differences between black and white patients.

   - Cohort consisted of patients who all received PCI.
   - Outcomes assessed are post-procedural results only.

   - Cohort consisted of ischemic heart disease patients (both acute and chronic forms)
- Outcomes assessed are racial differences in hospitalization rates, procedure rates, and mortality for ischemic heart disease patients. No specific AMI outcome data is provided.

   - Cohort consisted of patients who all received PCI.
   - Outcomes assessed are post-procedural results only.

   - Non-observational study
Appendix C: Catalog of Selected Articles from Electronic Search


Appendix D: Complete Article Reviews


Study Question: What is the association of coronary revascularization with hospital mortality in black, Hispanic, and white patients admitted to New York City hospitals with acute myocardial infarction?

Research design: Retrospective cohort study

Study population: Patients recorded in the New York State Department of Health Statewide Planning and Research Cooperate System (SPARCS) identified as black, white, or Hispanic who were 35 years and older and admitted to an NYC hospital with a principal discharge diagnosis of AMI in 1996.

- 12555 patients were eligible and included in the study (9138 white, 1873 black, and 1544 Hispanic)

Identification of race/ethnicity: Based on demographic information obtained from medical records and coded to describe the ethnic origin of patients.

Identification of AMI: International Classification of Diseases, Ninth revision, Clinical Modification chart codes for AMI.

Initial comparability of groups: White patients compared to black patients were 6.1 years older (p<.001), more likely to be male (58.6% vs 49.6%, p<.001), and more likely to have some form of insurance (94.7% vs 88.5%, p = .02). Blacks were more likely to have statistically significant higher rates of HTN (62.9% vs 44.7%), DM (38.2% vs 25.9%), and high cholesterol (13.2% vs
12.1%). Whites were more likely to have statistically higher rates of CHF (36.3% vs 29.1%) and shock (3.8% vs 2.3%) compared to blacks.

**Drop Outs / Loss to Follow Up: N/A**

**Potential for selection bias:** The black and white comparison groups had statistically significant differences in age, sex, insurance status, medical comorbidities, and complications. Attempts to account for these initial differences were made through multiple regression models during data analysis for these known differences. Differences in treatment facility characteristics and access were not measured, and it is possible that the comparison groups differed in access to quality care. Other potential unknown and unaccounted for differences also may exist between the groups that were not accounted for in the analysis.

**Measurement of intervention:** International Classification of Diseases, Ninth revision, Clinical Modification chart codes for angioplasty and coronary artery bypass surgery.

**Measurement of outcomes:** Measures of hospital mortality were based on discharge status (dead or alive). No other information regarding mortality measures is given.

**Potential for measurement bias:** No information is provided regarding the validity and reliability of using the New York State Department of Health Statewide Planning and Research Cooperate System (SPARCS) as a primary source of medical data to measure race, patient demographic information, clinical variables, treatments, or mortality.

**Potential confounders:** Potential confounders considered were patient age, sex, race/ethnicity, principal diagnoses, cardiovascular risk comorbidities (HTN, DM, hypercholesterolemia), and SES (indicated by type of insurance).
Potential for confounding: No systematic approach to the identification of potential confounders is described, though a number of factors are identified, described between comparison groups, and statistically adjusted for using stratification and regression. No information is provided regarding the validity and reliability of using the New York State Department of Health Statewide Planning and Research Cooperate System (SPARCS) for the measurement of potential confounders.

Analysis: Bivariate analyses were used to characterize the study population and calculate frequencies of cardiac procedure use and mortality stratified by age, sex, and race. Race specific multiple logistic regression models were used to compute ORs and 95% CIs using hospital mortality as the outcome variable, while controlling for covariates found to be significant from bivariate analyses. Separate regression models were stratified according to revascularization status to compare adjusted odds of death for blacks compared to whites who did and did not undergo the procedure.

Results: Whites were more likely than blacks to receive PTCA (15.8% vs 9.7%, p<.001) and CABG (9.6% vs 6.2%, p<.001). Regression modeling controlling for age, sex, insurance status, comorbidities, and angiography status also showed blacks were less likely to be revascularized than whites (OR 0.56 95% CI 0.48-0.66). Age adjusted mortality rates were higher in whites than blacks (6.4 per 100 vs 5.9 per 100 hospitalizations), though this difference was not statistically significant. Blacks had slightly lower hospital mortality than whites (OR 0.83 95% CI 0.69-1.00) after controlling for age, sex, insurance status, comorbid medical conditions, and complications, and revascularization status.
**Overall judgment of internal validity:** The internal validity of this study is threatened by the potential selection bias, measurement bias, and confounding described above. Validity would be strengthened by including a systematic search for potential confounders, more detailed group comparative information, and larger statistical models to control for more potential confounders. More information about the accuracy and completeness of the medical records system used would also strengthen internal validity.

**Overall judgment of external validity:** The external validity of this study is threatened by the selection of patients only from New York City hospitals. Geographic differences in acute myocardial infarction severity and treatment may limit the generalizability of this study. The inclusion of patients from a broader sample of treatment areas would increase the external validity of the study.

**Overall conclusions/interpretations:** The study results indicate that despite racial differences in rates of revascularization, in hospital-mortality rates remain similar between blacks and whites. The study results are limited by significant potential for selection bias, measurement bias, and confounding.


**Study Question:** Do differences in clinical presentation, including comorbidity, operative risk, and coronary anatomy, explain the differences in the use of PTCA and CABG between black and white male patients admitted with AMI or unstable angina.

**Research design:** Retrospective cohort study
**Study population:** Male patients age 30 and older admitted to 1 of 6 Veterans Affairs hospitals from 1989-1995 with acute myocardial infarction or unstable angina who underwent cardiac catheterization.

- 3137 eligible patients, of which 535 were black
- Of the 535 black patients, 414 (77%) medical records were available.
- Medical records for a white patient were requested for a matched black patient based on age, admitting diagnosis, and medical center. When not available, the medical record of another white matched patient was requested.
- Overall requested 710 medical records, for which 517 were available (73%).
- Those who had revascularization during the preceding year (51% black excluded patients vs. 63% white excluded patients), had a primary hospital diagnosis other than AMI or unstable angina (33% vs. 24%), had no cardiac catheterization performed (0% vs 2%), had a decision to revascularize before admission (14% vs. 8%), incomplete records (0% vs. 3%), and actual race other than black or white (2% vs. 1%) were excluded.

- Final study included 666 veterans (326 black, 340 white).
- 316 of the 666 patients were AMI patients (149 black, 167 white).

**Identification of race/ethnicity:** Recorded via Veterans Health Administration Patient Treatment File.

**Identification of AMI:** International Classification of Diseases, Ninth revision, Clinical Modification chart codes for AMI. Diagnosis was confirmed by a chart review according to patient presentation, cardiac enzymes, and EKG changes.
**Initial comparability of groups:** Blacks compared to whites with AMI were more likely to have HTN (73% vs. 47%, p <0.001), DM (29% vs. 17%, p <0.001), and to abuse alcohol (46% vs. 36%, p = 0.02). Whites tended to have higher degrees of stenosis according catheterization than blacks (severe stenosis 31% vs. 28%, moderate stenosis 15% vs. 7%, mild stenosis 47% vs. 46%, and no disease 7% vs. 19%, p = 0.002). RAND appropriateness for procedure ratings showed no significant differences between blacks and whites.

**Drop Outs / Loss to Follow Up:** N/A

**Potential for selection bias:** Black and white patients were matched according to age, admitting diagnosis, and medical center. Comparison data showed that blacks were more likely to have HTN, DM and to abuse alcohol, and less likely to have significant coronary disease on angiography compared to whites. Logistic regression models were used to control for group differences. Significant potential for sampling bias exists due to the unavailability of 23% of black patient and 27% of white patient requested medical records.

**Measurement of intervention:** Administrative data from the Veterans Health Administration was used to measure procedure use.

**Measurement of outcomes:** Administrative data from the Veterans Health Administration was used to measure mortality.

**Potential for measurement bias:** No information is provided on the validity and reliability of obtaining medical information from Veterans Health Administration Patient Treatment Files to measure patient and clinical variables. Chart reviewers were masked to patient identifiers and race. No information is given providing the validity and reliability of using these treatment files to identify race, and whether information reflects self-identified or assigned racial identity. The use of the Beneficiary Identification and Record Locator to measure mortality was shown to be
98% concordant with mortality measures using Medicare Health Insurance Skeletonized Writeoff Files.

**Potential confounders:** Potential confounders included were age, degree of stenosis, ejection fraction, comorbidity, prior MI, HTN, COPD, DM, peripheral vascular disease, smoking status, and alcohol abuse.

**Potential for confounding:** No systematic approach to the identification of potential confounders is described. White and black patients included in the study were initially matched for age, admitting diagnosis, and medical center. The use of the VA health system was intended to decrease socioeconomic and access to care differences between the groups. Blacks and whites did differ on severity of stenosis, HTN, diabetes, and alcohol use. No indicator of SES was included in the analysis, and it is possible that controlling for SES may alter some of the racial differences observed. Logistic regression models were used to control for group differences in the analysis.

**Analysis:** Chi-square tests were used to assess univariate relations between race and degree of stenosis, RAND appropriateness scores, and revascularization procedures. Multivariate polychotomous logistic regression was used to assess the independent effect of race on CABG and PTCA rates after controlling for RAND scores. Kaplan-Meier methods with Breslow statistics were used to test univariate relations between race, revascularization procedures, appropriateness, necessity levels, and time to death.

**Results:** Black patients were less likely than whites to undergo any form of revascularization (28% vs. 47%, p <0.001). This difference was maintained when considering only patients with angiographically demonstrated coronary disease (38% vs 54%, p < 0.001). Procedure specific analysis showed blacks were significantly less likely to receive PTCA (OR 0.48 95% CI 0.32-
0.70) and CABG (OR 0.38 95% CI 0.24-0.60). The difference in procedure rates were maintained when only considering patients with significant coronary stenosis defined as greater than 50% obstruction (PTCA OR 0.58 95% CI 0.42-0.81 and CABG OR 0.47 95% CI 0.30-0.74). No difference was found in 1 year mortality (5.2% vs. 7.4%) and 5 year mortality (23.3% vs. 26.2%) between blacks and whites.

**Overall judgment of internal validity:** The internal validity of the study findings is threatened by a significant potential for selection bias. A significant number of blacks and whites were initially eligible for the study, but were later excluded because medical files were unavailable. The lack of information regarding the validity and reliability of measurement tools creates potential for measurement bias that may limit internal validity.

**Overall judgment of external validity:** The study used medical information from 6 VA medical centers (Birmingham, Ala; Milwaukee, Wis; New York, NY; Philadelphia, PA; Pittsburgh, PA; and Los Angeles, CA) across the country with varying racial compositions. The fact that all medical centers used were in major metropolitan areas and all had the capacity to perform CABG on site may limit the generalizability of the study.

**Overall conclusions/interpretations:** The study shows that black patients were less likely to receive any form of revascularization procedures compared to white patients. Despite this difference, no significant difference was seen between the two groups regarding 1 year and 5 year mortality. A strong potential for selection bias may limit the accuracy of the study findings.

Study Question: What mechanisms create the racial disparity in mortality rate after myocardial infarction?

Research design: Prospective cohort study

Study population: Patients from 4 communities (Forsyth County, NC; Jackson, Miss; Minneapolis, Minn; Washington County, MD) age 45-64 years at initial recruitment diagnosed with AMI from the previous Atherosclerosis Risk in Communities (ARIC) cohort study.

- 642 patients identified (471 white, 171 black)
- In both Minneapolis and Washington County, all subjects were white.
- All patients from Jackson were black.
- In Forsyth County, there were 161 white and 17 black patients included.

Identification of race/ethnicity: Patient self-report

Identification of AMI: Measured using hospital discharge indexes, death certificates, or information elicited through follow up patient interviews. Hospital chart abstraction was carried out to identify International Classification of Diseases 9th Revision Clinical Modification codes for primary or secondary diagnoses of AMI.

Initial comparability of groups: Blacks compared to whites were less likely to be male (48.5% vs. 68.8%, p = 0.001), had higher baseline BMI values (29.6 vs. 27.8, = 0.001), had less cigarette years of smoking at baseline (345.2 vs. 555.0, p = 0.001), had higher HDL levels at baseline (47.8 vs. 42.0, p = 0.001), had higher rates of baseline HTN (67.2% vs. 37.0%, p = 0.001), higher rates of diabetes at baseline (31.7% vs. 19.6%, p 0.001), lower rates of high school graduation at baseline (46.8% vs. 70.2%, p = 0.001), lower baseline income (>16K/yr) (37.1%
vs. 81.4%), lower rates of abnormal cardiac enzymes (78.8% vs. 86.4%, p = 0.02), and fewer receiving cardiac procedures after MI (21.6% vs. 57.1%, p = 0.001).

**Drop Outs / Loss to Follow Up:** None

**Potential for selection bias:** Black and white patients had statistically significant differences for several measured variables. These differences were controlled for using Cox proportional hazard models during analysis. The fact that all patients from Minneapolis and Washington County were white, and all patients included in the study from Jackson were black introduces the potential for key geographic related differences between the groups. It confounds the ability to distinguish if measured differences are actually due to race or to geographical location. It also creates a difficult context to interpret measured SES indicators, education and income levels may have very different meanings depending upon the socioeconomic characteristics of the region being considered.

**Measurement of intervention:** Information on revascularization procedures collected from hospital charts.

**Measurement of outcomes:** Mortality was measured using hospital discharge indexes, death certificates, or information elicited through follow up patient interviews

**Potential for measurement bias:** Clinical and patient information was collected through patient examination and interview. Race was measured according to self-report. Mortality was measured using several sources including discharge indexes, death certificates, or information elicited through follow up contact. No patients are reported to have been lost to follow up.

**Potential confounders:** Several factors are accounted for and grouped into 4 main categories: vascular risk factors, socioeconomic position, severity of MI, and treatment.
**Potential for confounding:** No systematic approach to the identification of potential confounders is described, though a number of factors are identified, described between comparison groups, and statistically adjusted for. Hospital variables were not directly measured or adjusted for. The use of comparison groups from nearly exclusive geographic regions increases the risk for confounding.

**Analysis:** Cox proportional hazard models were constructed to control for significant variables to assess racial disparity in mortality. Unadjusted case fatality rates were calculated using the Kaplan-Meier method.

**Results:** Blacks received revascularization after AMI less often than whites (26.1% vs. 57.1%, p = 0.001). Unadjusted 3-year mortality was higher in blacks than whites (21% vs. 14%). After adjusting for age and sex, blacks still had higher rates compared to whites (Relative Hazard (RH): 1.80 95% CI 1.24-2.61). Mortality rates after adjusting for vascular risk factors (1.29 95% CI 0.83-2.00), adjusting for socioeconomic factors (RH 1.31 95% CI 0.83-2.09), adjusting for severity of MI (RH 1.60 95% CI 1.05-2.45), or adjusting for treatment (RH 1.36 95% CI 0.92-2.00) were still higher for blacks. The model controlling for all factors provided a mortality RH of 1.00 (95% CI 0.56-1.77) for blacks compared to whites.

**Overall judgment of internal validity:** The potential for selection bias and confounding limit the internal validity of study findings.

**Overall judgment of external validity:** External validity is severely limited due to the small sample size and the limited locations sampled for the study. The 4 areas sampled for the study are all very unique in terms of population demographics compared to the rest of the United States. The inclusion of patients from a broader sample of treatment areas would increase the external validity of the study.
Overall conclusions/interpretations: The study shows that black patients receive revascularization procedures less often than whites. Blacks have significantly higher mortality rates after AMI compared to whites, a difference that remains after independently adjusting for vascular risk factors, socioeconomic factors, severity of MI, and treatment. The difference in mortality did not exist after adjusting for all 4 variable categories together. Findings are limited by potential selection bias and confounding based on regional exclusivity of comparison groups.


Study Question: Do racial or ethnic differences in the use of invasive and several non-invasive procedures exist among elderly patients admitted for treatment of an acute myocardial infarction in California?

Research design: Retrospective cohort study

Study population: Patients recorded in the Cooperative Cardiovascular Project (CCP) database admitted to 1 of 383 non-federal acute-care California hospitals for treatment of an acute myocardial infarction in 1994-1995 who were identified as Medicare patients from the Medicare Provider Analysis and Review Record.

- 10,705 patients were identified as having a confirmed AMI who were 65 and older and who were not transferred to another hospital.
- Only white, black, and Hispanic patients were included in the analysis.
- 9489 white, 527 black, and 689 Hispanic patients were included in the study.
**Identification of race/ethnicity:** Abstracted from medical records.

**Identification of AMI:** International Classification of Diseases, Ninth revision, Clinical Modification chart codes for AMI. AMI diagnosis was confirmed by a chart review according to patient presentation, cardiac enzymes, and EKG changes.

**Initial comparability of groups:**

**Patient characteristics:** White patients compared to black patients were older (19.3% vs 13.5% age 80-84; 18.9% vs 12.3% 85 and older, \( p = 0.001 \)) and more likely to be male (53.8% vs 43.8%, \( p = 0.001 \)). Blacks had higher rates of diabetes (40.2% vs. 26.5%, \( p = 0.001 \)), HTN (80.7% vs 61.1%, \( p = 0.001 \)), history of CVA (17.8% vs 13.9%, \( p = 0.001 \)), history of peripheral vascular disease (13.9% vs. 10.9%, \( p = 0.011 \)), and history of CHF (27.5% vs. 21.9%, \( p = 0.001 \)). Whites were more likely than blacks to have COPD (21.1% vs 18.8%, \( p = 0.012 \)) and to have had previous CABG (15.1% vs 10.8%, \( p = 0.001 \)).

**Admission characteristics:** Blacks had higher APACHE II scores (10.56 vs. 9.99, \( p = 0.001 \)), longer lengths of hospital stay (7.8 vs. 6.7 days, \( p = 0.34 \)), and higher rates of CHF (33.6% vs. 29.0%, \( p = 0.006 \)) compared to whites. Whites were more likely have Q-wave MI (16.4% vs. 12.4%, \( p = 0.045 \)), atrial fibrillation (11.7% vs. 7.7%, \( p = 0.001 \)), and left bundle branch block (7.2% vs. 4.9%, \( p = 0.023 \)) on initial EKG compared to blacks.

**Drop Outs / Loss to Follow Up:** N/A

**Potential for selection bias:** The black and white comparison groups had statistically significant differences for several variables. Attempts to control for these initial differences were made through multiple logistic regression models. Differences in treatment facility characteristics and access were not measured, and it is possible that the comparison groups differed in access to quality care. Other potential unknown and unaccounted for differences also may exist between
the groups that were not accounted for in the analysis, though the list of the initial comparative variables is very extensive and includes patient characteristic, admission characteristic, and hospital stay characteristic variables.

**Measurement of intervention:** PTCA, CABG, cardiac catheterization, multiple gated acquisition scan, stress test, and echocardiography as indicated by medical records.

**Measurement of outcomes:** Events during hospitalization and mean time to procedure were indicated by medical records. 30-day mortality rates were obtained from databases of the Social Security Administration.

**Potential for measurement bias:** Two contractors abstracted information on admitting variables, variables concerning hospital stay, and discharge variables from the CCP data records of those selected to be in the study. It is unclear if those abstracting chart information were aware of patient outcomes before conducting the chart review. The completeness, validity, and reliability of the CCP medical data is also unknown. No information is provided regarding the validity and reliability of the chart based racial classification used during the study, it is unclear if race/ethnic identification was self-designated or assigned. AMI identification was done through chart codes, and further supported through confirmation using specific predefined laboratory and clinical parameters during the chart review. No information is provided regarding the validity and reliability of using Social Security Administration databases to measure 30-day mortality.

**Potential confounders:** Tables 1-3 list several potential confounders separated by patient characteristics, admission characteristics, and hospital stay characteristics.
Potential for confounding: No systematic approach to the identification of potential confounders is described, though extensive comparisons on several patient related factors are provided and statistically adjusted for using regression models. The adequacy of using medical records to identify and measure these potential confounders is unknown. No information was collected on hospital treatment capabilities and access to quality of care. There were no measures of SES, and no controls for SES within the regression models. Though patients were all on Medicare, it is possible that much of the observed effect according to race would be accounted for by differences in SES.

Analysis: Statistical significance of potential confounders was calculated using chi-square analysis for categorical variables and analysis of variance for continuous variables. Variables that were significant or borderline significant were included in multiple logistic regression models in which various procedures were the dependent variables and race or ethnicity was an independent variable along with other covariates.

Results: Blacks were less likely to receive PTCA (12.7% vs 17.8%, p = 0.001) and CABG (4.6% vs 9.7%, p = 0.001). Blacks received PTCA less often than whites (OR = 0.64 95% CI 0.49-0.85) and CABG less often than whites (OR 0.42 95% CI 0.27-0.64) after adjusting for age, sex, smoking, comorbidity, HTN, CVA, COPD, dementia, peripheral vascular disease, CHF, hemorrhage, rales, S3 gallop, chest pain during stay, duration of chest pain, atrial fibrillation, and left bundle branch block. Blacks had lower 30 day mortality compared to whites (OR 0.87 95% CI 0.59-1.27) after adjusting for age, sex, smoking, APACHE II scores, ejection fraction, comorbidities, various events after admission, hospital complications, and EKG abnormalities.
Overall judgment of internal validity: The extensive comparison of groups according to several variables, and the controlling for significant differences by regression modeling helps lower the potential for selection bias and confounding affecting internal validity of this study. Measurement bias remains a valid threat to the internal validity of this study, further reporting of the validity and reliability of several measures included within this study would further strengthen internal validity.

Overall judgment of external validity: The external validity of this study is threatened by the selection of patients only from California hospitals. Geographic differences in acute myocardial infarction severity and treatment may limit the generalizability of this study. The inclusion of patients from a broader sample of treatment areas would increase the external validity of the study. Findings may also differ among younger populations.

Overall conclusions/interpretations: The study results show that blacks were less likely than whites to receive revascularization after AMI. This difference remained after controlling for several patient and clinical variables. Despite this difference in treatment, blacks and whites had similar adjusted 30-day mortality rates. Significant effort was taken to minimize selection bias and confounding of the results. Further information on the adequacy of the measurement tools used for the study would strengthen findings.

**Study Question:** Do racial differences in cardiac procedure rates persist after matching for hospital of admission and adjusting for age, insurance, in-hospital mortality, and hospital transfer rates?

**Research design:** Retrospective cohort study

**Study population:** Patients over the age of 35 who were discharged from the hospital with a primary diagnosis of AMI between 1988-1990 and registered in the National Hospital Discharge Survey (NHDS).

- 12,837 eligible

- Excluded if persons likely had MI ruled out and persons who race was reported as neither black nor white.

- 10,348 patients included in study (5503 white men, 581 black men, 3786 white women, 478 black women).

**Identification of race/ethnicity:** Measured using NHDS data.

**Identification of AMI:** Measured using ICD-9 CM codes from NHDS data.

**Initial comparability of groups:** Black men, black women, white men, and white women differed according to age (64, 68, 66, and 68 years), private insurance of Blue Cross (36.9%, 18.0%, 36.4%, 17.3%), Medicare (51.4%, 64.7%, 58.2%, 77.7%), Medicaid or no insurance (11.7%, 17.4%, 5.5%, 5.0%), percent admitted to proprietary hospital (7.0%, 5.0%, 10.3%, 11.3%), percent admitted to government hospital (20.2%, 15.5%, 9.6%, 11.1%), percent admitted to non-profit hospital (72.8%, 79.4%, 80.1%, 77.6%), and region where care received: Northeast (20.5%, 18.7%, 26.1%, 30.2%), Midwest (12.1%, 18.4%, 26.9%, 25.6%), South (46.1%, 44.3%, 35.3%, 32.9%), and West (21.3%, 18.6%, 11.6%, 11.3%).
**Drop Outs / Loss to Follow Up:** N/A

**Potential for selection bias:** Black and white patients differed according to age, type of health insurance, and region of care. These differences were controlled for with regression models during analysis. No comorbidity or MI severity variables were measured for, compared between groups, or controlled for during analysis.

**Measurement of intervention:** Measured cardiac procedures using ICD-9 CM codes from NHDS data.

**Measurement of outcomes:** Measured using discharge data from the NHDS. No other information source is indicated.

**Potential for measurement bias:** There is no information on the reliability or validity of using the NHDS as a data source to measure patient variables, procedure utilization, or mortality. It is unclear how valid and reliable the determination of race was within the study, it is not clear if the data source reflected patient self reported or provider assigned identity.

**Potential confounders:** Potential confounders considered were age, sex, race, patient disposition at discharge, insurance status, hospital size, hospital type, and geographic region of care.

**Potential for confounding:** No systematic approach to the identification of potential confounders is described. Measured group variables are limited to patient age, sex, race, insurance status, and hospital size and type. There is no information regarding the comparisons of patient comorbidity or MI severity, and no adjustment is made for these variables during analysis. Measures of SES are limited to insurance status only, and SES differences may account for some of the differences seen according to race.
Analysis: Regression models were constructed to control for group differences. Matched analysis was also performed in which persons who underwent a cardiac procedure were matched with persons who were admitted to the same hospital but received no procedure. Separate matched analyses were undertaken for each cardiac procedure. Conditional logistic regression was used to calculate relative odds of having undergone PTCA or CABG for each race-sex group.

Results: White men had the highest age adjusted rates of PTCA (8.8%), followed by white women (8.0%), black women (4.8%) and black men (3.3%). White men had the highest age adjusted rates of CABG (11.2%), followed by black men (6.7%), white women (6.7%), and black women (3.6%). Black women had the highest age adjusted in-hospital mortality (16.1%), followed by white women (15.7%), white men (14.6%), and black men (12.4%).

Adjusted Odds Ratios for Invasive Cardiac Procedures:

PTCA: White men (OR 1.0); black men (OR 0.35 95% CI 0.21-0.58), white women (OR 0.94 95% CI 0.72-1.24), black women (OR 0.45 95% CI 0.19-1.03).

CABG: White men (OR 1.0), black men (OR 0.50 95% CI 0.33-0.77), white women (0.54 95% CI 0.41-0.70), black women (0.26 95% CI 0.11-0.61).

Overall judgment of internal validity: The limited number of variables measured, compared, and controlled for between black and white patients increases the potential for selection bias and confounding. The potential for measurement bias would be lowered if more information was given regarding the validity and reliability of measurement tools used during the study.
**Overall judgment of external validity:** The study included a large national sample of patients from over 400 medical centers across the United States. The large national sample strengthens the generalizability of study findings.

**Overall conclusions/interpretations:** The study shows that women and blacks are less likely to receive invasive cardiac procedures. Black women had the highest in-hospital mortality, while black men had the lowest in-hospital mortality. The results of the study may be limited by potential selection bias and confounding. The study design provides high generalizability of results to other populations.


**Study Question:** Do racial discrepancies in the use of cardiac procedures exist according to availability at first hospitalization? Are there long term racial differences in outcomes?

**Research design:** Retrospective cohort study

**Study population:** Non-hispanic white and black patients age 30-99 discharged in 1993 with a primary diagnosis of AMI with zip code of residence in New Jersey registered in the Myocardial Infarction Data Acquisition System (MIDAS).

- Excluded: Non-medicare patients and patients with AMI as non-primary diagnosis.
- 13,690 met selection criteria (1217 blacks, 12,473 whites).

**Identification of race/ethnicity:** Identified using hospital discharge data.

**Identification of AMI:** Identified using ICD-9 CM codes from hospital discharge data.
Initial comparability of groups

Younger than 65 cohort: Blacks compared to whites were younger (53.6 vs. 54.6 years, p < 0.01), more likely to be female (40.6% vs. 24.7%, p < 0.01), more likely to be on Medicare (12.8% vs. 7.1%, p < 0.01), more likely to be on Medicaid (10.4% vs. 2.2%, p < 0.01), more often to self pay (20.3% vs. 10.1%, p < 0.01), had longer length of hospital stay (9.0 vs. 7.6 days, p < 0.01), lower 90 day readmission rates (34.6% vs. 67.5%, p < 0.01), had higher comorbidity scores (11.1 vs. 8.3, p < 0.01), less likely to have inferior infarct (30.9% vs. 40.8%, p < 0.01), more likely to have subendocardial infarct (33.8% vs. 25.8%, p < 0.01), more likely to present to hospital with catheterization available (52.2% vs. 46.1%, p < 0.01), and more likely to present to hospital with PTCA/CABG available (50.3% vs. 41.8%, p < 0.01).

Older than 65 cohort: Blacks compared to whites were younger (75.8 vs. 76.9 years, p < 0.01), more likely to be female (62.5% vs. 48.2%, p < 0.01), had longer length of hospital stay (12.0 vs. 10.3 days, p < 0.01), lower 90 day readmission (19.9% vs. 26.7%, p < 0.01), and more likely to present to hospitals with catheterization available (34.0% vs. 38.3%, p < 0.01).

Drop Outs / Loss to Follow Up: N/A

Potential for selection bias: Black and white comparison groups differed according to several measured variables. The groups were stratified according to age, and variable differences were controlled for using logistic regression models. Measured and accounted for variables included patient demographics, comorbidity, insurance type, and hospital care capabilities.

Measurement of intervention: Procedures were measured using ICD-9 CM codes available through hospital discharge data.

Measurement of outcomes: Mortality was measured using death certificates.
**Potential for measurement bias:** No information is provided regarding the validity and reliability of using hospital discharge data to identify race, it is unclear if this data uses self-designated or assigned classifications. Using discharge data alone to measure patient clinical information may also limit validity and reliability.

**Potential confounders:** Potential confounders considered were age, sex, insurance status, hospital stay, comorbidity, infarct location, and hospital cardiac care capability.

**Potential for confounding:** No systematic approach to identifying potential confounders is described. Measured potential confounders were controlled for by stratifying analysis by age and logistic regression models. Only insurance status was used as an SES indicator, it is possible that some of the racial differences observed in the study are due to SES differences. Specific information regarding disease severity was not available, and infarct location was used as proxy for severity. It is possible that disease severity varied between the groups, and this explained some of the differences observed.

**Analysis:** Chi-square tests and Wilcoxon rank sum tests were used to describe the distributions of variables and outcomes. Logistic regression models were constructed to control for potential confounding variables to study the use of cardiac procedures. Cox proportional hazards regression models were used to study 1 year mortality.

**Results:** Adjusted rates showed blacks were less likely to receive revascularization than whites in both the younger than 65 cohort (OR 0.63 95% CI 0.52-0.76) and the older than 65 cohort (0.69 95% CI 0.54-0.86). Adjusted 1-year mortality rates showed no statistically significant difference between blacks and whites for the younger than 65 cohort (RR 0.85 95% CI 0.66-1.09) or the older than 65 cohort (RR 1.03 95% CI 0.89-1.19).
**Overall judgment of internal validity:** Study design and statistical analysis help limit the overall potential for bias affecting study results. The unknown validity and reliability of some measurement tools used, as well as a remaining potential for confounding caused by single proxy measures for disease severity and SES may limit internal validity.

**Overall judgment of external validity:** The study examined patients from a single geographic location, this significantly lowers the generalizability of findings.

**Overall conclusions/interpretations:** Blacks were shown to receive revascularization procedures less often than whites after presenting with AMI. Despite this difference, there was no statistically significant difference in 1-year mortality. Study design and statistical analysis help limit the effects of bias within this study, but generalizability of findings is limited.


**Study Question:** Are there sex and racial/ethnic disparities in prognosis after AMI across men and women in the 4 main ethnic groups (white, black, Hispanic, Asian)? To what extent are these disparities explained by differences in socioeconomic background, personal medical history, and medical management?

**Research design:** Prospective cohort study

**Study population:** Patients age 30-85 years who were discharged from northern California hospitals after being hospitalized for AMI between 1995-2002.

- 33,637 patients eligible
- 86 excluded because hospital discharge was after Dec. 31, 2002
- 380 excluded because no health care plan information available after index event
- 2,025 excluded because no available information on sex or race/ethnicity
- 696 excluded because of absent or incomplete address
- 117 were excluded because residency was outside northern California.
- 9 were excluded because of missing census data.

Patients included in study: 30,324

**Identification of race/ethnicity:** Identified through research surveys (self-reported ethnicity used in 55% of cohort) and inpatient electronic records (assigned ethnicity).

**Identification of AMI:** Identified by using ICD-9 CM codes available through computerized medical services utilization data and claims data.

**Initial comparability of groups:**

**Male Sociodemographic:** Blacks compared to whites were younger (61 vs. 64 years), more likely to have commercial insurance (67% vs. 48%), less likely to receive Medicare (29% vs. 45%), less likely to self pay (2% vs. 6%), less likely to be married (48% vs. 54%), had lower annual household incomes ($51,886 vs. $60,373), had a higher percentage of households below the poverty line (12% vs. 9%), lower rate of completed college or high school education (25% vs. 31%), and a higher rate of working class occupations (64% vs. 58%). All differences were statistically significant (p < 0.001).

**Male Clinical Characteristics:** Blacks compared to whites were more likely to have coronary heart disease (23% vs. 2%, p <0.001), higher rates of HTN (60% vs. 40%, p < 0.001), higher rates of diabetes mellitus (35% vs. 24%, p < 0.001), higher rates of depression (27% vs. 23%, p < 0.001), higher rates of stroke history (9% vs. 5%, p < 0.001), and higher rates of heart failure (9% vs. 5%, p < 0.001)
**Female Sociodemographic:** Blacks compared to whites were younger (64 vs. 69 years), more likely to have commercial insurance (52% vs. 32%), less likely to receive Medicare (41% vs. 63%), less likely to self pay (2% vs. 5%), less likely to be married (46% vs. 54%), had lower annual household incomes ($47,865 vs. $59,388), had a higher percentage of households below the poverty line (14% vs. 8%), lower rate of completed college or high school education (22% vs. 30%), and a higher rate of working class occupations (66% vs. 58%). All differences were statistically significant (p < 0.001).

**Female Clinical Characteristics:** Blacks compared to whites were more likely to have coronary heart disease (25% vs. 18%, p < 0.001), higher rates of HTN (71% vs. 55%, p < 0.001), higher rates of diabetes mellitus (42% vs. 29%, p < 0.001), higher rates of depression (35% vs. 34%, p < 0.001), higher rates of stroke history (9% vs. 5%, p = 0.003), higher rates of asthma (17% vs. 15%, p = 0.03), and higher rates of heart failure (15% vs. 8%, p < 0.001).

**Drop Outs / Loss to Follow Up:** None reported

**Potential for selection bias:** Black and white comparison groups differed according to several demographic, clinical, and socioeconomic variables. Regression models were used to adjust for these differences during final analysis. No hospital characteristic information is provided. All 16 hospitals included in the study are under the control of Kaiser Permanente, however, it is not made explicitly clear that all hospitals in the system are of similar care capability, and thus access to quality of care may have differed between groups. No participants appear to have been lost during follow up.
**Measurement of intervention:** Procedures measured using ICD-9 CM codes available through inpatient databases of hospitalizations occurring at any of the 16 KRMCP hospitals in northern California and out of plan hospitalizations using automated databases of claims.

**Measurement of outcomes:** Mortality measured using the California Automated Mortality Linkage System.

**Potential for measurement bias:** Race was measured using self-reported data along with the use of validated inpatient medical records (shown to have approximately 95% agreement with self-reported data in previous studies). Medical history data was measured using hospital discharge data, the validity and reliability of using discharge data alone to identify medical variables is not reported. Mortality was measured using the California Automated Mortality Linkage system, which has been shown to have a sensitivity of 97% compared with the National Death Index. SES indicators were measured using block census data, and may not accurately represent the cohort itself. It is unclear if chart data was reviewed by independent reviewers, and if researchers were masked to patient identity and race during the study.

**Potential confounders:** Several potential confounders were addressed within the study including age, sex, comorbidities, SES status, and treatment differences.

**Potential for confounding:** No systematic process to identify potential confounders is described. Several demographic and clinical variables were measured and adjusted for using regression models. Specific measures of disease severity were not included in the study. It is possible that the groups differed in disease severity, and this explained some of the observed differences in treatment and outcomes observed between groups. No hospital specific measures are provided, and it is possible that the comparison groups differed in their access to quality care during their index AMI admission.
**Analysis:** Bivariate analysis was performed using analysis of variance, Kruskall-Wallis nonparametric analysis of variance, and chi-square tests. A series of 3 proportional hazards regression models was used to model the association between joint categories of sex and race/ethnicity and hazard of AMI and all cause mortality.

**Results:** Black men received revascularization procedures less often than white men (49% vs. 63%, p<0.001). Black women received revascularization procedures less often than white women (41% vs. 48%, p < 0.001). Age adjusted risk of all-cause mortality was higher in black men (HR 1.55 95% CI 1.37-1.75) and black women (HR 1.45 95% CI 1.27-1.66) compared to white men. Age adjusted mortality rate/100 person years for males adjusted for age, insurance, sociodemographic factors was HR 1.34 (95% CI 1.18-1.52) and was HR 1.22 (95% CI 1.06-1.40) for females. After adjusting for patient demographic information, clinical variables, and treatment black men (HR 1.02 95% CI 0.90-1.15) and black women (HR 0.82 95% CI 0.71-0.94) did not have significantly higher all cause mortality rates compared to white men.

**Overall judgment of internal validity:** Study design and statistical analysis decreases the potential for bias to affect the internal validity of this study. A more complete comparison of disease severity between groups would further limit the potential for selection bias and confounding.

**Overall judgment of external validity:** External validity is strengthened by the use a large racially diverse population. External validity is limited by the use of treatment centers and patient populations solely located in northern California. A broader geographic representation would improve the external validity of the study.
Overall conclusions/interpretations: The study shows that black men and women are less likely than white men to receive revascularization procedures after AMI. Black men and black women had higher age adjusted all-cause mortality rates compared to white men, however, no statistically significant difference remained after controlling for patient factors, SES, and clinical variables.


Research design: Retrospective cohort study

Study population: Patients diagnosed with cardiogenic shock as the result of left ventricular failure that complicated AMI from 36 registry centers across the United States from 1993-1997 from the SHould We emergently revascularize Occluded Coronaries for cardiogenic shock (SHOCK) registry.

- Total patients included: 538 (440 white, 34 black)

Identification of race/ethnicity: Identified using information available through the SHOCK registry.

Identification of AMI: Identified using information available through the SHOCK registry.

Initial comparability of groups: Blacks compared to whites were younger (64.6 vs. 68.9 years, p = 0.001), had a higher rate of HTN (81.8% vs. 52.5%, p = 0.005), had longer median time from diagnosis of shock to PCI (4.6 vs. 2.7 hrs, p = 0.047), had higher diastolic blood pressure (57 vs. 53 mm Hg, p = 0.017), and higher median creatine kinase/ULN (11.6 vs. 9.3, p = 0.013).

Drop Outs / Loss to Follow Up: N/A
Potential for selection bias: Extensive comparisons are made between black and white patient groups according to medical history, disease severity, time to treatment, and presentation. Blacks compared to whites differed according to age, hypertension, time from shock diagnosis to PCI, diastolic blood pressure, and median creatine kinase levels. These differences were adjusted for during analysis. No comparisons were made between groups regarding hospital characteristics or SES. The small sample size (440 white and 34 black patients) may have been insufficient to detect all true differences between groups.

Measurement of intervention: Cardiac procedures measured using data from the SHOCK registry.

Measurement of outcomes: Mortality measured using data available from the SHOCK registry.

Potential for measurement bias: The process of compiling chart data for the SHOCK registry is not described, but available literature is cited. The cited literature along with this publication does not describe the reliability and validity of measures for race, patient and clinical variables, treatments, and mortality. It is unclear if chart reviewers were masked to patient identity, race, or outcome during the review.

Potential confounders: Potential confounders considered were age, sex, smoking status, medical history/comorbidity, time to treatment, and admission vitals/cardiac laboratories.

Potential for confounding: No systematic approach to identifying potential confounders is described. Regression models were used to control for measured group differences. Admission hospital characteristics and differences in SES were not measured or controlled for, and may account for some of the differences observed between the black and white patient groups.
**Analysis:** Comparisons across race and categorical variables were conducted using Fisher’s exact test. Comparisons between race and continuous variables were made using the nonparametric Kruskal-Wallis test. Multivariate modeling was conducted using logistic regression to compare race as an independent predictor of in-hospital mortality.

**Results:** Blacks diagnosed with left ventricular heart failure following AMI were less likely to receive any form of coronary revascularization (44.1% vs. 45.9%, p = 0.005) and less likely to receive coronary angioplasty (35.3% vs. 31.8%, p = 0.025) than whites. Adjusted in-hospital mortality rates showed black patients had higher mortality rates than white patients (OR 1.82 95% CI 0.84-3.94), though the difference was not statistically significant.

**Overall judgment of internal validity:** Internal validity may be limited by a potential for measurement bias caused by insufficient description of measurement tools and processes. Extensive group comparisons and large regression models help limit potential selection bias and confounding to affect internal validity.

**Overall judgment of external validity:** The study population was limited to patients with cardiogenic shock caused by left ventricular failure. The selection of this very specific patient population limits generalizability to other patient populations.

**Overall conclusions/interpretations:** The study results show that blacks compared to Whites diagnosed with cardiogenic shock caused by left ventricular failure that complicates AMI were less likely to receive any form of revascularization or coronary angioplasty. Differences in CABG alone were not statistically significant. Blacks compared to whites showed a trend toward higher adjusted in-hospital mortality rates, though the difference was not statistically significant. Potential for measurement bias may limit the accuracy of findings.

Study Question: Are there racial differences in the use of medications and invasive procedures for acute myocardial infarction in the VA health care system?

Research design: Retrospective cohort study

Study population: Males with a primary diagnosis of AMI discharged from acute care VA facilities between 1994-1995.

- 13,310 eligible patients
- Sampled patients from the 13,310 eligible stratified by hospital cardiac service capability.
- Stratified selected sample included 5503 patients.
- 94.4% of those selected had available records.
- Patients were excluded if they did not meet clinical criteria for AMI, were discharged to an acute care non-VA facility, or had incomplete chart information.
- Study population included 4760 patients (4,005 white, 606 black, 149 other)

Identification of race/ethnicity: Determined by using chart documentation in medical record.

Identification of AMI: Identified by International Classification of Diseases 9th revision of AMI and confirmed through chart review for necessary clinical criteria.

Initial comparability of groups: Blacks compared to whites were more likely to present to the hospital after the start of chest pain (34.4% vs. 27.7% for >12 hrs, p = 0.005), had a higher rate of CHF (21.4% vs. 15.4%, p <0.001), had lower rates of previous MI (29.4% vs. 35.5%, p = 0.003), had higher rates of HTN (75.2% vs. 58.6%, p <0.001), had lower rates of COPD (18.0% vs. 27.3%, p <0.001), higher rates of previous stroke (18.6% vs. 15.5%, p = 0.04), and had lower rates of previous CABG (7.8% vs. 18.4%, p <0.001).
Drop Outs / Loss to Follow Up: N/A

**Potential for selection bias:** Black and white patients differed according to time of presentation after onset of chest pain, prevalence of CHF, prior MI, HTN, COPD, history of stroke, and prior CABG. Logistic regression models were used to control for significant group differences. Other potential unknown and unaccounted for differences may exist between the groups that were not included in the analysis.

**Measurement of intervention:** Assessed use of angioplasty or CABG during index hospitalization as well as in the 90 days after the index admission in any VA facility or under Medicare financing using medical records.

**Measurement of outcomes:** Mortality was measured using the medical chart, inpatient discharge status from VA Patient Treatment File, the VA Beneficiary Identification and Record Location Subsystem, and the Medicare Denominator File.

**Potential for measurement bias:** Data abstraction of patient records by trained nurses showed a 96% agreement for collected clinical variables. No information is provided that indicates the reliability and validity of the chart based racial identification used for the study, it is unclear if identification was self-designated or assigned. Measurement of procedure utilization included both VA and Medicare records to account for veterans receiving procedures under Medicare funding. Four different sources were used to measure mortality (including VA and Medicare files), but no information is provided regarding the validity and reliability of any of the sources. It is unclear if chart reviewers were masked to patient identity and race while collecting data.

**Potential confounders:** Potential confounders considered were age, time to presentation after onset of chest pain, blood pressure, CHF, prior MI, HTN, DM, COPD, peripheral arterial
Potential for confounding: No systematic approach to the identification of potential confounders is described. Potential confounders identified in the study were controlled for by using regression models. Hospital variables were not directly measured, but the selection of patients was stratified according to hospital cardiac care capability. SES indicators were not measured. Male veterans were selected with the goal of limiting SES differences between patients.

Analysis: Chi-square and t-tests were used to examine differences between black and white patients. Logistic regression was used to calculate the risk adjusted odds of mortality for blacks compared to whites.

Results: Blacks did not receive PTCA significantly less often than whites during index hospitalization (12.5% vs. 11.6%, p = 0.51) or within 90 days of index admission (15.4% vs. 15.4%, p = 0.96). Blacks did receive CABG less often than whites during the index hospitalization (3.6% vs. 7.0%, p <0.01) and within 90 days of index admission (6.9% vs. 12.5%, p <0.001). Blacks were slightly less likely to receive any revascularization during the index admission, though this difference did not achieve statistical significance (15.2% vs. 18.2%, p = 0.07). Blacks were less likely to receive revascularization than whites within 90 days of index admission (20.8% vs. 26.9%, p = 0.001). Crude 30 day mortality (13.1% vs. 12.4%, p = 0.61), 1 year mortality (23.3% vs. 23.8%, p = 0.76), and 3 year mortality (37.7% vs. 36.8%, p = 0.68) did not show statistically significant difference between black and white patients respectively. After adjusting for age, hospital type, comorbidity, prior angioplasty, and complications, 30 day mortality (OR 0.99 95% CI 0.74-1.3), 1 year mortality (OR 0.86 95% CI
0.68-1.09), and 3 year mortality (0.93 95% CI 0.76-1.15) for blacks compared to whites remained similar.

**Overall judgment of internal validity:** The described study design and analysis significantly lowers the potential for bias to compromise internal validity of the study. Further reporting on the validity and reliability of measurement tools, a more extensive comparison of groups according to clinical factors, and larger regression models would strengthen the findings.

**Overall judgment of external validity:** External validity is strengthened by the fact that the study used a national sample of patients from 81 veteran hospitals across the US of varying cardiac care capabilities. External validity may be limited because the study only included male veterans.

**Overall conclusions/interpretations:** Blacks were shown to receive CABG less often than whites, but received PTCA at similar rates. Despite differences in procedure utilization, there were no significant differences in 30 day, 1 year, and 3 year mortality. Improved reporting on the validity and reliability of measurement tools and the assessment of SES as a potential confounder would strengthen findings.

10. **Citation:** Peterson E, Wright S, Daley J, Thibault G. Racial variation in cardiac procedure use and survival following acute myocardial infarction in the Department of Veterans Affairs. JAMA. 1994; 271: 1175-1180.

**Study Question:** Are blacks admitted to Veterans Affairs Medical Centers with acute myocardial infarction less likely than whites to undergo cardiac catheterization and revascularization procedures? If differences exist, how do they impact patient survival?
**Research design:** Retrospective cohort study

**Study population:** Male veterans discharged from Veteran Affairs Medical Centers (VAMC) with a primary or secondary diagnosis of AMI between 1988-1990.

51,585 eligible patients.

- Excluded if Hispanic/white, Hispanic/black, Native American, or Asian/Pacific Islander (2426 patients).

- Excluded if first surgical procedure during hospitalization was not for cardiac surgery, cardiac catheterization, PTCA, or minor cardiac procedures (2838 patients).

- Excluded if had a diagnosis of AMI and a length of stay less than 5 days and discharged alive ("rule out AMI’s") (5863 patients).

- Excluded if previous AMI within 365 days (4459 patients).

- Excluded if PTCA, CABG, or cardiac catheterization within 90 days prior to admission for AMI (1099 patients)

- Excluded patients with lengths of stay greater than 180 days (261 patients).

- Excluded patients with a recent AMI admitted for subsequent care within 8 weeks of the acute episode (994 patients).

33,641 patients included (29,119 white, 4522 black).

**Identification of race/ethnicity:** Identified using patient data from the Veterans Health Administration Patient Treatment File database.

**Identification of AMI:** Identified using ICD-9-CM codes available from Veterans Health Administration Patient Treatment File database.
**Initial comparability of groups:** Blacks compared to whites were younger (63.0 vs. 64.4 years, \( p < 0.05 \)), had fewer cardiac complications (58.6% vs. 53.4%, \( p < 0.05 \)), were less likely to present to a hospital without a cardiac catheterization laboratory (20.0% vs. 36.5%, \( p < 0.05 \)), and more likely to present to a hospital with a cardiac catheterization laboratory and cardiac surgery program (52.4% vs. 44.6%, \( p < 0.05 \)).

**Drop Outs / Loss to Follow Up:** N/A

**Potential for selection bias:** Black and white comparison groups differed according to cardiac complications and hospital characteristics of index admission. Regression models were constructed to adjust for these differences during analysis. Comorbidity comparisons are limited to number of secondary diagnoses, it is possible that the groups differ significantly according to individual comorbidity status. No SES indicators are compared between groups. Participants are all veterans with likely comparable health and economic benefits, but differences in supplemental insurance, income, education, etc. may still exist between groups. Characteristics of admitting hospitals are compared and controlled for during analysis.

**Measurement of intervention:** Cardiac procedures measured using ICD-9-CM codes available through the Veterans Health Administration Patient Treatment File database.

**Measurement of outcomes:** Mortality measured using the Beneficiary Identification and Record Locator System.

**Potential for measurement bias:** The validity and reliability of using veteran treatment files to measure race is not reported, it is unclear if information collected reflects self-designated or provider assigned race. The validity and reliability of using this database to measure patient, clinical, and procedural variables is also not reported. Researchers did perform a random full medical chart review of 1000 patients to compare database AMI diagnosis with cardiac enzyme
and electrocardiogram confirmation from medical records. The diagnosis of AMI was clinically confirmed in 88% of cases. The Beneficiary Identification and Record Locator System used to measure mortality is reported to have 98% concordance with Medicare’s Health Skeletonized Eligibility Writeoff data in more than 98% of cases. It is unclear if chart reviewers were masked to patient identity and race.

**Potential confounders:** Potential confounders included were age, cardiac complications, secondary diagnoses, year of AMI, hospitalized within previous year, and characteristics of index hospital of admission.

**Potential for confounding:** No systematic approach to identifying potential confounders is described. The comorbidity data provided only includes number of secondary diagnoses. It is possible that patients may have the same number of secondary diagnoses but differ in prognosis based upon the specific collection of diagnoses themselves. Both primary and secondary AMI diagnoses were included in this study. It is possible that outcomes attributed to AMI in patients with a secondary diagnosis of AMI were more associated with their respective primary diagnosis. It is unclear if black and white patients differed in the proportion of patients diagnosed with primary and secondary AMI. No specific SES indicators are measured or controlled for. Veterans were selected specifically to limit differences in access to quality care, however, SES differences may still exist between black and white veterans that may explain some of the racial differences in treatments and outcomes.

**Analysis:** Chi-square and t-tests were used to analyze the relationship between patient and hospital characteristics to race. Logistic regression models were constructed to determine the effect of race on the use of cardiac procedures. Likelihood ratios for the effect of race on 30-day, 1-year, and 2-year survival were calculated.
Results

Unadjusted procedure rates and morality: Blacks compared to whites received PTCA (4.2% vs. 6.2%, p<0.0001) and CABG (5.1% vs. 9.6%, p < 0.0001) less often. Blacks received any form of revascularization less often than whites (9.0% vs. 15.3%, p < 0.0001). Blacks had higher 30 day (OR 1.21 95% CI 1.11-1.21), 1 year (OR 1.11 95% CI 1.04-1.19), and 2 year (1.05 95% CI 0.99-1.12) survival compared to whites.

Adjusted procedure rates and mortality: Blacks compared to whites received PTCA (OR 0.58 95% CI 0.48-0.66) and CABG (0.46 95% CI 0.40-0.53) less often than whites. Blacks received any form of revascularization less often than whites (OR 0.46 95% CI 0.41-0.52). Blacks had higher 30 day (OR 1.18 95% CI 1.07-1.31), 1 year (OR 1.07 95% CI 0.99-1.16), and 2 year (OR 1.01 95% CI 0.92-1.07) compared to whites, though 1 and 2 year survival differences did not achieve statistical significance. Model adjusted for age, cardiac complications, number of secondary diagnoses, hospitalization in the previous year, characteristics of index hospital, and year of discharge.

Overall judgment of internal validity: Study design and analysis help limit the effects of bias within this study. Potential unmeasured differences in comorbidity status and SES between black and white patient groups may confound results and decrease internal validity.

Overall judgment of external validity: External validity is strengthened by the large study population from VA medical facilities across the United States. The study population consisted of only males, and results may not be generalizable to female patients.

Overall conclusions/interpretations: The study results indicate blacks receive revascularization procedures after AMI less often than whites. Blacks compared to whites have better 30 day survival after AMI, but no differences in survival are seen at 1 and 2 years. Study results may be
limited by unmeasured potential differences in comorbidity and socioeconomic status between blacks and whites.


Study Question: Do black and white patient AMI populations differ according to baseline and clinical features, AMI treatment, and outcome?

Research design: Prospective cohort study

Study population: Patients admitted to coronary care units for chest pain in 19 hospitals in metropolitan Seattle between 1988-1990 contained within the Myocardial Infarction Triage and Intervention (MITI) registry database.

- 14,283 total patients admitted for chest pain
- 1749 excluded because of missing race data or race other than black or white.
- Of the remaining 12,534 patients, 2,870 patients were diagnosed with AMI.
- AMI cohort included 2,870 patients (2749 white and 121 black)

Identification of race/ethnicity: Identified through medical chart data.

Identification of AMI: Identified through hospital discharge data.

Initial comparability of groups: Blacks compared to whites were younger (59 vs. 67 years, p<0.0001), more likely to be admitted to Central City Hospital (69% vs. 33%, p<0.0001), and more likely to have HTN (67% vs. 46%, p<0.0001).

Drop Outs / Loss to Follow Up: None reported
Potential for selection bias: Black and white patients differed according to age, admission to Central City Hospital, and HTN. No group comparisons are made according hospital characteristics or SES. Minimal comorbidity and risk factor comparisons are made, most notably the prevalence of diabetes and smoking status is not compared between the groups.

Measurement of intervention: Cardiac procedures were measured using patient hospital records.

Measurement of outcomes: Mortality was measured using patient hospital records.

Potential for measurement bias: Little information is provided on the details of the data collection process used for the study. It is unclear how comprehensive the review process was. The reliability and validity of information sources is not described. The validity and reliability of measures for race, cardiac procedures, and mortality is not described.

Potential confounders: Potential confounders considered were age, sex, admission to Central City Hospital, medical history, admission symptoms, and time to treatment.

Potential for confounding: No systematic approach to identifying potential confounders is described. No differences in hospital characteristics or SES status is measured or adjusted for during analysis. Comorbidity and risk factor comparisons are limited. Logistic regression models were used to control for measured differences.

Analysis: Chi-square tests and t-tests were used to test for differences between race and measured variables. Multiple stepwise logistic regression was used to determine whether race was associated with mortality for AMI.

Results: Blacks compared to whites received angioplasty (12% vs. 18%, p = 0.026) and coronary artery surgery (5% vs. 10%, p = 0.042) less often. Hospital mortality was 7.4% for black and 13.1% for white patients (p = 0.07).
**Overall judgment of internal validity:** Internal validity is severely limited by potential selection, measurement, and confounding biases. More detailed group comparisons and more in depth reporting of measurement tools and processes may strengthen the internal validity of results.

**Overall judgment of external validity:** The study is limited to 19 hospitals in Seattle, WA and therefore has limited generalizability to other regions of the United States with varying patient and medical characteristics.

**Overall conclusions/interpretations:** The study results show that blacks receive angioplasty and coronary artery surgery less often than whites. Despite this difference in treatment, blacks have lower hospital mortality than whites. Study findings are severely limited by potential selection, measurement, and confounding bias.


**Study Question:** Does the less intensive use of revascularization procedures influence the long-term survival of black patients who were hospitalized for AMI in metropolitan Seattle.

**Research design:** Retrospective cohort study

**Study population:** Patients admitted to coronary care units in 19 hospitals in metropolitan Seattle with discharge diagnosis of AMI between 1988-1994 contained within the Myocardial Infarction Triage and Intervention (MITI) registry database.

- Patients who had cardiac arrest at admission were excluded.

- Patients who had AMI develop while hospitalized for another medical condition were excluded.
- Non-black and non-white patients were excluded.
- Study included 420 blacks, 10,834 whites.

**Identification of race/ethnicity:** As indicated in the MITI registry

**Identification of AMI:** As indicated in the MITI registry

**Initial comparability of groups:** Blacks compared to whites were younger (60 vs. 66 years, p<0.0001), less educated (22% vs 13% non-high school graduates; 29% vs 36% college graduates, p <0.0001), had lower household income (27.9 thousand vs. 38.2 thousand, p <0.0001), more likely to be unemployed (6% vs. 3%, p <0.0001), more likely to be on Medicaid (13% vs. 3%, p<0.0001), more likely to have HTN (67% vs. 46%, p < 0.0001), more likely to have DM (36% vs. 19%, p < 0.0001), and less likely to have had previous bypass surgery (6% vs. 10%, p = 0.004).

**Drop Outs / Loss to Follow Up:** N/A

**Potential for selection bias:** Black and white patients differed according to age, education, SES indicators, HTN, diabetes and history of previous heart surgery. Regression models were constructed to control for significant differences in patient variables. Other potential unknown and unaccounted for differences may exist between the groups that were not included in the analysis.

**Measurement of intervention:** Procedures measured using the MITI registry during index case, rehospitalization procedures identified using International Classification of Diseases version 9 diagnosis and procedure codes from the Washington hospital discharge abstract program.

**Measurement of outcomes:** Mortality measured using MITI registry, the National Death Index, and state of Washington death certificates.
Potential for measurement bias: No information is provided regarding the validity and reliability of using the MITI registry to measure patient and clinical variables or using the National Death Index and Washington state death records to measure post-hospitalization mortality. No information is provided regarding the validity and reliability of the chart based racial classification used during the study, it is unclear if race/ethnic identification was self-designated or assigned. It is unclear if researchers were masked to patient identity and race while performing the study.

Potential confounders: Potential confounders considered were age, sex, SES aggregate indicators, insurance, comorbidities, and smoking status.

Potential for confounding: No systematic approach to the identification of potential confounders is described; those identified are statistically adjusted for using regression models. The reliability and validity of using the MITI registry to measure potential confounders is unknown. SES indicators were developed from aggregate US census data and described census blocks in which patients lived. It is possible that the SES variables do not appropriately reflect the true status of patients enrolled in the study. Hospital characteristics were limited to either “central city” or “suburban” classification, no further indications of treatment capability or quality of care is included in the analysis.

Analysis: Racial differences in procedure use and mortality were adjusted for age and compared with logistic regression models. The log rank statistic was used to determine if survival differed between blacks and whites, and Kaplan Meier survival curves were constructed. Stepwise Cox regression analysis was used for all patients to determine if race was an independent predictor of survival. Statistically significant predictors were entered into the model, and race or revascularization procedures were forced into the model to determine association with survival.
Results:

Hospital Treatment and Outcomes: Blacks received angioplasty (18% vs. 26%, p = 0.0004) and CABG (7% vs 12%, p = 0.002) less often than whites. Overall 22% of blacks had a revascularization procedure compared to 33% of whites (p <0.0001). After controlling for use of cardiac catheterization, percent professionals in the census block, prior coronary surgery, history of angina, the use of thrombolytic therapy, sex, and history of CHF, blacks were less likely to undergo revascularization (OR 0.60 95% CI 0.45-0.81). Hospital mortality was slightly lower in blacks (OR 0.71 95% CI 0.50-1.04), though age adjusted hospital mortality showed no difference between the groups (OR 1.05 95% CI 0.72-1.54).

Long-term survival: Unadjusted 2 year survival was 79% for blacks and 77% for whites (p = 0.12). After controlling for all statistically significant variables except revascularization, there was no significant association between race and survival (Hazard Ratio 1.17 95% CI 0.94-1.45).

Overall judgment of internal validity: The potential for selection bias limits the internal validity of the study. Data comparing the actual group participants in the study are limited to age and comorbidities. Comparative SES measures including insurance and education were derived from census block data, and may not accurately reflect participants. Findings would be strengthened if more information was provided regarding the validity and reliability of all measurements. The statistical power of the study to detect survival difference regarding race and revascularization is also limited due to a lower number of black participants.

Overall judgment of external validity: Only patients from hospitals surrounding Seattle, Washington were selected. Geographic differences in disease and treatment may limit the
The generalizability of the results. The inclusion of patients from a broader sample of treatment areas would increase the external validity of the study.

**Overall conclusions/interpretations:** Blacks were significantly less likely than whites to receive PTCA or CABG after AMI. Despite these differences in treatment, no significant differences were observed in either short-term or long-term mortality. Study results may be limited by a potential for selection bias created by limited group comparative data.

13. **Citation:** Mickelson J, Blum C, Geraci J. Acute myocardial infarction: Clinical characteristics, management and outcome in a metropolitan veterans affairs medical center teaching hospital. Journal of the American College of Cardiology. 1997; 29: 915-925.

**Study Question:** Do race and age influence the use of thrombolytic therapy, invasive cardiac procedures, and subsequent outcomes in a Veterans Affairs teaching hospital?

**Research design:** Retrospective cohort study

**Study population:** Patients admitted to Houston Veterans Affairs Medical Center between 1993-1995 diagnosed with AMI.

- 353 patients were included in the study (232 white, 84 black, and 37 Hispanic).

**Identification of race/ethnicity:** Identification made by medical chart data.

**Identification of AMI:** Identified by chart review for clinical presentation, cardiac enzymes, and EKG changes.

**Initial comparability of groups:** Black and white patients were significantly different only according to COPD comorbidity (whites 20.7% vs. blacks 4.8%, p = 0.001) and aspirin prescription (20.7% vs. 88%, p <0.05). Patient age, cardiac enzyme, MI location,
revascularization, and other medical comorbidities and treatments were not significantly different between the groups.

Drop Outs / Loss to Follow Up: N/A

Potential for selection bias: The lack of comparative differences between the black and white comparison groups may suggest insufficient power to detect statistically significant differences between groups. Several studies have shown that blacks presenting with AMI tend to be younger, receive revascularization procedures less often, and also have higher rates of HTN and diabetes than white patients. The fact that none of these common differences were observed in this study, along with a study population of only 353 patients, may suggest insufficient group size to detect difference.

Measurement of intervention: Measured by medical record review.

Measurement of outcomes: Hospital survival was measured using medical records. The means of measuring post-hospitalization mortality is not specified.

Potential for measurement bias: Patient presentation variables were collected directly from medical charts. Comorbid information was collected from the Veterans Affairs Treatment File database, the validity and reliability of using this database to measure comorbidities is not described. Means of racial identification are unclear. The measurement tools to assess post-hospitalization mortality are unclear. It is unclear if chart reviewers were aware of patient identity or race during the study.

Potential confounders: Potential confounders considered were age, cardiac enzymes, MI location, procedure, medication management, and medical comorbidities.

Potential for confounding: No systematic approach to the identification of potential confounders is described. Potential confounders used may be inappropriately compared between
the groups due to insufficient sample sizes to detect valid differences. Logistic regression was used to control for significant variables identified. There were no measures of SES, and no controls for SES within the regression models. Some of the differences based on race may be explained by differences in SES.

**Analysis:** Logistic regression was used to determine the relation between patient characteristics and mortality. Model construction was performed using a hierarchic approach; age and race were included in all models, and individual comorbid conditions were examined if they were univariately associated with mortality.

**Results:** Blacks did not receive PTCA (17% vs. 23.3%) or CABG (7.1% vs. 10.3%) at rates significantly different from whites. In-hospital (14.3% vs. 10.3%) and 22-month mortality (30.9% vs. 23.3%) also showed no statistically significant differences between blacks and whites respectively.

**Overall judgment of internal validity:** The internal validity of the study is significantly threatened by potential selection bias and confounding as described above.

**Overall judgment of external validity:** The external validity of the study is significantly threatened by a small study population from a single hospital.

**Overall conclusions/interpretations:** The study shows no statistically significant difference in revascularization procedures or mortality between black and white patients diagnosed with AMI. The findings are severely limited based on a strong potential for selection bias and confounding.

Study Question: Do black patients presenting with acute myocardial infarction experience differences in treatment and in-hospital mortality?

Research design: Retrospective cohort study

Study population: Black and white patients diagnosed with AMI and enrolled in the National Registry of Myocardial Infarction 2 (NRMI 2) between 1994-1996.
- Non-black minorities or those of unknown racial background were excluded.
- 275,046 selected for study (236,166 white, 17,141 black).

Identification of race/ethnicity: Specific means of race identification is unclear.

Identification of AMI: Identified using predetermined cardiac enzyme changes, EKG changes, and ICD-9 CM coding.

Initial comparability of groups:

Demographic Information: Blacks compared to whites were younger (63 vs. 67 years, p < 0.001), more likely to be female (46% vs. 37%, p < 0.001), less likely to have commercial insurance (19% vs. 24%, p < 0.001), more likely to be on Medicaid (8% vs. 2%, p < 0.001), more likely to be uninsured (9% vs. 5%, p < 0.001), more likely to have history of CHF (15% vs. 12%, p < 0.001), more likely to have diabetes (34% vs. 24%, p < 0.001), more likely to have HTN (68% vs. 48%, p < 0.001), more likely to be current smokers (32% vs. 28%, p < 0.001), less likely to have history of high cholesterol (19% vs. 24%, p < 0.001), and less likely to have a family history of coronary artery disease (23% vs. 31%, p < 0.001).

Presenting characteristics: Blacks compared to whites were less likely to present with chest pain (72% vs. 76%, p < 0.001), had higher initial systolic blood pressure (148 vs. 142, p < 0.001), less likely to have ST-segment elevation (40% vs. 46%, p < 0.001), more
likely to have non-specific EKG changes (37% vs. 31%, p < 0.001), less likely to have Q-wave infarction (46% vs. 54%, p < 0.001), more likely to have non-Q wave infarction (54% vs. 46%, p < 0.001), and less likely to have an admission diagnosis of MI (40% vs. 48%, p < 0.001).

**Hospital characteristics:** Blacks were more likely to present to large hospitals that were more likely to have on site coronary angioplasty and CABG compared to whites. (As stated in text, actual rates not provided in text or tables).

**Drop Outs / Loss to Follow Up:** N/A

**Potential for selection bias:** Black and white patients differed according to several demographic and presenting characteristics as described above. Significant differences were controlled for with regression models. No specific information is given regarding differences in the characteristics of admitting hospitals, although multivariate analysis claims to account for “hospital characteristics”. The exact hospital differences measured and adjusted for are unclear. Without this information it is unclear if group differences in hospital of care exist, and if this difference accounts for any differences in outcome.

**Measurement of intervention:** Measured using data from the NRMI2 registry.

**Measurement of outcomes:** Specific means of measuring mortality is unclear.

**Potential for measurement bias:** Several quality assurance mechanisms are described for the NRMI2 registry, but no specific information is provided regarding the validity, reliability, and completeness of medical information within this registry. The specific tools used to measure race for this study are unclear. The specific tools used to measure mortality for this study are unclear.
**Potential confounders:** Potential confounders considered were several patient variables including patient demographics, insurance status, cardiac risk factors, presentation, and laboratory findings.

**Potential for confounding:** No systematic approach to the identification of potential confounders is described, though a broad and extensive list of potential confounders are measured and adjusted for. The validity and reliability of using the NRMI2 to measure potential confounders is unknown. Hospital cardiac care capabilities were not reported, though they are indicated to be controlled for in regression models. The NRMI2 is a voluntary registry, and is not randomized sample of MI patients. Several unknown and unmeasured potential confounders may be associated with being in the registry.

**Analysis:** Chi-square tests, analysis of variance, non-parametric median tests, and Wilcoxon rank-sum tests were used to compare variables between groups. Multivariate logistic analyses was used to identify and control for variables predictive of utilizing invasive cardiac procedures and mortality.

**Results:** Blacks were found to receive primary angioplasty at lower rates compared to whites (OR 0.84 95% CI 0.79-0.89). Blacks were less likely to receive “non-primary” angioplasty (OR 0.83 95% CI 0.80-0.86) and CABG (OR 0.66 95% CI 0.63-0.68). Adjusted in-hospital mortality was not significantly different between black and white patients (as stated in results section, actual rates not provided in text or tables).

**Overall judgment of internal validity:** The internal validity of the study is severely threatened by a high potential for measurement bias. Complete information regarding the key measures of racial identity and mortality is not provided. Both of these measures are critical to the assessment
of racial differences in hospital mortality, one of the primary research questions of the paper.

Selection bias and confounding may also limit the internal validity of results.

**Overall judgment of external validity:** The NRMI2 is a large patient registry representing more than 1400 medical centers located in every state of the US. It is a voluntary registry, and therefore may represent patients who differ fundamentally than those not included in the registry. The NRMI2 also includes a disproportionate number of technologically advanced medical centers. The limitations may lower the generalizability of findings based on registry data.

**Overall conclusions/interpretations:** Blacks compared to whites presenting with AMI received primary angioplasty, non-primary angioplasty and CABG less often. In-hospital mortality was similar between the groups. Study results may be limited by a strong potential for measurement bias created by insufficient reporting of the key measures of race and mortality.